Louisiana Agritechnology Curriculum Guide
Version 1.0

Developed Spring 2020
Acknowledgements and Introduction:

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Introduction to the Agritech Curriculum

This curriculum guide was developed to assist teachers in delivering content that leads to the Agritech credential. The guide is designed as one complete guide, however as a teacher, you have the freedom to determine when content is taught within your program. On the next page we present a sample guide for completing this content in two years within the Agriculture I and Agriculture II courses additional blueprints are available for course planning as well. This may be an ideal guide for your program, or it may be spread out further under three years with the Addition of this content to an Agriculture III curriculum. This guide is also not intended to be the limit to what you can develop for your courses and we hope that you will supplement this guide with content that is most appropriate for your overall program.

In this first draft, we have tried to outline the curriculum in a very basic format. In future drafts we will be adding activities, content and laboratories for you to use while teaching.

We hope this guide is helpful and provides you with information that you need to help your students become Agritech credentialed in Louisiana!

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Recommended Teaching Schedules
Recommended schedules are developed from the Louisiana Agritechnology study guide which can be downloaded at: https://aest.app.box.com/s/aea63g0evpn897jvgacqni5mxa4s9d1f

AEST Recommended Teaching Schedule

**Year 1:**
Standard 4 – Standard 12

**Year 2:**
Standard 13 – Standard 22

**Year 3:**
Standard 26 – Standard 36

Suggested Teaching Schedule (2-year course plan)

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UNIT A: Introduction to Agriculture
Developed by Ms. Olivia Broussard and Ms. Janiece Pigg

STANDARDS:
LA-AGTECH: S4, S13, S21
AFNR: CS.02.01-02, CRP.06.02, CRP.11.01

Goal: Students should be familiar with the history of agriculture including but not limited to technological advancements and agriculture’s impact on the national and global economy.

Objective(s):
1. Recognize the major sciences contributing to the development, existence, and improvement of living things
2. Define agriculture and agriscience
3. Analyze the scope of agriculture, food, and natural resources and its effect upon society
4. Evaluate significant historical and current agriculture, food, and natural resources developments
5. Describe how emerging technologies and globalization impacts agriculture, food, and natural resources
6. Describe the agricultural industries impact on the U. S. gross national product and the total global economy
7. Identify and describe the function of U.S. government agencies involved in agriculture

Agritech Guiding Questions:
1. What metal revolutionized agriculture?
2. For every dollar spent on food, what percent of that dollar is returned to the producer?
3. For every dollar spent on food, what percent of that dollar goes to transportation?
4. What government agency oversees meat quality grading?
5. The average U.S. Farmer produces enough food to feed approximately how many people?

Content:
Scientific connections to Agricultural Sciences
1. Agriscience contains many endeavors including aquaculture, agricultural engineering, animal science technology, crop science, soil science, biotechnology, integrated pest management, organic foods, water resources, and environment.

2. Agriscience is really the application of many sciences including biology, chemistry, biochemistry, agronomy, animal sciences, agricultural economics, agricultural education, entomology, pathology, and environmental science.
Defining agriculture and agriscience
1. Agriscience is the application of scientific principles and new technologies to agriculture.

2. Agriculture is defined as the activities involved with the production of plants and animals and related supplies, services, mechanics, products, processing, and marketing.

Scope of Agriculture
1. Agriculture is defined as the activities concerned with the production of plants and animals, and related supplies, services, mechanics, products, processing and marketing.

2. USDA refers to Agriculture as “Agriculture/Agribusiness and renewable natural resources”

3. Another definition is food, fiber and environmental systems

Significant Historical Agricultural Developments
1. Mechanization through inventive engineering was an important factor in the United States’ agricultural development. The change from 90% to less than 2% of the workers being farmers evolved over a 200-year period.
   A. 1793 – Eli Whitney invented the cotton gin to transform cotton to a usable product by removing the cottonseed from the cotton fiber. This revolutionized the cotton industry by speeding up the process of removing seeds and husks from cotton fiber allowing farmers to get more usable product from their crops. Before this, separating cotton was labor intensive and expensive.

   B. 1834 – Cyrus McCormick invented the grain reaper to save labor in cutting wheat, oats, and similar crops. This made harvesting much easier and allowed farmers to harvest using less labor. Later, a threshing device was added to the grain reaper, and it became known as a combine. The combine is now often recognized as one of the most economically important labor-saving inventions in agriculture.

   C. Early 1800’s – Iron spurred inventions that revolutionized agriculture in the United States, British Isles, and northern Europe. Iron revolutionized agriculture by allowing for the development of tools that were stronger and were able to complete more difficult and demanding work.

   D. Early 1800’s – Charles Newbold invented the first iron plow, greatly improving the strength of plowing over the wooden plows that were easily broken. Thomas Jefferson later developed a version specially designed for hillside planting.
E. 1837 – John Deere improved the iron plow by inventing the steel moldboard plow, making plowing more efficient since the steel was less likely to break and did not get stuck and bogged down in the soil like previous wooden and iron plows. Steel allowed the farmer to work without having to manually remove soil every few feet.

F. 1850 – Edmund Quincy invented the corn picker, making corn harvesting faster and more economical.

G. 1878 – Anna Baldwin changed the dairy industry by inventing a milking machine to replace hand milking. This allowed cows to be milked more quickly with less labor.

H. 1904 – Benjamin Holt invented the tractor, which came to replace the mule as the source of power (horse power).

2. One of the most significant technologies to increase the efficiency of farm production was the generation and distribution of electricity to rural farming areas.

3. Beginning in the 1960’s improved high-yield crops were being developed all over the world. This time became known as the Green Revolution and allowed many countries to become self-sufficient in food production.

4. Mechanization of agriculture in the 20th century has substantially improved society and has allowed for food to become cheaper and more abundant.

5. The use of GPS (Global Positioning Systems) developed precision agriculture at the beginning of the 21st century allowing farmers to navigate to specific locations in the field, year after year, to collect soil samples or monitor crop conditions.

   A. GPS also allows pilots to work with farmers to develop accurate maps
      (i) When partnered with other technology can allow maps to be developed that show crop conditions such as disease, drought or soil conditions.

Emerging Technologies and Agriculture’s Impact on the Economy

1. The American Farmer produces enough food to feed 144 people

2. For every dollar spent on food, the American farmer receives approximately 8 cents.

3. In 2019, U.S. consumers, businesses, and government entities spent $1.77 trillion on food and beverages in grocery stores and other retailers and on away-from-home meals and snacks (USDA, ERS).

   A. For a typical dollar spent in 2018 by U.S. consumers on domestically produced food, including both grocery store and eating out purchases, 37.4 cents went to pay for services provided by foodservice establishments, 14.9
cents to food processors, 12.5 cents to food retailers and 3.5 cents goes to transportation.

4. Americans spend approximately 9.9% of their budgets on food compared to other countries that may spend up to half of their income on food.

5. The projection of the agricultural industry is for the average farm size in the United States to increase, while the number of farms decreases.

6. Agronomy uses biology and chemistry to discover new ways to control weeds in crops.

7. Agricultural engineering uses physics to develop new machinery.

8. New types of farming, such as aquaculture, will be used in addition to traditional farming methods.

9. Increased commercialization of agriculture will continue.

10. As the world’s population increases, it will require a highly sophisticated agriscience industry to provide the food, clothing, building materials, ornamental plants, recreation areas, and open-space needs for the world’s billions.

11. Americans will have to work more in the international arena, as more countries become highly competitive in agriscience and as trade barriers are removed.

12. Research and development will continue to play a dominant role as they lead the way in agriscience expansion in the future.

13. The future of U.S. agriculture will require that farmers become even more efficient in the production of food and fiber crops.

U.S. Governmental Agencies involved in Agriculture

1. The United States Department of Agriculture (USDA) is the U.S. federal department responsible for regulating farming, forestry, rural economic development, and our food supply. It works to meet the needs of farmers and ranchers, promotes agricultural trade and production, assures food safety, protects natural resources, develops rural communities and develop nutrition and food labeling programs.
   A. At the State level, these programs are run by the Louisiana Department of Agriculture and Forestry (LADAF)

2. The USDA manages several departments in different areas of agriculture to fulfill its overall mission
   A. Agricultural Marketing Service (AMS)
B. Agricultural Research Service (ARS)
C. Animal and Plant Health Inspection Service (APHIS)
D. Center for Nutrition Policy and Promotion (CNPP)
E. Economic Research Service (ERS)
F. Farm Service Agency (FSA)
G. Food and Nutrition Service (FNS)
H. Food Safety and Inspection Service (FSIS)
I. Foreign Agricultural Service (FAS)
J. Forest Service (FS)
K. National Agricultural Library (NAL)
L. National Agricultural Statistics Service (NASS)
M. National Institute of Food and Agriculture (NIFA)
N. Natural Resources Conservation Service (NRCS)
O. Risk Management Agency (RMA)
P. Rural Development (RD)
Q. Rural Utilities Service (RUS)
R. Rural Housing Service (RHS)
S. Rural Business-Cooperative Service (RBS)
UNIT B: Agricultural Careers
Developed by Ms. Janiece Pigg

STANDARDS:
LA-AGTECH S13, S22.1, S26
AFNR CRP.10.01-04

Goal: Students will be knowledgeable of the availability and classification of agricultural careers, as well as the appropriate methods of preparation to enter those careers.

Objective(s):
1. Describe career opportunities found within the agricultural industry
2. Identify statistics regarding agricultural employment in the U.S.
3. Compare the scope and types of career opportunities in different sectors of the agriculture industry
4. Evaluate learning activities at the secondary, post-secondary, and non-traditional level that will appropriately prepare individuals for agricultural careers
5. Identify the components of a basic job description
6. Identify the steps in applying and interviewing for an agricultural career
7. Identify the function and benefits of professional and trade organizations

Agritech Guiding Questions:
1. What jobs fall within the natural resources agricultural career area?
2. What percent of the workforce is employed in Agriculture?
3. Professional and trade organizations often provide what types of publications?
4. What is the most common cause for a job application to be eliminated from consideration?

Content:
Career Opportunities within the agricultural industry
1. American agriculture is the world’s largest commercial industry, with a wide variety of commodities and assets nearing $1 trillion.

2. Agricultural production is supported by a wide variety of careers ranging from agricultural production to packaging, transportation, marketing, and retail.

3. Approximately 21 million jobs or roughly 11% of total U.S. employment are in the agricultural industry.
   A. Career opportunities exist in all aspects of agriculture

4. There are about 400,000 open positions in agriculture each year, with only 100,000 being filled by people with training in agriculture or agriscience.
Types of Career Opportunities in Agriculture -

1. Production Agriculture – The heart of the agriculture industry. Jobs in this field are directly related to the growing and marketing of food crops and livestock.
   A. When most people think of agriculture, production jobs are what come to mind, however, they only make up about 20% of the people in the overall agriculture industry.
      (i) Example careers: Farmer, Rancher, Poultry Scientist, Agronomist, etc.

2. Agricultural Processing, Products, and Distribution
   A. This part of the agriculture industry is responsible for hauling, grading, processing, packaging, and marketing agricultural commodities from agricultural producers.
   B. Most products can be traced back to an agricultural source, but almost all undergo processing of some kind before being delivered to consumers.
   C. Buying, selling, processing, logistical management, inspection, research, and merchandising are parts of this sector of the agricultural industry.
   D. Example careers: Butcher/Meat Cutter, Crop Grader, Food Inspector, Livestock Buyer, Quality Control Supervisor, Food Chemist, Poultry Scientist, Dairy Nutrition Specialist, etc.

3. Horticulture – Production, processing, and marketing of fruits, vegetables, and ornamental plants.
   A. While considered a type of farming, horticulture is different from traditional production agriculture as it tends to be highly specialized and labor-intensive toward individual commodities.
   B. Horticultural crops are often produced in greenhouses or similar growing facilities. Greenhouse production is specialized and requires many integrated components to be successful.
   C. The ornamental market, consisting of flowers, trees, shrubs, and turfgrass, and similar products, makes up a large part of the horticulture sector.
   D. Example careers: Landscape designer, Greenhouse manager, Golf course superintendent, Florist, Vegetable Wholesaler, Entomologist, Organic Chemist, Herpetologist, Botanist, Hydroponics, etc.

4. Forestry – The industry that grows, manages and harvests trees for lumber, poles, posts, panels, pulpwood, and other wood-fiber commodities.
   A. Careers in forestry often involve interaction with large machinery used in preparing sites, planting, cutting, skidding, preparing, loading, and hauling trees.
5. **Renewable Natural Resources** – Careers in this industry revolve around the management of land, water, fish, and wildlife.
   A. This field usually involves ample time working outside, often in conjunction with landowners to enhance the quality of natural resources.
   B. There are many renewable natural resource careers in the public sector. The Natural Resource Conservation Service (NRCS) is an example of a federal agency active in this field.
   C. Example careers: Ecologist, Environmental researcher, Soil conservationist, Wildlife manager, Wildlife Researcher, etc.

6. **Technology and Computing in Agriscience** - The use of computers is extensive in agriscience. This means there are many opportunities to combine computer skills within agriscience settings.
   A. Among the agricultural uses of computers are machinery management, farm financial records, livestock management, crop management, commodity marketing, farm/ranch inventory management, agricultural business management, taxes, irrigation management, and precision farming
   B. In addition, tractors and combines are equipped with computer and global positioning systems and other high technology devices that are highly sophisticated.
   C. Example careers: Computer Specialist, Electronic Editor, Graphic Designer, Satellite Technician, Software Reviewer, etc.

7. **Agricultural Supplies and Services** – A supporting industry, this sector sells materials and supplies to other parts of the agricultural industry and also provides support services.
   A. Supplies and materials commonly sold are seed, feed, fertilizer, herbicide, pesticide, machinery, hardware, and building materials.
   B. Services often include the management, delivery, or application of the products listed above, as well as other services that support production agriculture.
C. Example careers: Artificial Breeding Technician, Chemical Applicator, Auctioneer, Insect & Disease Inspector, Agricultural Sales Representative, etc.

8. Agricultural Mechanics – This sector of the agriculture industry focuses on the engineering, design, construction, operation, maintenance, service, selling, and use of equipment, machinery, structures, and utilities.
   A. Careers in agricultural mechanics have significantly increased with the mechanization of modern agriculture.
   B. Careers in agricultural mechanics require knowledge and skills in several areas including hand and power tool operation, woodworking, metalworking, welding, electricity, power systems, hydraulics, large equipment operations, painting, and construction.
   C. Example careers: Agricultural Engineer, Equipment Designer, Land Surveyor, Diesel Mechanic, Equipment Operator, Parts Manager, etc.

9. Agriscience Professions – Many other careers that require specialized education in agriculture to operate successfully would be considered agriscience professions.
   A. These professions have a wide range in specific career skills, but all require knowledge of agriculture at their core.
   B. Example careers: Agriculture Educator, Extension Agent, Agricultural Law, Agricultural Market Analyst, Agriculture Journalist, Food Chemist, etc.

Preparing for a career in agriculture
1. Forming a plan – The best course of action, if a student is interested in an agriculture career, is to develop a career plan detailing options they can pursue at certain stages to prepare for the career they are interested in.

2. Middle School Preparations – While in middle school, students can explore the different sectors of the agriculture industry and build their knowledge and skills.

3. Appropriate preparation activities:
   A. Involvement in agricultural organizations;
   B. Job shadowing;
   C. Agriculture-related volunteer work;
   D. Enrolling in entry-level agricultural education courses
   E. Foundational Supervised Agricultural Experience (SAE) project.
4. High School Preparations – High school students may start in a phase of exploration into agricultural careers but will begin the process of post-secondary planning before graduation.
   
   A. Appropriate preparation activities:
      
      (i) Enroll in agricultural education courses;

      (ii) Involvement in agricultural organizations;

      (iii) Supervised Agricultural Experience (SAE) projects;

      (iv) Involved work experiences (part-time jobs, internships, etc.) in agriculture;

      (v) Agriscience research projects;

      (vi) Career advising with a counselor;

      (vii) College-prep or dual-enrollment courses;

      (viii) Develop a resume;

      (ix) Apply to post-secondary institutions and apply for scholarships.

5. Post-secondary planning – Deciding what to do after graduating after high school is dependent on the career that each student wants to pursue. Three of the most common options are:
   
   A. On-the-job training – gain an entry-level position that can be built upon as the worker gains knowledge and skills. This may require specialized certifications or short training programs.

   B. Technical training – enrolling at a technical school for training that is specific to a particular career. Technical training programs range in completion time but can take up to two years.

   C. Traditional college degrees – many careers require a Bachelor’s degree in a related field as one of their requirements for hire. On average, a bachelor’s degree takes four years to complete.

   D. Students need to pursue the best path for their career interest but should educate themselves on the training and education requirements to meet their goal, including the time and financial investments required to do so.

Job Descriptions

1. To find applicants for job openings, employers often post job descriptions to encourage qualified individuals to apply. Though they can be found in various types of media, many job descriptions today are found online.
A. Components – There is not a standard form for job descriptions, but most contain the following information:

B. Heading information – this includes the job title, type of work (full or part-time), and possible pay information.

C. Job summary/objective – outlines general responsibilities and descriptions of critical components of the particular job. There may be specific information on essential skills that are expected of an individual that will fill this position.

D. Qualifications – in this part of the job description, details will be given about the work experience, educational experience, and other necessary skill sets or certifications that the employer expects a candidate to have to be considered for the job.

E. Special duties/demands – any requirements that are special about the job, especially physical stresses that may be required to do the job successfully.

Applying and Interviewing for a Career in Agriculture

1. When an appropriate job opening is located, submitting an application, cover letter, and resume is the next step.
   A. Applications vary from company to company, but most require general information about the applicant and necessary background information.
      (a) Personal information – Includes name, address, phone number, etc.
      (b) Education and experience – This is one of the most critical areas of the job application. Most applications get rejected because the individual fails to demonstrate how they are qualified for the job.
      (c) Employment history – A listing of jobs and past experience
      (d) References – Important to include references who have experience with you as an employee and can speak well of your work.

   B. Following the submission of the appropriate documents, an interview may be requested, allowing an individual to market themselves to a potential employer.

2. Interviewing for a job is one of the most important steps in successfully acquiring a career. There are ways to help ensure that you make a strong first impression
   A. Research the company and the job that you are applying for.

   B. Practice responses to common interview questions. Have specific examples of how you demonstrate the skills that the company is looking for.
C. Have questions prepared to ask during the interview.

D. Arrive on time and plan to be at least 10 – 15 minutes early.

E. Dress appropriately for the interview (what is considered “professional” may change depending on the employment setting).

F. Bring copies of your application materials with you.

G. Follow-up with a thank you letter or email.

**Becoming involved in professional trade organizations**

1. Trade organizations provide many benefits for their members
   A. Benefits often include, insurance, discounts, professional development, career resources, and sharing new technology or information about the industry that they represent.

   B. Some trade organizations hire professional lobbyists or lobbying firms, who work with state and national governments on the organizations behalf and keep the organization up to date on laws or new legislation that may affect the industry or organization.
      (i) These professionals often speak to state and national government leaders to encourage them to vote for or against issues that may impact their clients.

2. Trade publications
   A. Some trade organizations also manage professional publications or journals where members can publish articles or scientific research that is important to the organization.
UNIT C: Leadership
Developed by Ms. Olivia Broussard and Ms. Janiece Pigg

STANDARDS:
LA-AGTECH: S11.2, S12
AFNR: CRP.04, CRP.09.01

Goal: Students should understand what leadership entails and ways to develop themselves and others as leaders in the agricultural industry.

Objective(s):

1. Define the terms leader and leadership
2. Explain why effective leadership is needed in agriscience.
3. List characteristics of good leaders.
4. Describe the opportunities for leadership development in youth organizations.
5. Describe the opportunities for leadership development in FFA.
6. Identify basic elements of oral, written and non-verbal communication.
7. Identify the basic components of a prepared speech.
8. Demonstrate basic elements of good business meetings.
9. Identify the steps in the Order of Business.
10. Identify basic elements of parliamentary procedure.

Agritech Guiding Questions:
1. What is the highest degree that the FFA can bestow upon a member?
2. What is another word for integrity?
3. What does two taps of the gavel mean?
4. What are the three parts of a speech?

Content:
Defining Leadership
1. Leadership may be defined as the capacity or ability to solve problems and to set a direction.

2. To lead is to show the way by going in advance or guiding the actions or opinions of others.

3. A leader uses the knowledge and skills of others to achieve a common goal.

Why is Leadership Important?
1. In order for the agricultural industry to thrive, leaders are needed to help companies and organizations reach their full potential.
2. Without good leadership, companies and organizations are not able to succeed

3. The agricultural industry has grown and changed rapidly. Because of this, leadership is needed to help guide change, organize companies and organizations, and inform the public about agriculture.

Characteristics of Effective Leaders
1. Good leaders possess integrity (honesty), knowledge, dependability, courage, tact, enthusiasm, selflessness, and loyalty.

Opportunities for Leadership in Youth Organizations
1. There are many opportunities within schools and community organizations to become active and involved.
   A. Leadership Opportunities
      (i) Athletics
         (a) Captain/mentoring opportunities
      (ii) Arts
         (a) Theater
         (b) Choir
         (c) Band
      (iii) School Organizations
         (a) Student Government
         (b) Language Clubs
         (c) Debate Team
         (d) Quizbowl Team
      (iv) Math Team
   B. 4-H Clubs
      (i) The 4-H network of clubs is directed by Cooperative Extension System personnel to enhance personal development and provide skill development in many areas, including agriscience. These four Hs in 4-H stand for head, heart, hands, and health.
      (ii) These provide the basis for the 4-H pledge, which is, “I pledge my head to clearer thinking, my heart to greater loyalty, my hands to larger service, and my health to better living for my Club, my community, my country, and my world.”
C. Scout Organizations
   (i) Girl Scout and Boy Scout organizations provide opportunities for leadership development and skill development in agriscience and other areas.

   (ii) Scouts focus heavily on outdoor activities and provide excellent leadership development and natural resources skills.

   (iii) They provide recognition through a system of merit badges, which are earned by learning skills and obtaining experiences in many areas, including agriscience.

   (iv) Famous leaders from this organization include: Buzz Aldrin, Jon Bon Jovi, John Wayne, Michael Bloomberg, First Lady Laura Bush, Kathleen Couric

D. FFA
   (i) The FFA is a youth-oriented organization that was developed specifically to expand the opportunities in leadership and agriscience skill development for students in public schools.

   (ii) Famous leaders from this organization include: President Jimmy Carter, Tim McGraw, Trace Adkins, Bo Jackson

Opportunities in FFA
1. FFA Basics
   A. The primary aim of the FFA is the development of agriscience leadership, cooperation, and citizenship.

   B. The FFA emblem contains five major symbols that help demonstrate the structure of the organization

   C. Eagle - The emblem is topped by the eagle and other items of our national seal. The eagle was placed in the emblem to represent the national scope of the organization.

   D. Corn - Corn is grown in every state in the United States. It reminds us of our common interest in agriscience, regardless of where we live.
E. Owl - The owl represents knowledge and wisdom. Use of this symbol in the emblem recognizes the fact that people in agriscience need a good education and that education must be tempered with experience to be of greatest usefulness.

F. Plow - The plow has been used to represent work–labor–effort. These qualities are needed to cause things to happen and to get results in agriscience.

G. Rising Sun - The rising sun is a symbol of the progressive nature of agriscience. It is symbolic of the need for workers in agriscience to cooperate and work toward common goals.

2. The official FFA colors are blue and gold. The shade of blue is national blue. The shade of gold is the yellow color of corn.

3. The FFA motto contains phrases that describe the philosophy of learning and development in agriscience.
   A. The motto is:
      Learning to Do
      Doing to Learn
      Earning to Live
      Living to Serve

4. The Pledge of Allegiance to the American flag is the official FFA salute.

5. The FFA Code of Ethics
   A. FFA members conduct themselves at all times to be a credit to their organization, chapter, school, community and family. FFA members pledge to:
      (i) Develop my potential for premier leadership, personal growth and career success.
      (ii) Make a positive difference in the lives of others.
      (iii) Dress neatly and appropriately for the occasion.
      (iv) Respect the rights of others and their property.
      (v) Be courteous, honest and fair with others.
      (vi) Communicate in an appropriate, purposeful and positive manner.
      (vii) Demonstrate good sportsmanship by being modest in winning and generous in defeat.
(viii) Make myself aware of FFA programs and activities and be an active participant.

(ix) Conduct and value a supervised agricultural experience program.

(x) Strive to establish and enhance my skills through agricultural education in order to enter a successful career.

(xi) Appreciate and promote diversity in our organization

6. The FFA has four degrees, which indicate the progress a member is making within the organization. These are: Greenhand, Chapter, State, and American degrees.
   A. The American Degree is the highest degree that the National FFA can bestow upon its members.

7. The FFA Creed outlines the National FFA Organization's values and beliefs regarding the industry of agriculture, FFA membership, citizenship and patriotism.
   A. The Creed Speaking Leadership Development Event (LDE) is for students who are enrolled in an agriscience class for the first time. It requires the speaker to repeat the FFA Creed from memory and answer questions.

8. The FFA sponsors competitive career development events for a wide range of career interests.
   A. The purpose of FFA Career Development Events (CDE’s) are to encourage agriscience students to develop technical and leadership skills and to practice these skills in friendly competition with other FFA members.

Public Speaking
1. Oral communication skills are important for good leadership. Effective leaders must speak with individuals, committees, small groups, and in large forums.
   A. These skills are developed by applying basic principles of speech preparation and organization.

   B. The Prepared Speaking contest provides an opportunity for a student to research an agricultural topic and develop his or her own ideas.

   C. Extemporaneous Speaking competitions require students to gather original documents and materials in a notebook or file, but no written preparation of a manuscript may be done before the competition.

   D. A speech should have at least three sections: the introduction, body, and conclusion.

   E. The speaker must prepare the plan well and practice the speech extensively.
F. Body language and non-verbal communication skills are essential to practice as well since they can communicate unintended emotions or project confidence.
   (i) Non-verbal skills can make a speaker seem more confident, trustworthy and add clarity to a presentation.

Conducting Business Meetings
1. A good business meeting is a gathering of people working together to make wise decisions for their organization.

2. Meetings run by groups of individuals who know and use parliamentary procedure are smooth, efficient, orderly, and focused, and such meetings accomplish much more than poorly organized meetings.

3. A presiding officer is a president, vice president, or chairperson who is designated to lead a business meeting.

4. A secretary is a person elected or appointed to take notes and prepare minutes of the meeting.

5. Informed members are members who are active in the organization and want to be part of the group.

6. The order of business refers to the items and sequence of activities conducted at a meeting. The order of business is usually made up by the secretary.

7. The gavel is a wooden mallet used by the presiding officer to direct a meeting.
   
   A. The gavel is a symbol of the authority of the office of president or chairperson, and it should be respected by all attending the meeting.
   
   B. The gavel is not only a symbol of authority, but different taps can direct the actions of the room.
      (i) One tap
         (a) Announces the results of a vote
         (b) Adjourns the meeting
         (c) Asks members to be seated

      (ii) Two taps
         (a) Calls the meeting to order

      (iii) Three taps
         (a) Signal for all members to stand at the end of the third tap
Rapid series of taps
(a) Used to restore order to a meeting

8. A motion is a proposal, presented in a meeting, that is to be acted upon by the group.

Steps in the Order of Business (Agenda)
1. Call to order by the President. An opening ceremony by FFA officers is also part of FFA meetings.

2. Minutes of the previous meeting read by the Secretary and approved by the body in accordance with organizational by-laws and parliamentary procedure to remind members of what happened in the last meeting.

3. Treasurer reports on the financial standing of the club.

4. Report on Chapter Program of Activities (by officers and committee chairmen).

5. Old Business – also called unfinished business – Business left over from the previous meeting.


7. Adjournment and closing ceremony – Adjournment is either by passing a motion to end the meeting or by consensus of the body.

Parliamentary Procedure Basics
1. Parliamentary procedure is a system of guidelines or rules for conducting meetings.

2. Parliamentary procedure is used to guide the meetings conducted by city councils, school boards, church groups, commissions, professional organizations, and civic organizations, such as Lions, Rotary, and Ruritan clubs.

3. The use of parliamentary procedure extends courtesy to everyone.
   A. Members (except in emergency or to enforce parliamentary law) must be recognized to speak.

   B. Members ask the President for recognition by saying, “Madame/Mr. President.”

4. The use of parliamentary procedure focuses on one thing at a time. There may be only one main motion on the floor at a time.
   A. The main motion is presented by saying “I move.”

5. The use of parliamentary procedure observes the rule of the majority.
A. Only motions that have been seconded can be discussed and take the time of the group.

B. Most motions require a majority vote to pass: (In a meeting of 30 people, 16 people would have to vote in favor of the motion to have a majority). The chapter takes the action only after a majority agrees it should be taken.

C. The use of parliamentary procedure ensures the rights of the minority. For instance, even the minority have a right to voice their opinion through discussion. Therefore, a motion to stop discussion requires a 2/3 vote to pass. (In a meeting of 30 people, 20 people would have to vote to close debate or stop discussion).

Resources:
For additional information on FFA basics, the FFA Creed, FFA degrees and parliamentary procedure motions, please visit https://www.ffa.org/
UNIT D: Supervised Agricultural Experiences
Developed by Dr. Kristin Stair and Ms. Janiece Pigg

STANDARDS:
LA-AGTECH: S11.1

Goal: Students should know how to develop, implement and maintain an SAE including using a record keeping system.

Objective(s):
1. Define Supervised Agricultural Experience (SAE)
2. Identify the AFNR career pathways
3. Identify the basic types of SAE’s and their characteristics
4. Identify the steps in choosing an SAE project
5. Develop, implement and maintain an SAE including using a record keeping system.

Agritech Guiding Question(s):
1. A student who has a Supervised Agricultural Experience (SAE) involves owning their own herd of cattle has what type of SAE?

What is SAE?
1. Supervised Agricultural Experience (SAE) is a student-led, instructor-supervised, work-based learning experience within a specific area of the Agriculture, Food and Natural Resources (AFNR) Technical Standards and Career Ready Practices aligned to a student’s career interest
   A. SAE’s are designed to grow and modify as a student develops skills and identifies new interests in agriculture.
   B. The end goal of an SAE is to provide career awareness and skills
   C. SAE’s are designed to be student led
   D. SAE’s should be instructor guided
      (i) Agriculture teachers guide and foster growth within a student’s SAE as needed.
   E. Work-Based Learning SAE’s may take place in school or outside of school
   F. SAE’s should have measurable outcomes
      (i) Because SAEs are connected to agriculturally-based knowledge and skills growth can be measured as a graded component of agricultural coursework.

SAE’s and AFNR Pathways
1. SAE’s should be agriculturally-related. They should ultimately fall into one of the AFNR career pathways:
A. Agribusiness Systems

B. Animal Systems

C. Biotechnology Systems

D. Environmental Systems

E. Food Products and Processing Systems

F. Natural Resources Systems

G. Plant Systems

H. Power, Structural and Technical Systems.

Types of SAE’s
1. Foundational SAE’s – Foundational SAE’s are introductory projects that are designed to encourage agricultural exploration. These type of SAE’s focus on five main components:
   A. Career exploration and planning – Includes research and exploration of career opportunities within an AFNR industry. Students should develop interest inventories and identify a career goal. Ultimately, students will be able to describe AFNR career opportunities and the path to achieving those opportunities.

   B. Employability skills for college and/or career readiness
      (i) Students should develop skills needed to succeed in both college and career.

      (ii) Skills developed should include responsibility, communication, innovation, critical thinking and collaboration.

   C. Personal Financial Management and Planning - Crafting a personal financial management plan is the focus of the Personal Financial Management and planning component.
      (i) Students need to understand how personal financial practices like budgeting, saving and appropriate use of credit lead to financial independence.

   D. Workplace safety - Where many of the AFNR career pathways contain hazardous occupations, it is critical that all students have a strong base of instruction and experience with workplace safety.
      (i) In this component, students will examine and summarize the importance of health, safety and environmental management systems in the AFNR
workplace.

E. Agricultural literacy - Students need an understanding of the wide variety of options within the agricultural industry.
   (i) This component will require students to research and analyze how issues, trends, technologies and public policies impact AFNR systems.

   (ii) They will also evaluate the nature and role of agriculture in society and the economy.

2. Immersion SAE’s
   A. Placement/Internship - Involves placing students in an employment setting (either paid or volunteer).
      (i) The student performs the tasks determined by the employer which are necessary for the operation of the business.

      (ii) Students are evaluated by the employer under the guidance of the agriculture instructor.

3. Ownership/Entrepreneurship
   A. Includes the planning, implementing, operating and assuming financial risks in an agricultural business or farming activity such as creating and selling plant hybrids or breeding livestock for show / sale.
      (i) Students conducting an Entrepreneurship SAE operate an individual business which provides goods and/or services to the marketplace.

      (ii) The operational and risk management decisions on how goods and/or services are provided are made by the student owner.

      (iii) Some facilities, resources and equipment that are necessary for the SAE operation can be provided from outside individuals without expectations of compensation coming from the student or SAE.

4. Experimental, Analyst or Invention SAE
   A. A student conducting a Research SAE is involved in an investigation of materials, processes and information to establish new knowledge or the validation of previous research.

      (i) Research conducted must have applications within AFNR Technical Standards. There are three variations of research SAE available that students may conduct:

         (a) Experimental: An Experimental SAE involves the application to the scientific method to control certain variables while manipulating others to observe the outcome.

         (i) The student defines the hypothesis the experiment will test, determines the experimental design, conducts the research, collects the data, draws conclusions from the data and recommends further
research that can be done.

(ii) Example: Agriscience Fair

(b) Analytical: An Analytical Research SAE often begins with a question that asks why or how something occurs, followed by a period of data collection using qualitative and/or quantitative methodologies.
(i) The student then conducts analysis of data, facts and other information to determine the answer to the posed question.

(c) Invention: An Invention Research SAE applies the engineering design process to create a new product or service.
(i) This type of research often begins with the identification of a need and the development of a product followed by an iterative process of prototyping and testing that results in a product that meets the identified need.

5. School Based Enterprise SAE - is the development of an operation based at the school and involves a group of students working cooperatively.
   A. School-Based Enterprise SAEs are student-led business enterprises that provide goods or services.
      (i) They are operated from the school campus and utilize facilities, equipment and other resources provided by the agricultural education program or the school in general.

6. Service Learning SAE is conducted by one or more students in which they plan, conduct and evaluate a project designed to provide a service to the school, public entities or the community.
   A. It must provide benefit to an organization, group or individuals other than the FFA chapter.
Choosing an SAE
1. Students should use great imagination when considering the SAEP they will participate in.

2. When planning a SAE, a student must first take inventory of what is possible, practical, and beneficial.

3. The primary components of choosing a suitable SAE are:
   A. Personal Interest
      (i) Personal interest is an important factor in the success of an SAEP. Consider the kinds of activities you like to do and then build on those interests
      (ii) Consider using a student interest survey.
   B. Resource Inventory
      (i) A resource inventory is a listing of the assets and sources of help that may be available for conducting SAEP activities.
      (ii) It includes information about your home, farm, work setting, and community that might be useful in considering your SAEP

4. After completing the Personal Interest Survey and the Resources Inventory, you should arrange a conference with your teacher.
   A. The conference should include discussions of your interests, and it should take a look at the possible production enterprises, improvement projects, and supplementary skills available to you.

Using SAE Record Books
1. Students who conduct SAE’s should use some type of record books to maintain records of their projects.
   A. Some agriculture programs use paper record books
   B. Some agriculture programs use computer record books with the most popular being AET

2. Foundational SAE’s
   A. Records should include the date, activity, observations/activities and comments, hours, etc.

3. Ownership/Entrepreneurship SAE’s
   A. Require records on the type of enterprise, amount bought or sold, expenses, income, efficiency factors, etc.
4. Experimental/Analytical and Inventions SAE’s
   A. Require a review of literature, hypothesis, data log, findings, recommendations, etc.

   B. Analytical SAE’s and Inventions should include the title of the activity, identification of problem, background information, steps to solve the problem/develop the product, project log of what was done, results and recommendations.

5. Placement/Internship SAE’s
   A. Should include a training agreement signed by student, teacher, employer and parent or guardian stating which each person will contribute to the project and documenting the required hours and expectations of the SAE

   B. Records should include a record of work, hours and income.

6. Service Learning SAE’s
   A. Should include the date started, date completed, activity and steps or tasks involved in the project, hours, costs, impact/success of the project.

7. School Based Enterprise SAE’s
   A. Requires records on the type of enterprise developed, items bought or sold, expenses, income, hours worked by students, etc.

References: SAE for all resource guides: https://saeforall.org/
Additional Supplements: SAE Cards from www.ffa.org
RecordBook Resources: www.theaet.com
UNIT E: Ag Safety and Science
Developed by Mr. Tyler Granberry and Ms. Raegan Ramage

STANDARDS:
LA-AGTECH: S5, S6.1
AFNR: CS.03.01-04, BS.02.01-04

Goal: Students should be able to identify potential accidents in agriculture and know how to prevent accidents through the use of personal safety equipment, basic safety information, knowledge of safety data sheets, and an understanding of basic safety procedures in the agricultural shop and laboratory

Objective(s):
1. Define safety
2. Identify ways to create a safe workplace
3. Recognize and reduce hazards in agriscience settings
4. Select appropriate protective clothing and devices for personal protection (PPE) and safety equipment
5. State the conditions necessary for combustion
6. Match the appropriate types of fire extinguishers to each class of fire
7. Identify components of labels and safety data sheets
8. Describe appropriate action in case of fire, accident, or other emergency
9. Identify basic safety protocols and principles
10. Identify safety equipment used in an agricultural setting
11. Identify methods of sterilizing equipment and maintaining a sterile environment
12. Identify methods of preparing reagents and solutions
13. Determine methods of working with biological materials
14. Use common laboratory equipment and employ scientific measurement skills.

Agritech Guiding Questions:
1. When discharging a fire extinguisher, how far away should you be positioned from the fire?
2. Approximately how many grams are equal to one pound?

Content:
Introduction to Safety
1. Safety
   A. The condition of being protected from danger, risk, or injury.
   
   B. Commonly, safety is maintained through workplace organization and regulations and through the use of PPE or Personal Protective Equipment

2. The Occupational Safety and Health Administration is the primary government agency that regulates workplace safety in the U.S
Common Hazards in Agricultural Settings -
1. Physical
   A. Associated with slipping, falling, being struck, bodily movement, etc.

2. Biological
   A. Associated with viruses, bacteria, plants, animals, or their by-products.

3. Chemical
   A. Associated with contact with chemicals or their toxic properties.

4. Fire
   A. Associated with contact with open flame or intense heat.

5. Mechanical
   A. Associated with machinery, vehicles, or moving parts.

6. Electrical
   A. Associated with electricity or electric shock.

OSHA Safety Colors
1. The Occupational Safety and Health Administration (OSHA) uses a color system that is used to increase safety
   A. Red
      (i) Identifies areas of danger. Red is used on safety switches and fire extinguishers.
   
      B. Orange
      (i) Identifies areas of warning

      (ii) wheels, levers, and knobs

   C. Yellow
      (i) Identifies areas of caution

      (ii) Identifies wheels, levers, and knobs that adjust or control machines and could be a potential risk

   D. Blue
      (i) Used for information signs such as “out of order” to identify broken shop equipment that does not work properly.

   E. Green
      (i) Indicates the presence of first aid and safety equipment.
PPE (Personal Protective Equipment)

1. Appropriate Clothing
   A. Body covering (shirts, pants, etc.), aprons, lab coats, jackets, or coveralls, protection of hair, jewelry, or accessories

2. Eye and Face Protection
   A. Safety glasses, face shields, etc.

3. Ear Protection
   A. Ear plugs or earmuffs

4. Gloves
   A. Type of gloves is dependent on the application (biological, chemical, mechanical, fire, etc.)

5. Footwear
   A. Closed-toed shoes, non-slip or reinforced toe when necessary

6. Other PPEs
   A. Hardhats, masks, respirators, etc.

Safety Equipment:

1. Eye Protection- safety glasses, safety goggles, or face shield
   A. Used to protect eyes and face from spills or splashes, one of the most common accidents in labs.
   B. Face shields offer the most protection.
   C. Never lay glasses or goggles face down to avoid scratches.

2. Lab Coats- protect body and clothes from spills, contribute to sterile environment

3. Gloves- usually surgical style, thin plastic, offer some protection and are used to achieve aseptic conditions

4. Materials Storage Cabinets-
   A. Flammables- most common, isolates flammable chemicals for safety, should contain chemicals ONLY. (fire resistant, not fireproof)
   B. Acids- isolate chemicals with specialized spill containers.

5. Eye Wash / Shower- should be checked often but used only in the case of emergency.
   A. After chemical exposure, eyes should be rinsed for more than a minute to ensure that damage is limited as much as possible.
6. Fume Hood- expensive piece of equipment that removes noxious fumes produced by chemical solutions from the laboratory.

**Fire Safety**

1. Combustion requires three parts; oxygen, fuel, and heat.

2. Removal of any one of the three parts of the “fire triangle,” will prevent or extinguish a fire.

3. Preventative measures involve preventing a fuel and heat sources from coming into contact, while extinguishing uses one of many methods of removing oxygen.

4. Fire Protection Equipment- fire blanket, fire extinguisher, fire alarm
   A. Should be easily accessible and clearly marked.
   
   B. In order to extinguish a fire, the fuel of the fire must be known.
   
   C. Fire extinguishers should be rated for chemical and / or liquid fires.
      (i) Classes of fire extinguishers:

      (ii) Class A – paper / wood

      (iii) Class B – liquids

      (iv) Class C – electrical

      (v) Class D – combustible metals

   D. Fire extinguishers should be aimed at the base of flames and used until flames are completely extinguished.

   E. Fire blankets are most effective for smothering small flames on an individual's clothing or person.

**Chemical Safety Information (Labels and SDS)**

1. All chemicals used in agriscience settings will have labels and safety data sheets (SDS) that provide the user with important information about the product.

2. Important information found on labels and SDS:
   A. Identification
   
   B. Hazard Identification
   
   C. Composition and Information on Ingredients
D. First Aid Measures
E. Fire-Fighting Measures
F. Accidental Release Measures
G. Handling and Storage
H. Exposure Controls and Personal Protection
I. Physical and Chemical Properties
J. Stability and Reactivity
K. Toxicological Information
L. Ecological Information
M. Disposal Considerations
N. Transport Information
O. Regulatory Information
P. Update from previous versions of the related safety information

Emergency procedures and safety protocols
1. The steps to be taken when reacting to an emergency situation vary from case to case. However, standard procedures are in place for specific events and familiarization with those procedures allows everyone to be ready should an incident occur.

2. Appropriate methods of response to emergency situations
   A. In any emergency it is important to not panic and to immediately a teacher or supervisor

   B. Many institutions and companies will require that an incident form be completed once the emergency has passed.

   C. Clothing on Fire
      (i) Roll around on floor to smother flame or drench with water.
      (a) If the fire resulted from chemical, be sure to know the proper procedure for extinguishing that chemical

      (ii) Obtain medical attention; if necessary
D. Hazardous Material Splashed in Eye:
   (i) Immediately rinse eyeball and inner surface of eyelid with water
        continuously for 15 minutes.
   (ii) Forcibly hold eye open to ensure that the wash can get behind eyelids.
   (iii) Obtain medical attention. Make sure to take Material Safety Data Sheets
         of the chemical with you.

E. Minor Cuts and Puncture Wounds:
   (i) Vigorously wash injury with soap and water for several minutes
   (ii) Obtain medical attention

F. Biological Spill on Body:
   (i) Remove contaminated clothing.
   (ii) Vigorously wash exposed area with soap and water for one minute.
   (iii) Obtain medical attention.

3. Methods of basic first aid (From the American Red Cross)
   A. Before administering care to an ill or injured person, check the scene and the
      person. Never move a person, this could cause additional injury.
   B. Pause and looks at the scene and the person before responding. Answer the
      following questions:
      (i) Is the scene safe to enter?
      (ii) What happened?
      (iii) How many people are involved?
      (iv) What is my initial impression about the nature of the person’s illness or
           injury? Does the person have any life-threatening conditions, such as
           severe, life-threatening bleeding?
      (v) Is anyone else available to help?
   C. If the person is awake and responsive and there is no severe life-threatening
      bleeding:
      (i) Tell the person your name, describes type and level of training, states what
          you think is wrong and what you plans to do, and asks permission to
          provide care.
(ii) Tell a bystander to get the first aid kit: Point to a bystander and speak out loud. Tell another bystander to contact a teacher, supervisor or administrator.

(iii) Use appropriate PPE: Put on gloves, if available.

D. Interview the person
   (i) Use questions to gather more information about signs and symptoms, allergies, medications, pertinent medical history, last food or drink and events leading up to the incident.

E. Conduct a head-to-toe check
   (i) Check head and neck, shoulders, chest and abdomen, hips, legs and feet, arms and hands for signs of injury.
   (ii) Provide care consistent with knowledge and training according to the conditions you find.

F. If the Person Appears Unresponsive:
   (i) Shout to get the person’s attention, using the person’s name if it is known. If there is no response, tap the person’s shoulder (if the person is an adult or child) or the bottom of the person’s foot (if the person is an infant) and shout again, while checking for normal breathing. Check for Responsiveness and breathing for no more than 5-10 seconds.

G. If the person is breathing:
   (i) Proceed with gathering information from bystanders
   (ii) Roll the person onto his or her side into a recovery position if there are no obvious signs of injury.

H. If the person is NOT breathing:
   (i) Send someone to call 911
   (ii) Ensure that the person is face-up on a firm, flat surface such as the floor or ground.
   (iii) If you are trained in giving CPR and using an AED. Begin CPR (starting with compressions) or use an AED if one is immediately available.
   (iv) Continue administering CPR until the person exhibits signs of life, such as breathing, an AED becomes available, or EMS or trained medical responders arrive on scene.
(a) End CPR if the scene becomes unsafe or you cannot continue due to exhaustion.

**Safety Protocols and Principles**

1. Keep the workspace clean and clear of any obstructions and excess equipment, people, and/or supplies.

2. Keep supplies and equipment in an easily accessible location.

3. Make certain that chemicals are clearly labeled with Safety Data Sheets (SDS) well marked and easily accessible.
   - A. SDS sheets contain important information on chemicals including: chemical properties, storage, disposal, and treatment for exposure.

4. Chemical Spills & Exposure-
   - A. Spills should be quickly contained and the area secured.
   - B. Special media can be used to absorb harmful chemicals.
   - C. Any exposed skin should be immediately rinsed or neutralized, (in the case of an acid/base) particularly with eye exposure SDS sheets should be consulted for further treatment.
     (i) A mild acid can at times be used to neutralize areas exposed to a strong base. (works both ways)
   - D. Chemicals consumed orally should be treated using the chemical’s (i) SDS sheet.

**Principles for Handling Chemicals**

1. Only use chemicals that are properly labeled, with current SDS sheets.

2. Use only approved containers for mixing and storing chemical solutions.

3. Use a graduated cylinder or digital scale to ensure that the proper amount of chemicals are added to a solution.

4. When pouring liquid chemicals, place containers in contact whenever possible to prevent spills.

5. Do not leave chemicals unattended outside of storage areas.

6. When creating acid solutions, acids should always be poured slowly into water, to prevent splashing.
7. Federal law requires chemicals to be diluted before disposal being careful
   A. not to mix chemicals that react violently.
   B. Make certain that all necessary permits are obtained from government regulatory agencies for the use of restricted chemicals and biologicals.

Sterilizing Equipment & Materials
1. An autoclave is the best method for sterilization of small lab equipment, water / solutions, glassware, and lab materials. (even paper towels and cotton swabs can be sterilized)
2. Autoclaves will kill living and biological material
3. Flow hoods and surfaces can be cleaned / disinfected with a bleach-based solution.
4. Forceps and other equipment should never be placed in contact with surfaces. Instead they should be placed in a 70% ethanol (alcohol) solution, and flamed over an alcohol lamp before contacting sterile material.

Creating a Sterile Environment
1. Tissue culture and other aseptic lab techniques work best in a clean room or under a laminar flow hood.
2. Laminar flow hoods use a special filter (hepa filter) to clean air that needs changed after a given number of hours.
3. Sterile boxes can be created with plexiglass or plastic sheeting for a more affordable but less reliable alternative.
4. Once the area is sterilized the movement of equipment and materials into and out of the work area should be minimized.

Maintaining Sterile Conditions
1. A face shield or front cover should be used to prevent contamination from mouth and nose (breathing).
2. Hands / Arms
   A. Should be carefully washed with soap and water
   B. An antibacterial soap should be used on hands over wrists, immediately before placement in sterile surgical gloves.
   C. Hands should be kept inside the air curtain of the flow hood at all time- away from the edge or entrance to avoid accidental contamination
   D. Sleeves should be away from hands and shedding materials should be avoided- a lab coat is ideal.
Tips for the Preparation of Reagents and Solutions
1. Safety Data Sheets (SDS) provide all the information necessary for storage, handling and disposal of a chemical or solution.
   A. Includes- the chemical formula, reactivity data, storage temps, exposure / inhalation / ingestion treatment, disposal methods, dangers with use, etc.
   B. Should be easily accessible in the lab.

2. Make certain to clearly label the composition and strength of all solutions.
   A. Under concentrated solutions can be ineffective.
   B. Over concentrated solutions can be extremely dangerous.

3. When mixing chemicals:
   A. Always pour concentrated acids into cool water (not the other way around).
   B. Pour with beakers or bottles in contact when possible, running the liquid down the side of the glass to avoid splashing or flash boiling.

(i) Always follow directions and be aware of what ingredients you are combining and what the final product will be

Tips for Safe and Effective use of Biological Materials
1. Biological materials should be carefully stored and utilized with careful attention to temperature.
   A. Bacteria cultures should never be incubated at temperatures above 30C, as higher temps encourage the growth of organisms harmful to humans.
   B. Biological materials should be clearly labeled and stored in clearly marked and isolated areas.
   C. Any harmful biological materials should be destroyed prior to disposal.
      (i) Autoclaves can be used to destroy most bacteria cultures & plant / animal cells.
      (ii) Agricultural labs often use special biological materials disposal containers to store materials until pickup for destruction by an external company.

Measurements
1. Importance of accurate measurement
   A. in order to maintain a safe working environment in lab settings, all materials used should be measured as accurately as possible.
B. Failure to use accurate measurements can cause harmful chemical reactions, fumes, or injuries
   (i) May also prevent the lab from working correctly or cause data to be incorrect

2. How to measure
   A. Dry materials should be weighed on a scale in grams. Careful attention should be paid to zeroing the scale to the weight of the container before weighing materials.
   
   B. Liquid materials should be measured using graduated cylinders. When reading the measurement, ensure that the measurement is being taken at the lowest point of the meniscus, or the curve of the liquid at the top.

3. Conversions
   A. Lab measurements should be made in SI or metric units. Conversion to and from American measurements may be required for accuracy.
   
   B. Grams to pounds – 1 kilogram or 1000 grams = 2.2 pounds
   
   C. Fluid ounces to milliliters – 1 fluid ounce = 29.57 milliliters or 0.03 liters
   
   D. Temperature – The formula to convert Fahrenheit to Celsius is (Degrees Fahrenheit – 32) x 5/9 = Degrees Celsius. Example: 100°F – 32 x 5/9 = 37.78°C.
UNIT F: Animal Science
Developed by Ms. Brynn Witte

STANDARDS:
LA-AGTECH: S9.1, S15
AFNR: AS. 01-08

Goal: Students should know the animal science concepts including, animal categories (use, type, breed, and scientific classification), basics of animal systems, and animal care and handling techniques.

1. Define Livestock
2. Define various animal industries including cattle, swine, sheep, goats, poultry, equine and small animal industries
3. Identify specific livestock terminology unique to each animal production system.
4. Evaluate specific animal breed and their development origin, domestication and distribution.
5. Identify specific components of production systems in various animal industries including cattle, swine, sheep, goats, poultry, and equine
6. Identify animal care and handling techniques that ensure safety and animal welfare.

Agritech Guiding Questions:
1. What is the name of the class of animals that have a stomach with 4 compartments?
2. A Holstein is a breed of what type of animal?

Additional Resources:
http://www.animalhandling.org/
https://www.nationalhogfarmer.com/
https://animalsmart.org/

Content:

Large Animal (Livestock) Industry
1. Defined: Farm animals raised to produce milk, meat, work and wool.
   A. Examples: Cattle, swine, sheep, goats, specialty animals, etc.

2. General Breed Terminology
   A. Birth Weight – Weight taken in the first 24 hours of a calf’s life

   B. Breed - a group of animals that, as a result of breeding and selection, have certain distinguishable characteristics
C. Breed Characteristics – Physical traits that differentiate one breed from another

D. Composite Breeds – A breed that is developed from a series of specific crosses for desirable traits that are passed onto offspring

E. Domestication - Adapting an animal to the needs of humans

F. Feed Efficiency – The product (usually weight gain) produced per unit of feed consumed

G. Longevity – The functional lifespan of an animal that endures beyond the average

H. Milk Production – Amount in pounds of milk that a cow produces during a lactation period

I. Pedigree – A chart showing a line of ancestry

J. Polled – Cattle that are born without horns due to genetics

K. Prolific – producing a large number of offspring

L. Purebred – A breed with established origins and genetic markers, whose parents are of the same breed and are recorded with the registry association

M. Registered - An animal whose name, along with the name and number of its sire (father) and dam (mother), has been recorded in the record books of its breed association. The association gives the animal a number, known as a registration number. The association gives the animal a certificate known as a registration certificate showing that the animal has been registered

N. Species – a class of animals having some common characteristics or qualities;

O. Traits - Characteristics that can be passed down from parent to offspring

P. Weaning Weight - Weight of a calf at weaning

2. Related Breed Organizations:
   A. National Cattlemen’s Beef Association – www.beef.org

C. National Pork Board - www.pork.org


E. American Sheep Industry Association – www.sheepusa.org


G. American Dairy Goat Association – www.adga.org


I. Cooperative Extension
   (i) https://beef-cattle.extension.org/

   (ii) https://dairy-cattle.extension.org/

   (iii)https://swine.extension.org/

   (iv)https://sheep.extension.org/

   (v) https://goats.extension.org/

Poultry Industry
1. Defined: Domesticated fowls that are raised primarily for their meat, eggs or feathers
   A. Examples: chickens, turkeys, ducks, geese, etc.

   B. Related Organizations:
      (i) U.S. Poultry & Egg Association – www.poultryegg.org

      (ii) Poultry Hub, Edu Resources - www.poultryhub.org/

      (iii) National Chicken Council - https://www.nationalchickencouncil.org/

      (iv) Cooperative Extension - https://poultry.extension.org/

Equine Industry
1. Defined: The breeding, raising, and training of equine for various markets and use
   A. Examples: Horses, Mules, Donkeys and other members of the family Equidae

   B. Related Organizations:
      (i) United States Equestrian Federation - www.usef.org

      (ii) American Horse Council - www.horsecouncil.org
Small Animal Industry
1. Defined: Domesticated small animals used for service or companionship
   A. Examples: Dogs, Cats, Rabbits, Birds, and Exotics

2. Related Organizations:
   A. American Kennel Club – www.akc.org
   B. Cat Fanciers’ Association – www.cfa.org
   C. American Association of Feline Practitioners – www.catvets.com
   D. American Rabbit Breeders Association – www.arba.net
   E. American Birding Association - www.aba.org
   F. Exotic Wildlife Association - www.myewa.org

Species Specific Terminology
1. Cattle
   A. Scientific Family Name: Bovidae (Bovine)
   B. Giving Birth: Calving
   C. New Born: Calf
   D. Immature Female: Heifer
   E. Mature Female: cow
   F. Male: Bull
   G. Castrated Male: Steer

2. Swine
   A. Scientific Name: Sus (Porcine)
   B. Giving Birth: Farrowing
   C. Newly Born: Piglet
   D. Immature Female: Gilt
E. Mature Female: Sow
F. Male: Boar
G. Castrated Male: Barrow

3. Sheep/Goats
   A. Scientific Name: Ovis Aries (Ovine)/ Capra Hircus (Caprine)
   B. Giving Birth: Lambing/Kidding
   C. New Born: Lamb/Kid
   D. Female: Ewe/Doe
   E. Male: Ram/Buck
   F. Castrated Male: Wether

4. Poultry
   A. Scientific Family Name: Phasianidae
   B. Giving Birth: Laying
   C. New Born: Chick/Poult
   D. Female: Pullet/Jenny
   E. Laying Female: Hen
   F. Male: Cockerel/Jake
   G. Mature Male: Rooster/Tom
   H. Castrated Male: Capon

5. Equine
   A. Scientific Family Name: Equidae
   B. Giving Birth: Foaling
   C. New Born: Foal
   D. Immature Female: Filly
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E. Mature Female: Mare

F. Immature Male: Colt

G. Mature Male: Stallion

H. Castrated Male: Gelding

6. Rabbits
   A. Scientific Family Name: Leporidae (Leprine)
   B. Giving Birth: Kindling
   C. New Born: Kit
   D. Immature Male/Female: Fryer
   E. Female: Doe
   F. Male: Buck

Animal Species and Breeds:
1. There are a variety of species throughout the world that are considered livestock and used for production. All have unique characteristics and display different traits associated with their species, and often further classified by breed.

Cattle - Beef Breeds:
1. Bos Taurus – scientific term for cattle, primarily originating from the eastern hemisphere, Euro and African descent. Commonly referred to as British (or English) & Exotic (or Continental) breeds.

2. British (or also referred to as English) breeds, were imported for their docile nature and high-quality carcasses. Predominant British/English beef breeds in the United States are:
   
   A. Angus - Originated in Northeastern Scotland, black in color, moderate frame size, Polled, Mainly used for meat production in the U.S. and crossbreeding.
      (i) Advantages: Superior marbling abilities, cold tolerant, early maturing, highly fertile, Good mothering and milking ability
      (ii) Disadvantages: lack of size, require cooler climates, lacking in reproductive stamina
      (iii) American Angus Association - http://www.angus.org/
B. Hereford – Originated in Herefordshire, England, coloring includes - white face with red body with white extending down the throat and through brisket and underline with switch of tail and feet also white, medium to large frame, can be horned or polled.

(i) Advantages: Hardiness, grazing ability, reproductive efficient, good disposition, Heavy boned, Thick fleshes

(ii) Disadvantages: Susceptible to eye issues because of pigment, generally low in milk production


C. Shorthorn – Originated on the Northeastern Coast of England, coloring is red, white, or roan, World’s Most Numerous Breed with more than 45 breeds showing traces of shorthorn in their parentage.

(i) Advantages: Maternal traits, Calving ease, Excelling in growth and carcass traits, Good Disposition, Rapid gain in the feedlot

(ii) Disadvantages: Lower quality carcass if fed past optimum slaughter weight

(iii) American Shorthorn Association - https://shorthorn.org/

D. Red Angus - Originated in Scotland, similar to Black Angus but evolved through the expressing of the recessive trait for red coloring.

(i) Advantages: Cold tolerant, good mothering and milking ability, early maturing, little calving difficulty, highly fertile, produce a high quality carcass with good muscling and small bones.

(ii) Disadvantages: Lack of Size, Lacking in reproductive stamina

(iii) Red Angus Association of America - https://redangus.org/

3. Exotic (or sometimes referred to as Continental) breeds, were imported into the United States for their size and growth. Predominant Exotic/Continental beef breeds in the United States are:

A. Chianina – Originated in Italy, coloring is typically off-white or black, but can now vary in solid colors, one of the world’s oldest breeds, originally known it’s large frame size but modern trend is moderate, had a tremendous impact on the “show steer” industry

(i) Advantages: Large Framed, fast growing, Produce lean muscular carcasses

(ii) Disadvantages: late maturing now more moderate frame size, marbling is suspect, lack maternal characteristics
(iii) American Chianina Association - https://chicattle.org/

B. Charolais - Originated in France, typically white to off-white to cream coloration, Large frame size, can be horned or polled, mainly used for meat
   (i) Advantages: Extremely fast growing, produce lean muscular carcasses, excellent Muscling in the loin and hindquarters, heavy boned, good mothering ability, high dressing percentage, cold and heat tolerance
   (ii) Disadvantages: Heavy birth rates, late maturing, wide variation in the breed, marbling can be a problem

(iii) American International Charolais Association - https://charolaisusa.com

C. Gelbvieh – Originated in Germany, color varies from golden red to russet to grey and black, developed as dual purpose breed, leaned toward beef production, moderate sized
   (i) Advantages: Early maturing, good disposition, excellent fertility and milk production, high cut ability
   (ii) Disadvantages: Lack natural marbling

(iii) American Gelbvieh Association – https://gelbvieh.org/

D. Limousin – Originated in France, range from reddish gold to brown to black in color, moderate size
   (i) Advantages: High fertility, calving ease, mothering ability, longevity, adaptability
   (ii) Disadvantages: Below average maternal stamina, slow maturing, lack natural marbling ability, bulls tend to lack docility

(iii) North American Limousin Foundation - https://nalf.org/

E. Maine-Anjou – Originated in France, deep red color to black sometimes with white underline and patches, largest continental breed in terms of weight, popular breed in the production of show steers for youth
   (i) Advantages: Large size, heavy weaning weight, rapid growth rate, good milking ability, good mothering ability, feed efficiency
   (ii) Disadvantages: Coloration concerns, large size leads to birthing issues

(iii) American Maine-Anjou Association - https://maine-anjou.org/
F. Simmental – Originated in Switzerland, range in color from any solid to painted combination
   (i) Advantages: Longevity, early maturing, feed efficient, gentle disposition, heaviest milking Exotic breed, large framed with large mature size, highly fertile
   (ii) Disadvantages: Calving difficulties, variation in color, marbling is below average
   (iii) American Simmental Association - https://simmental.org/

4. Bos Indicus
   A. Originated in South Asia from the zebu/Brahman type breeds that are known for their high heat tolerance, drought tolerance, and disease/parasite resistance. Notable for their excessive skin folds, and obvious hump above their shoulders. Brahman influenced cattle are most commonly known as American Breeds, as they all originated in America.
   B. Brahman - Originated in India, Red or gray with black pigmentation, naturally horned, very large frame size
      (i) Advantages: heat tolerant (thrive in hot, humid climates of the south), disease and insect resistant (Ticks, flies, and mosquitoes and the diseases they may carry).
      (ii) Disadvantages: Poor marbling, late sexual maturity, lack of cold tolerance, late maturing, low fertility
      (iii) American Brahman Breeders Association - https://brahman.org/
   C. Brangus – Cross began in Louisiana as early as 1932, a combination of 5/8 Angus and 3/8 Brahman, black color, naturally polled, intermediate carcass merit between the two parent breeds, and moderate frame size
      (i) Advantages: mothering ability, good growth rates, thick conformation, heat tolerant and excellent foraging ability
      (ii) Disadvantages: Bad disposition, limited cold tolerance, late sexual maturity
      (iii) International Brangus Breeders Association - https://gobrangus.com/
   D. Red Brangus – Cross began in Texas as early as 1936, a combination of 5/8 Angus and 3/8 Brahman with a specific retention of red gene calves, naturally polled, and moderate frame size
      (i) Advantages: Excellent mothering ability, early maturing, extremely heat tolerant

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(ii) Disadvantages: Lack of cold tolerance, below average disposition

(iii) American Red Brangus Association - https://americanredbrangus.org/

E. Simbrah - Developed in the Gulf Coast regions in late 1960’s, originally a combination of 5/8 Simmental and 3/8 Brahman, but breeding programs can be flexible with percentages to maintain percentage registration, color varies, medium frame size

(i) Advantages: Longevity, maternal calving ease, hardiness, rapid growth, adaptability and excellent foraging ability

(ii) Disadvantages: No set color pattern, below average feedlot efficiency

(iii) Registry is maintained by the American Simmental Association

F. Santa Gertrudis - Developed on the King Ranch in Kingsville, TX during the 1920’s, consist of 5/8 Shorthorn and 3/8 Brahman, uniquely a dark red/burgundy color, can be horned and polled with a large frame size

(i) Advantages: Good maternal ability, productive under hot, adverse conditions, adaptable and hardy, good foraging ability, large lean muscling

(ii) Disadvantages: Not considered docile, late maturing, coarse if fed too long, bulls can have pendulous sheaths, below average fertility rates

(iii) Santa Gertrudis Breeders International - https://santagertrudis.com/

G. Beefmaster - Developed by Tom Lasater from Falfurrias, TX in 1930’s, approximately ½ Brahman, ¼ Shorthorn, and ¼ Hereford, no set color pattern, can be horned or polled, considered America’s all-purpose breed

(i) Advantages: Consistently produce Choice grade carcasses, docile, good mothering ability, high feed efficiency, longevity

(ii) Disadvantages: Lack of uniformity, no set color pattern

(iii) Beefmaster Breeders United - https://beefmasters.org/

H. Braford – Established through breeding programs in both Florida, and Queensland, Australia between 1946-47, purebred combination originally consisted of 3/8 Brahman and 5/8 Hereford, but can be recognized as ½ and ½ today, unusual color patterns could be brindle or mottled and various combinations, with a medium frame size.

(i) Advantages: Thrive under little management, good mothering ability, feed efficient, heavy weaning weights, adaptability

(ii) Disadvantages: Lack cold tolerance, variation in breeding percentages

(iii) United Braford Breeders - https://brafords.org/
Dairy Breeds:

1. Holstein – Origin: Netherlands, Imported to the US in 1852 (Massachusetts)
   A. Black and white color pattern, large framed, easy going nature
   B. Annual Milk Production Average 25,000lbs (around 2900 gallons)
   C. Most dominant breed of dairy cattle in U.S. (over 90% of all commercial dairy cattle)
   D. Produce lowest butterfat content (3.6%), not as valuable for cheese, butter and non-fat dry milk production
   E. Holstein Association USA - http://www.holsteinusa.com/

2. Jersey – Origin: Isle of Jersey in the English Channel, Imported to the US in the 1850’s
   A. Color varies from light grey/tan to dark fawn, Medium size frame
   B. Annual Milk Production Average 10 - 13,000lbs (Around 1100-1500 gallons)
   C. Produces more pounds of milk per body weight than any other dairy breed
   D. Produce highest butterfat content (4.7%), making it the second most popular breed
   E. American Jersey Cattle Association - https://www.usjersey.com/

3. Guernsey - Origin: Isle of Guernsey off the Coast of France, Imported to the US in 1840
   A. Red (Fawn) and White in color, Medium sized
   B. Annual Milk Production Average 10, 600lbs (Around 1100 gallons)
   C. Produce golden milk due to high beta carotene
   D. Second highest percentage butterfat (4.5%)
   E. American Guernsey Association - https://www.usguernsey.com/

   A. Solid brown, vary from light to dark with light colored band around the muzzle
   B. Annual Milk Production Average 12,100lbs (Around 1400 gallons)
C. Oldest Dairy Breed

D. Brown Swiss Association - https://www.brownswissusa.com/

5. Ayrshire - Origin: Scotland, Imported to US in 1822
   A. Red and white in color (amount varies), Medium sized
   B. Annual Milk Production Average 11 – 14,500lbs (Around 1250 – 1700 gallons)
   C. Excellent grazers that do well under pasture conditions

   A. Red and white or any combination of red and white, Medium size
   B. Annual Milk Production Average 15,000lbs (Around 1700 gallons)
   C. Dual purpose breed, split from the American Shorthorn Assoc.(beef) in 1949

7. Milking Devon - Origin: Brittan, Imported to US in 1623
   A. Red to chestnut in color with any addition of white, medium size
   B. No longer a primary milking breed in U.S., was a multiple purpose breed
   C. Milk is good for creams and cheeses
   D. American Milking Devon Cattle Association - https://www.milkingdevons.org/

Additional Resources:

   (i) http://afs.okstate.edu/breeds/cattle/

   (ii) https://www.thecattlesite.com/breeds/beef/

Swine

1. Maternal Breeds:
   A. Landrace – Originated in Denmark in 1895, imported to US in 1934
      (i) White hair and skin, with very large drooped ears
(ii) Known for their maternal instincts

(iii) Longer than other breeds, known for its length

(iv) Sows are prolific, farrow large litters, and have good mothering ability

B. Chester White - Originated in Chester County, Pennsylvania
   (i) White with drooped ears

   (ii) Mothering breed, known to produce large, fast growing litters

C. Yorkshire - Originated in England, County of York, Imported to United States 1830
   (i) Large white/pink bodies with large, erect ears

   (ii) Known as “The Mother Breed” – Excellent mothering ability and produces large litters, very prolific

   (iii) One of most recorded breeds of swine in United States, used widely in crossbreeding programs

2. Terminal Breeds:

   A. Berkshire – Originated in Berkshire County, England, Brought to U.S. in 1823
      (i) Black with six white points: legs, snout and switch, with erect ears

      (ii) Known for producing high quality meats

      (iii) One of oldest, improved breeds of swine

   B. Duroc - Originated in the United States (NJ, NY & CT) in 1885
      (i) Solid medium cherry red; shades vary golden yellow to dark red, with drooped ears, and slight dish to the face

      (ii) Identified as superior genetics source for improving quality

      (iii) Most popular in U.S. due to female longevity, prolificness; terminal sire lean gain efficiency, carcass yield, product quality

   C. Hampshire - Originated in southern Scotland, Northern England, US bred in Kentucky
      (i) Probably the oldest American breed and also known as “Old English Breed”
D. Hereford - Originated in Missouri
   (i) Developed from crossing Berkshires and Durocs

   (ii) Red with white face, legs and underline, with medium-sized, drooping ears

E. Poland China - Originated in the US between 1800 and 1850 in Ohio
   (i) Black with six white points: blazed white face, white feet, white tip of tail with drooping ears

   (ii) Noted for ability to easily gain weight

   (iii) Quiet dispositions, but generally poor mothers

F. Spots - Developed in Indiana, derived from Poland China breed
   (i) Black and white spots, any combination

   (ii) Large breed known for producing fast growing, feed efficient offspring

Additional Resources:
   (i) For Duroc, Hampshire, Landrace and Yorkshires - https://nationalswine.com/

   (ii) For Chester Whites, Herefords, Poland China and Spots - https://cpsswine.com/

   (iii) For Berkshires - https://americanberkshire.com/

Lambs/Sheep

1. Fine-wool Breeds:

   A. Merino – Originated in Spain
      (i) White-faced, white legs, Head and legs covered with wool

      (ii) Rams - 175 to 235lbs; ewes - 150 to 175lbs
(iii) Extremely hardy; popular where poor grazing conditions and adverse weather exist

(iv) Annual fleece weight ranges from 12-20lbs, with grade from 64s in spinning count to as high as 80s

B. Rambouillet - Developed as breed in France, imported to U.S. in 1840
   (i) Descendant of Spanish Merino

   (ii) Large, wide head; white hair around nose and ears, wool covers most of face and legs, Body fleece close and compact

   (iii) Rams: horned or polled; weight: 190-300lbs, Ewes: polled; weight: 120-210 lbs.

   (iv) Wool production: very acceptable; annual fleece weight ranges 8-18lbs

C. Debouillet – Developed in 1930 in New Mexico,
   (i) Cross between Delaine Merino ram & Rambouillet ewe

   (ii) White-faced, white legs, open faced and smooth bodied

   (iii) Rams: horned or polled, 150-250lbs and Ewes: polled, 125-170lbs

   (iv) Fleece production fairly uniform in grade, annual fleece weight: 8-16 lbs.

2. Medium-Wool Breeds:

A. Cheviot - Originated between England and Scotland, imported to U.S. in 1838
   (i) Face and legs free of wool, covered with white hair. Nose, lips, and feet are black in color.

   (ii) Rams: horned or polled; weight: 200 - 300lbs, Ewes: polled; weight: 150-225lbs

   (iii) Fleece is light; annual average 5-8lbs

B. Dorset – Originated in England, Imported to U.S. in 1885
   (i) Face, ears, legs: white in color, practically wool free

   (ii) Mature rams: 225 - 275lbs, Mature ewes: 150-200lbs

   (iii) Fleece is light; annual average 4-10lbs

C. Hampshire - Originated in Hampshire County, England, Imported to U.S. in 1860
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(i) Face, ears, and legs are rich brown/black, and wool-free

(ii) Both sexes polled, Mature rams: 275lbs +, Mature ewes: 200lbs +

(iii) Fleece is medium quality; annual average 8lbs

(iv) Most noted for carcass cutability and prolific

D. Shropshire - Originated in England, Imported to U.S. in 1855
   (i) Face, ears, legs range in color from dark brown to soft black
   (ii) Rams: 225 - 275lbs, Ewes: 160-190lbs, polled with dense wool covering
   (iii) Considered good dual-purpose breed; produces very desirable carcass, annual wool weight averages 10 lbs.

E. Southdown - Originated in hills of Sussex County, England, Imported to U.S. in 1803
   (i) Face, legs, ears are light/mouse brown and wool covers face and legs
   (ii) Mature rams: 210lbs, Mature ewes: 160lbs
   (iii) Excels in carcass quality, body conformation, and early maturing
   (iv) Criticized for lightweight fleece; annual fleece weight: 3-8 lbs

F. Suffolk - Originated in England, Imported to United States 1888
   (i) Black face, black legs, black ears; all free from wool with small head
   (ii) Both sexes polled, Mature rams: 300lbs +, Mature ewes: 200-225lbs
   (iii) Very large bodied, prolific
   (iv) Wool is not most desired, annual fleece weight: 5-8 lbs

3. Cross/Other Breeds:

A. Columbia - First breed developed in U.S. in 1912, Laramie, Wyoming
   (i) Open face, white hair on face and feet, Hooves either white or black in color
   (ii) Both sexes polled, Mature rams: 175-300lbs, Mature ewes: 130-225lbs
   (iii) Largest crossbred-wool type
   (iv) Produce high-quality fleece; annual weight of 10-18 lbs
B. Dorper – Developed in South Africa between 1930s-40s
   (i) Two distinct strains: Dorper, White Dorper
   (ii) Coat is mixture of hair, short wool which sheds, eliminating shearing
   (iii) Excellent in adapting to range grazing, heat, insect tolerance
   (iv) Extremely prolific, rapid growing lambs

Additional Resources:
   (i) For all Breeds - https://sheepusa.org/contacts-industry-breedassns
   (ii) For all Breeds - http://afs.okstate.edu/breeds/sheep

Goats

1. Dairy Breeds:

   A. Alpine - originated in the Alps, developed in France
      (i) Medium to large size animal, alertly graceful, with erect ears, offering all colors and combinations of colors

   B. Guernsey – Developed in Britain from 1920s-1950s
      (i) Medium size with forward erect ears and coat/hair color should be shades of gold
      (ii) Guernsey Goat Breeders of America - http://guernseygoats.org/

   C. LaMancha - originated from Spain, developed on West Coast in California & Oregon
      (i) Any color or combination of colors is acceptable with hair that is short, fine and glossy. Come with 2 distinct ear types – Gopher ears & elf ears
      (ii) American LaMancha Breeders Association - http://www.lamanchas.org/

   D. Nigerian Dwarf – Originated in West Africa and developed in the United States
      (i) Miniature breed of dairy goat

   E. Nubian - originated from Sudan, developed in Britain
Any color or combination of colors is acceptable with hair that is short, fine and glossy. Come with long pendulous ears – known for high quality, high butterfat, milk production

(ii) International Nubian Breeders Association - http://i-n-b-a.org/

2. Fiber Breeds:

   A. Angora - originated in district of Angora in Asia Minor, dating to 1500 B.C.
      (i) Produce Mohair – a strong, smooth fiber with elastic properties and easily dyed


   B. Cashmere – Developed in U.S. using select Spanish meat goats and goats from Australia

      (i) Produces a desirable silky fiber undercoat, usually of solid colors

      (ii) Cashmere Goat Association - https://cashmeregoatassociation.org/

3. Meat Breeds:

   A. Spanish - originated from Spain, developed throughout history around the world
      (i) Versatile, mixed influenced breed that is adaptable, require minimal care

      (ii) Spanish Goat Association - http://www.spanishgoats.org/

   B. Boer – Developed in U.S. using select Spanish meat goats and goats from Australia

      (i) Known for its rapid growth rate, excellent carcass qualities and is highly adapted to different environments.

      (ii) Characterized by its solid white body and solid colored head, typically red/bronze

      (iii)American Boer Goat Association - http://abga.org/

   C. Kiko - originated from New Zealand, imported to U.S. in 1992

      (i) Created for meat production, hardiness, fast growth and survivability

      (ii) American Kiko Goat Association - https://kikogoats.com/

   D. Mytonic (Fainting) – Documented in U.S. around 1870’s in Tennessee
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(i) Known for its excellent mothering abilities, year around breeders that are self-sufficient

(ii) International Fainting Goat Association - https://www.faintinggoat.com/

Additional Resources:
1. For all Breeds - https://americangoatfederation.org/resources/
2. For all Breeds - http://afs.okstate.edu/breeds/goats

Poultry Species

1. Chickens - classified as layers or broilers, and standard or bantam breeds
   A. Cornish – Primary broiler breed for meat production
   B. Rhode Island Red – Dual purpose standard breed
   C. Leghorns – Standard Egg production breed
   D. Plymouth Rock – Bantam Variety, used for egg production

2. Ducks – classified as domestic, dabblers or divers
   A. Domestic breeds are raised primarily for meat & egg production, Ex – Peking
   B. Dabbler Breeds - types of shallow water duck that feeds primarily along the surface of the water, Ex – Mallard, Wood Duck
   C. Diving Breeds – also called sea ducks, are typically birds of large, deep lakes and rivers, coastal bays and inlets, and feed by diving beneath the surface, Ex – Canvasback, Ring-Necks

3. Geese – in a domesticated setting, primarily raised for meat, but can be used for eggs
   A. Common Breeds: African, American Buff, Chinese, Embden, Pilgrim, Pomeranian, Roman, Shetland, and Toulouse

4. Quail – Small versatile birds used for meat & egg production, classified into broiler or layer breeds, just like chickens
   A. Broilers Breeds: Bobwhite and White-Breasted
   B. Layer Breeds – Tuxedo, Pharaoh, British Range, English White, Manchurian Golden

5. Turkey – Large commercially raised meat bird. The Broad-Breasted White breed makes up 90% of turkeys commercially grown
Equine Species

1. Light Horse Breeds:
   
   A. American Paint Horse – Originated in United States
      (i) Color – White with any other color; must be a recognizable paint. The three distinct patterns are overo, tobiano, and tovero.
      
      (ii) Height – 14-1 to 16-2 hands
      
      (iii) A Paint Horse is eligible for registry if its sire and dam are registered with the American Paint Horse Association, the American Quarter Horse Association, or the Jockey Club (Thoroughbred). Other breed types may be registered with the Pinto Registry.
      
      (iv) Uses – Stock horses, pleasure horses, show purposes, and racing
      
      (v) American Paint Horse Association - www.apha.com
   
   B. American Saddlebred Horse – Originated in Kentucky
      (i) Color – Bay, brown, chestnut, gray, black, or golden
      
      (ii) Height – 15 to 16 hands
      
      (iii) Three-gaited horses show at the walk, trot, and canter. Five-gaited horses also show at the slow gait as well as the rack.
      
      (iv) Uses – Three- and five-gaited horses (saddle), pleasure horses, stock horses, and fine harness horses.
      
      (v) American Saddlebred Horse Association - https://asha.net/
   
   C. Appaloosa – Originated in Idaho, Oregon, and Washington.
      (i) Descended from horses originating in Central Asia, and in North America were first bred by the Nez Perce Indians.
      
      (ii) Color – Variations and combinations of colors and spots.
      
      (iii) Four distinguishable characteristics are used to identify the Appaloosa: coat pattern, mottled skin, white sclera, and striped hooves
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(iv) Height – 14 to 15–2 hands

(v) Uses – Stock horses, pleasure horses, race horses, parade horses, hunters and jumpers

(vi) Appaloosa Horse Club – www.appaloosa.com

D. Arabian – Originated from Saudi Arabia
   (i) Color – Bay, gray, and chestnut are predominant; with occasional white or black. White marks on the head and legs are common.
   (ii) Height – 14–2 to 15–2 hands
   (iii) The dished face of the Arabian is one of its most distinguishing characteristics.
   (iv) Uses – Saddle horses, show horses, stock horses, pleasure horses, racing, endurance races and competitive trail rides
   (v) Arabian Horse Association – https://www.arabianhorses.org/

E. Morgan – Originated in Vermont
   (i) Color – Predominantly bay, brown, and chestnut, there are also black, palomino, buckskin, and some grays.
   (ii) Height – 14–2 to 16 hands
   (iii) Noted for stamina, docility, beauty, courage, and longevity
   (iv) Uses – Saddle horses, stock horses, and harness horses
   (v) American Morgan Horse Association - https://www.morganhorse.com/

F. Palomino - Originated from animals of Spanish descent, developed in U.S.
   (i) Color – Golden in color with a light-colored mane and tail and no more than 15 percent dark or chestnut hair in either mane or tail
   (ii) Height – 14–2 to 16 hands
   (iii) The type desired in the Palomino will depend entirely on the use for which the horse is intended.
   (iv) Uses – Parade, stock, pleasure, saddle, and fine harness horses
   (v) Palomino Horse Breeders of America - http://www.palominohba.com/
G. Pinto – Originated from descendants of horses brought in by Spanish conquistadors
   (i) Color – White with any other color. There are two distinct patterns of pintos; they are tobiano and overo.

   (ii) The Pinto Horse is a color breed rather than a type breed. The Pinto Registry is unlike the American Paint Horse Association in that it accepts several different types of breeds.
   (iii) Uses – Hunters, polo mounts, racing, saddle horses, and stock horses

   (iv) Pinto Horse Association of America - https://www.pinto.org/

H. Quarter Horse – Developed in United States, primarily in the southwestern states
   (i) Color – Gray, black, bay, sorrel, chestnut, brown, buckskin, palomino, dun, grullo, red dun, blue roan, and red roan

   (ii) Height – 15 to 16 hands

   (iii) They are well muscled and powerfully built. Some people consider the quarter horse the most versatile of all breeds

   (iv) The first breed of horse native to the United States.

   (v) Uses – Stock horses, racing, pleasure horses, hunters and jumpers

   (vi) American Quarter Horse Association – www.aqha.com

I. Standardbred – Originated in U.S.
   (i) Color – Bay, brown, and black are the predominant colors with some being chestnut, gray, roan, and dun

   (ii) Height – 15 to 16 hands

   (iii) The breed was developed primarily for harness racing; a pleasing conformation and an abundance of style and quality are important requirements

   (iv) Uses – Harness racing, trotting or pacing, and show horses

   (v) U.S. Trotting Association - http://www.ustrotting.com/

J. Tennessee Walking Horse – Originated in Tennessee
   (i) Color – Sorrel, chestnut, roan, black, white, golden, gray, bay, and brown
(ii) Height – 14–3 to 17 hands

(iii) This breed has three easy-riding gaits. They are the flat-foot walk, the running walk, and the canter. All of these gaits are natural, inherited characteristics.

(iv) Uses – Pleasure horses, plantation walking horses, and show horses

(v) Tennessee Walking Horse Breeders’ & Exhibitors’ Assoc. - https://www.twhbea.com

K. Thoroughbred – Originated in England, developed as a running horse
   (i) Color – Bay, brown, chestnut, sorrel, black, and gray; white markings on the face and legs are common.

   (ii) Height – 15 to 16–2 hands

   (iii) Conformation emphasizes factors contributing to racing and sports.

   (iv) Uses – Race horses, saddle horses, hunters and jumpers, and polo mounts

   (v) Thoroughbred Owners and Breeders Association - https://toba.org/

   (vi) National Thoroughbred Racing Association – www.ntra.com


2. Breeds of Ponies:
   A. Miniature Horse – Originated in England
      (i) Color – Any color or marking pattern as well as any eye color is acceptable.

      (ii) Height – No more than 34 inches

      (iii) Uses – Pets and show

      (iv) Miniatures were first used to pull ore carts in the coalmines of England and Northern Europe.

      (v) American Miniature Horse Association – www.amha.org

   B. Pony of the Americas – Originated in Mason City, Iowa
      (i) Color – Very similar to the Appaloosa; several color patterns are acceptable.
(ii) Height – 46 to 54 inches

(iii) The breed standard calls for a conformation between that of the Quarter horse and the Arabian.

(iv) Uses – Primarily used by juniors who have outgrown Shetland ponies but are not ready for a horse

(v) Pony of the Americas Club – www.poac.org

C. Shetland Pony – Originated in Shetland Isles
   (i) Color – Any color, solid or mixed

   (ii) Height – Two class sizes are recognized by the breed registry: (under 43 inches), (43 to 46 inches)

   (iii) Develops long shaggy outer coat during winter months and has a full mane and tail

   (iv) One of the oldest breeds in existence

   (v) Uses – Used mainly by children for riding, but also used for harness, racing, and roadster

   (vi) American Shetland Pony Club - https://www.shetlandminiature.com

D. Welsh Pony – Originated in Wales
   (i) Color – Usually gray, roan, black, brown, bay or chestnut; cream, white, and dun colors may be found.

   (ii) Height – Two divisions are acceptable in the American Welsh Stud Book:
      (a) “A” Division – Cannot exceed 12–2 hands.

      (b) “B” Division – Over 12–2 but not more than 14–2 hands.

   (iii) Weight – Usually less than 500 lbs. For the “A” type, and for the “B” type, 500 to 900.

   (iv) Uses – Used mainly by children for riding, but also used for harness racing, trail riding, and parades

   (v) Welsh Pony & Cob Society of America – www.wpcsa.org

3. Warmblood Breeds:
   A. American Warmblood – Originated in United States, from our own sporting horses
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(i) Color – Any color, preferably solid with few white markings

(ii) Height – 16 to 17 hands

(iii) Unlike many other breed registries, the American Warmblood consists of horses with varying breed backgrounds that qualify to be registered with the American Warmblood Registry either by pedigree or through their individual performance and conformation.

(iv) Uses – Dressage, driving, jumping and three-day eventing

(v) American Warmblood Registry - https://americanwarmblood.com/

B. Hanoverian – Originated from Lower Saxony in Northern Germany
   (i) Color – Should be a solid color, e.g. bay, chestnut, gray; excessive white is not desired

   (ii) Height – 16 to 17 hands

   (iii) Known as a noble horse with a cooperative temperament, elastic gaits and for outstanding ability in international equestrian disciplines

   (iv) Uses – Dressage, driving, jumping and three-day eventing


C. Holsteiner – Originated from Province of Schleswig-Holstein in Northern Germany
   (i) Color – Bay with a preference for no or few white markings

   (ii) Height – 16 to 17 hands

   (iii) This breed is known for its relaxed and willing temperament with good character and an eagerness for work. It is also noted for carrying its head in a beautiful arch and for its excellent jumping ability.

   (iv) Uses – Dressage, driving, jumping and three-day eventing

   (v) N. American Breeding District of Holsteiner Verband - https://www.holsteiner.com/

D. Trakehner – Originated from Trakehner, East Prussia
(i) Color – Should be a solid color, e.g. bay, chestnut, sorrel or gray without excessive white markings

(ii) Height – 15–3 to 16–3 hands

(iii) This breed was originally developed as a new type of cavalry mount for the Prussian army. It is noted for having a “floating trot” and excellent balance, which allows it to excel in dressage

(iv) First introduced to North America in 1957 with the importation of 4 stallions and 12 mares

(v) Uses – Dressage, hunting, jumping and three-day eventing


4. Draft Breeds:

A. Belgian – Originated in Belgium
   (i) Color – Chestnut and sorrel are the dominant colors of the breed, but roans and bays are occasionally seen.

   (ii) Size – Known for its draftiness, and for being the widest, deepest, most compact massive, and lowest set draft breed

   (iii) Height: 15–2 to 17 hands (stallion)

   (iv) Very docile, quiet, and gentle

   (v) The most numerous draft breed.

   (vi) Uses – Exhibition purposes, special attractions, and farm work

   (vii) Belgian Draft Horse Association - https://www.belgiancorp.com/

B. Clydesdale – Originated in Scotland
   (i) Color – The most common color is bay. However, black, brown, chestnut, and roan are occasionally seen. Four white socks and a well-defined blaze or bald face is preferred.

   (ii) Size – Medium draft breed

   (iii) Height – 16–2 to 18 hands (stallion)

   (iv) Superior style and action
(v) Heavy feathering of feet

(vi) Uses – Exhibition purposes, special attractions, farm work

(vii) Clydesdale Breeders of the USA - http://www.clydesusa.com/

C. Percheron – Originated in France
   (i) Color – Black or gray, but bay, brown, chestnut, and roan are occasionally seen.
   (ii) Size – Intermediate, between the Clydesdale and Belgian
   (iii) Height: 16–2 to 17–3 hands (stallion)
   (iv) Extremely docile
   (v) Noted for its clean-cut head
   (vi) Uses – Exhibition purposes, special attractions, and farm work. Percherons are sometimes mated with thoroughbreds to produce hunters and jumpers
   (vii) Percheron Horse Association of America - https://www.percheronhorse.org/

D. Shire
   (i) Origin – England
   (ii) Color – Black, brown, gray, or chestnut/sorrel. Excessive white markings and roaning are undesirable.
   (iii) Size – Large, matched in weight only by the Belgian
   (iv) Height: 16–2 to 17–1 hands (stallion)
   (v) Used as war horses in the 15th and 16th centuries
   (vi) Uses – Exhibition purposes, special attractions, and farm work
   (vii) American Shire Horse Association - https://shirehorse.org/

5. Mules:
   A. Created by crossbreeding a horse with a donkey
   B. Typically produced by a male donkey (a jack) and a mare
C. Due to crossbreeding of species, mules are inherently sterile

D. Phenotypic features will depend on parents breed

E. American Mule Association - https://americanmuleassociation.org/

6. Donkeys:
   A. Distinct for their long ears and braying call
   B. Origin dates back to more than 5000 years ago
   C. Most commonly used as a pack animal and herd protector
   D. Can live 20-50 years
   E. Wild donkeys are referred to as a burro
   F. More than 50 breeds and variations can be found around the world. Most popular include:
      (i) Bethlehem
      (ii) American Mammoth
      (iii) Miniature donkeys

Small Animal Species

1. Small animal species in the United States are usually used for showing, recreation or companionship. The small animal industry is a large and growing segment of animal agriculture.

2. Canine (Dog) Breeds:

   A. Herding Group- Are born with the instinct to control the movement of animals
      (i) Include the following breeds: Australian Cattle Dog (Blue or Red Heeler), Australian Shepherd, Collie, Border Collie, German Shepherd, Old English Sheepdog, Shetland Sheepdog, Pyrenean Shepherd, Welsh Corgi – Cardigan, Welsh Corgi – Pembroke

   B. Working Group - Are bred to do work such as pull sleds, make water rescues and protect property
      (i) Include the following breeds: Alaskan Malamute, Bernese Mountain Dog, Boxers, Doberman Pinscher, Great Dane, Great Pyrenees, Mastiff,
Newfoundland, Portuguese Water Dog, Rottweiler, Siberian Husky, Saint Bernard, Standard Schnauzer

C. Hound Group - Are bred with a good sense of smell, high stamina and hunting performance
   (i) Include the following breeds: Afghan Hound, Basenji, Basset Hound, Beagle, Black and Tan Coonhound, Bloodhound, Dachshund, Greyhound, Rhodesian Ridgeback, Whippet

D. Sporting Group - Are bred for their natural instinct in water and woods, which allow them to be great hunting and field activity dogs
   (i) Include the following breeds: Brittany, English Cocker Spaniel, Cocker Spaniel (American), English Setter, German Shorthaired Pointer, Golden Retriever, Irish Setter, Labrador Retriever, Vizsla, Weimaraner

E. Non-Sporting Group - Are dogs which lack the qualities and characteristics of a hunting dog
   (i) Include the following breeds: Bichon Frisé, Boston Terrier, Bulldog, Chinese Shar-Pei, Chow Chow, Dalmatian, Lhasa Apso, Poodle (Standard), Shiba Inu

F. Terrier Group- Are traditionally bred to hunt, especially rodents & varmint
   (i) Include the following breeds: Bull Terrier, Parson Russell Terrier, Airedale, Border, Carin, Norwich, Rat Terrier, Scottish, West Highland White

G. Toy Group- Are bred for their small size and companionship
   (i) Include the following breeds: Cavalier King Charles Spaniel, Miniature Pinscher, Pekingese, Brussels Griffon, Chihuahua, Maltese, Papillon, Pomeranian, Pug, Shih Tzu, Yorkshire Terrier

H. Miscellaneous Class
   (i) Breeds that are not yet eligible for full American Kennel Club Privileges (AKC) until they receive full recognition, but are still enrolled in the AKC Foundation Stock Service

3. Feline (Cat) Breeds:

A. Common domestic cat breeds found in the U.S. include:
   (i) Abyssinian

   (ii) American Shorthair

   (iii) Balinese
(iv) Birman
(v) Burmese
(vi) Devon Rex
(vii) Domestic Long/Shorthair
(viii) Egyptian Mau
(ix) Exotic Shorthair
(x) Havana Brown
(xi) Maine Coon
(xii) Manx
(xiii) Persian
(xiv) Ragdoll
(xv) Russian Blue
(xvi) Scottish Fold
(xvii) Siamese
(xviii) Sphynx

4. Avian (Bird) Breeds:

A. Common domestic birds kept as companions in the U.S. include:
   (i) African Gray Parrot
   (ii) Canary
   (iii) Cockatiel
   (iv) Cockatoos
   (v) Love Birds
   (vi) Macaw Birds
Animal Production Systems
1. Animal production refers to the production of animal in specialized operations. Based on the type of animal, productions systems may vary greatly.

Beef Production Systems
1. Total Cattle Population in United States nears 100 million (economic impact approx. $50 billion)

2. Top 5 cattle producing states: Texas, Kansas, Nebraska, California, Oklahoma

3. Types of Operations
   A. Cow/Calf Production – an operation that focuses on calf production through weaning.
      (i) Cattle graze in herds in large pastures

      (ii) Calves are kept with their mothers.

      (iii) Most cow/calf operations are family owned

      (iv) Calves range in age from birth to approximately 6-8 months of age

      (v) Ranchers produce cattle for the stocker market or feedlot or other breeding herds

   B. Stocker – (Backgrounding) a growing program for feeder cattle from time calves are weaned until they go to a feedlot.
      (i) Calves of similar age and weight are kept together and graze on pasture.

      (ii) Calves begin to receive grain to supplement their diets.

      (iii) Many Stocker/backgrounding operations are family owned.

      (iv) Calves come from the cow/calf operations and are raised until they are approximately 700 - 900 pounds, or 12-18 months old, pending on breed/market

   C. Feedlot – Enterprise in which cattle are fed grain and a balanced diet for 90-120 days.
Feedlots range in size from less than 100-head capacity to many thousands.

Cattle are kept in groups of approximately 100 head.

Cattle are kept in large lots allowing at least 125 square feet per head.

They are fed a scientifically formulated ration and have constant access to water.

The health of the livestock is carefully monitored, usually 1-2 times per day.

Cattle are fed until they reach approximately 1,000 – 1,400 pounds.

**Dairy Production System**

1. Production Cycle
   A. New Born
      (i) Calves are separated from cow usually within 24-72 hours after birth
      (ii) Fed colostrum within two hours
      (iii) Heifers typically tattooed in left ear on day of birth
      (iv) Umbilical cord is dipped in iodine
      (v) Colostrum from first 6 milkings saved and fed to calf
   B. Calf – up to 6 months
      (i) Fed milk for 6-8 weeks, slowly converted to dry feed rations with free choice hay
      (ii) Dehorned at 5 or 7 weeks of age with an electric dehorning iron
      (iii) Calves ear tagged or tattooed if still needed
      (iv) De-wormed every 6 weeks as needed
      (v) Males are typically sent to be processed for veal, or to be fed out for later harvest, with few retained for genetic/breeding purpose
(vi) Females are either retained in the herd, sold to another herd or sent to be processed

C. Retained Females
   (i) Typically bred at 12-15 months, depending on breed

   (ii) Peak lactation occurs 4-8 weeks after calving

   (iii) Continue to produce milk for up to 40 weeks, before entering dry cow phase

   (iv) Typically bred once a calendar year

   (v) Artificial Insemination technique is primary breeding technique for selection and safety purpose

2. Dairy Production Facts
   A. Dairy cattle are the most efficient among domestic livestock in production of protein and energy.

   B. 20,000 lbs. of milk in 305 days = 640lbs of high quality protein. This equals: ten 1200lbs steers or thirty-two 200lbs pigs

   C. Consumption of Dairy Products Provides: 22% of U.S. protein consumed and 76% of U.S. calcium consumed

   D. 1 gallon of milk equals 8.6lbs

   E. Dairy cattle provide a versatile food source
      (i) Liquid, Fluid Milk

      (ii) Cheese, Cream, Butter and yogurt

      (iii) Dry milk

      (iv) Frozen desserts, etc.

   F. 40,000 US dairy farms exist
      (i) Number decreases every year with industry struggles

      (ii) Majority are located in the Midwest, followed by the Northeast regions

   G. Largest cooperative in the world is Dairy Farmers of America (DFA). It buys and markets milk over 2/3rds of the U.S.
H. Dairy Herd Improvement Association (DHIA) – was started in 1926 and has the most extensive and complete record system in the livestock species. Information evaluated includes milk yield, fat yield, income over feed cost, reproductive information, and a herd summary.

(ii) Records are used as appraisal of productive worth of dairy cows and to prove dairy sales

(iii) http://www.dhia.org/

Sources
https://extension.psu.edu/dairy-heifer-production

Swine Production System

1. Types of swine operations:
   A. Feeder-pig producers
   B. Market-hog producers

2. Purebred producers produce high-quality boars to:
   A. Improve the genetic makeup of one breed of swine.
   B. Purebred boars bred to crossbreed sows & increase hybrid vigor.

3. Types of Systems:
   A. Indoor – Environmentally controlled buildings that house swine at similar stages of development
   B. Outdoor – Systems where swine have access to the outdoors and shelter buildings are not environmentally controlled

4. Production Cycle of Swine
   A. Farrow – Pigs from birth until approximately three weeks old or 10-15 pounds
      (i) Sows are placed in individual farrowing pens or stalls
      (ii) Protects the piglets, usually 9-10 pigs per litter, from getting crushed by the sow.
      (iii) Highest loss of piglets happens from birth until they are 3-4 days old.
      (iv) Several protective measures are taken to protect the young pigs:
         (a) The navel is disinfected
(b) Needle teeth are clipped so they do not injure other pigs or the sow

(c) They receive a supplement of iron

(d) Their tails are docked to prevent damage from getting stepped on

(e) Young males are castrated so they do not injure other pigs or workers

B. Nursery – Pigs from approximately three weeks (10-15 pounds) until nine weeks old (40-60 pounds)
   (i) Pigs are housed on slatted floors that let waste fall through, keeping the pigs clean

   (ii) Pigs are fed as many as five different diets changed to meet the needs of the growing pig

C. Grower to Finish – Pigs from approximately nine weeks old (40-60 pounds) until they are approximately 265-275 pounds
   (i) Pigs are focused on growth and development

   (ii) Although types of housing vary, they are kept as clean and comfortable as possible to ensure high rates of gain

   (iii) Diets are adjusted to meet the needs of the specific needs of the pigs at stage of growth

D. Market – Pigs weighing approximately 265 pounds
   (i) Pigs are marketed to a terminal or live market

Lamb & Goat Production Systems

1. Hair Production- Angora goat is primarily used, produces Mohair. Cashmere goats are used for cashmere.

2. Wool Production – Consist of fine, medium, long and crossbred wool types that produces various fiber strands for market products

3. Meat Production- Spanish and Boer goats are used for meat production. Spanish are hardy and adaptable, Boer are more intensely managed.

4. Dairy Production- very intensely managed, confinement of animals, alternative to cow milk for some people

5. Types of Operations
A. Purebred Flock – Mating of parents from a common genetic group or breed.

B. Commercial Flock – Flocks that sell pounds of meat and/or wood instead of breeding stock.

C. Farm Flock – Slightly smaller operations that are kept more confined in fenced pastures.

D. Range Band – Raised on the range in herds of 1,000 or more

6. Types of Management Systems –
   A. Extensive Management System- sheep and goats are grazed on large tracts of land, little inputs are provided (feed, shelter)

   B. Intensive Management System- sheep and goats are kept in much more confinement than with other system, producers provide feed, shelter, care (feedlots)

Poultry Production Systems:

1. Vertical Integration System- raising, processing, and distributing poultry is now one continuous chain. A large company is composed of smaller companies that carry out all the processes from manufacturing to distributing

2. Primary Types of Operations –

   A. Commercial Egg Laying Operations
      (i) House laying hens, collecting their eggs to be sent to market or sent to hatcheries

   B. Pullet Growing Operations
      (i) Raise female chicks until they reach egg producing age and are sent to laying operations

   C. Hatchery Operations
      (i) Facility where eggs are transported in mass quantities for hatching using incubators.

      (ii) Primarily produce chicks to send to broiler producers, but special batches to replace pullet populations are also produced

   D. Market Broiler Producers
      (i) Raise chicks for approximately 6 weeks, or until chicks weigh 4lbs or more
(ii) Provide an optimal diet for adequate muscle development/ meat production

(iii) Facilities include optimal housing, typically enclosed barns with expansive space

(iv) Once broilers are finished, they are collected and shipped to processing plants for harvest

E. Breeding Turkey Producers
   (i) Collect eggs from turkeys for the sole purpose of hatching market turkey chicks

   (ii) Eggs are not retained for human consumption since it is not cost effective

F. Market Turkey Producers
   (i) Consists of confinement houses or open range operations

   (ii) Provide free range feeding to allow faster weight gain, high in protein

   (iii) Toms are raised to 17-20 weeks, weighing 26-32lbs

   (iv) Hens are raised to 14-16 weeks, weighing 14-18lbs

Egg Production
1. The primary purpose of egg production is for reproduction
   A. Preventing fertilization of eggs allows for product collection

   B. The eggs are produced in the body and then expelled.

   C. An egg is produced approximately every 18-22 hours. The next egg is released 24 hours after the first egg.

2. Eggs are produced for hatching and consumption.

3. More than 90% of eggs are produced by layers in cages.
   A. The layer chicken puts most of its metabolism toward egg production versus meat production.

   B. Light is used to stimulate hormonal activity. Hens are given 14-15 hours of light daily to keep the egg production process active.

   C. Cage operations provide for adequate room, ventilation, correct temperature, plenty of food, and fresh water.
D. As the eggs are laid, they are rolled onto a conveyor belt and sent to the processing area.

4. Cage-Free & Free-Range Egg Producers are on the rise to meet consumer demands and preferences

5. Eggs to be hatched for broiler production come from breeds of chicken that are large and muscular

6. Quail and Duck eggs are becoming increasingly popular

7. Egg Production Cycle:
   A. Pullets & layers are fed a high-quality diet to meet nutritional needs
   B. Eggs are collected & processed
   C. In processing, eggs are cleaned, graded, and sorted for distribution
   D. Eggs are packaged & shipped to various product markets

8. Housing Systems -
   A. Conventional Housing
      (i) Completely enclosed and utilize environmental control systems
   B. Pole Barns
      (i) Long houses with open or adjustable siding
         (ii) 6,000 to 40,000 birds can be raised in one house
         (iii) The houses are insulated and have ventilators that help with air circulation and remove the heat
         (iv) As the birds grow larger, their body heat will keep them warm in a well-insulated house if cool outside
         (v) Birds are often debeaked upon hatching by removing the tip of the upper mandible of poultry to prevent fighting and reduce risk of injury
         (vi) In addition to debeaking, houses are generally lighted around the clock to prevent cannibalism
         (vii) Many feeding, watering, and air quality systems are computer controlled and monitored now
Equine Production Systems
1. Horse are primarily produced for recreational activities

2. Equine activity types include:
   A. Showing & Exhibition
   B. Racing
   C. Working
   D. Recreation

Animal Needs and Facilities
1. Sanitation, Facilities & Waste Management
   A. Sanitation practices – Act of cleaning; procedures to conduct before, during and after activities to prevent direct contamination
   B. Common Sanitation Chemicals – Alcohols, Iodine/Iodophors, Aldehydes, Quaternary Ammonias, and Chlorine
   C. Methods – Physical, Filtration, Dry Heat, Ultrasound, Autoclave and Radiation

2. Operational Sanitation (Facilities & Housing) - Maintenance of facilities conducive to sanitary practices
   A. HACCP & CCP Tree – are processes that can be used for addressing sanitation procedures for various animal product operations
   B. Isolation and/or quarantine practices should also be in place and planned for to reduce possible contamination of herd/facilities
   C. Pasture Rotation can be utilized to reduce waste build-up and need for pest control intervention

3. Facilities - Proper facilities for housing and handling animals can greatly reduce disease and pest management, potential hazards, and reduce feed waste
   A. The following considerations are important when planning facilities:
      (i) Land requirements
      (ii) Building requirements
      (iii) Fence and pen requirements
      (iv) Water facility requirements
(v) Feeding facility requirements

(vi) Waste management facility requirement

B. Key facility features must include – adequate space, accessibility, ideal location and efficient arrangement of structures such as feeding and working devices

4. Waste Disposal Methods - Dispose in accordance with all applicable Federal State and Local regulations. Always contact a permitted waste disposer to assure compliance.

5. Handling manure and animal waste require appropriate facilities & storage structures:
   A. Solid waste structures - employ walls and slabs for stacking heavily-bedded manure
   B. Semi-solid waste designs - use pumps or scrapers to transport manure into contained areas and may divide solids from liquids; and
   C. Liquid waste facilities - maintain manure in tanks, pits, waste storage ponds, or lagoons.

6. Housing, Bedding and Feeding areas should always be kept up to an appropriate level of sanitation for optimal waste and pest control

7. Pest Control - Can be minimized with proper sanitation procedure, facility design and waste management
   A. Pesticides, Herbicides and Insecticides can be used to manage pest, but should be used on as-needed basis to save on cost and possible contamination issues
   B. Improper application or timing that can lead to contamination of water sources or residues on products
   C. Integrated pest management systems work best

Care and Handling of Animals
1. Common transportation practices
   A. Important to always limit amount of stress on animals
      (i) Examples of ways to do this
   B. Method used depends upon the number of animals transported and the destination (local, national, or even international).
C. Producers must choose cost-effective and safe methods of moving livestock from farms, ranches, and feedlots to markets.

D. Modes of transportation –
   (i) Truck/Trailer
   (ii) Rail car/Railroad
   (iii) Airlines
   (iv) Barges/Ships

E. Considerations to reduce loss and stress:
   (i) Available space (per animal)
   (ii) Temperature (especially for pigs)
   (iii) Ventilation
   (iv) Loading/unloading procedures
   (v) Flooring/FOoting (especially for horses)
   (vi) Limit time/Plan for stops (every 8hrs)
   (vii) Feed/Hay/Water needs (especially long trips)

2. Dangers involved in working with animals
   A. Being around animals
      (i) Demonstrate calmness
      (ii) Refrain from being loud
   B. Approaching animals
      (i) Always approach within vision/eye-sight of the animal
      (ii) Avoid breaking an animals’ flight zone
      (iii) Be aware of the animals point of balance
   C. When not to approach
      (i) If animal appears irritated or aggressive
      (ii) Presence of offspring, and mother is not restrained
   D. Types of Safety Hazards
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(i) Physical

(ii) Chemical

(iii) Biological

(iv) Zoonotic

E. Follow OSHA Protocols and recommendations in animal working

3. Restraint during handling
   A. Properly restraining an animal protects them, and the handler(s)

   B. Restraint Devices and techniques
      (i) Clamps or tongs

      (ii) Nose rings

      (iii) Squeeze chute

      (iv) Working chutes

      (v) Tilting table

      (vi) Grooming chute

      (vii) Roping/Casting

References:
Farm Analyst North Carolina, Improving Storage, Handling, and Disposal of Livestock Waste
UNIT G: Animal Nutrition, Health and Reproduction
Developed by Mrs. Brynn Wittie

STANDARDS:
LA-AGTECH: S14, S15, S27

Goal(s):
1. Explain requirements for proper animal nutrition and select appropriate feed and supplement sources to meet nutritional requirements.
2. Identify general concepts related to animal production and reproduction, animal nutrition, animal pests, diseases and disorders.

Objective(s):
1. Identify major systems of animal anatomy and physiology
2. Identify characteristics of healthy and unhealthy animals
3. Explain requirements for proper animal nutrition and select appropriate feed and supplement sources to meet nutritional requirements
4. Identify methods of formulating feed rations
5. Identify common diseases, parasites and disorders that can negatively impact animal health
6. Identify tools for administering medications and other additives
7. Identify tools to select and apply growth stimulators and implants
8. Identify common terminology related to animal production
9. Describe general animal reproduction practices
10. Identify selection factors related to animal reproduction
11. Evaluate animals for breeding readiness and soundness.

Agritech Guiding Questions:
1. What is the name of the class of animals that have a stomach with four compartments?
2. Where is an intramuscular injection made?
3. What tool is used to restrain cattle from moving while receiving an injection?
4. What are some common by-products of the animal industry?
5. What is the function of the circulatory system in the body?
6. What are the functions of carbohydrates in the diet of a ruminant?
7. What factors should be considered before administering medications to a meat or dairy animal?
8. What device is used to place a pill in an animals throat
Content:
Animal Anatomy and Physiology

1. Skeletal System
   A. The skeletal system is made up of bones joined together by cartilage and ligaments
   B. Purpose is to provide support for the body and protection for the brain and other soft organs of the body
   C. Bone is the main component, made of mineral material that is mostly calcium, phosphate, and calcium carbonate
   D. Bone is 26% minerals, 50% water, 20% protein, 4% fat

2. Muscular System
   A. Purpose is to provide for movement in cooperation with the skeletal system and to support life (as in the heart muscle and the diaphragm)
   B. The lean meat of the animal and the part of the body that is used for consumption (food)
   C. 2 types of muscles –
      (i) Voluntary muscles can be controlled by animals to do such things as walk and eat food
      (ii) Involuntary muscles operate in the body without control by the will of the animal, and they function even while the animal sleeps
   D. Muscles are composed largely of protein. Large amounts of protein are required for the maintenance of the animal and for growth and reproduction

3. Circulatory System
   A. Composed of the heart, veins, arteries, capillaries, and lymph system
   B. Purpose is to transport food and oxygen to the cells of the body and filters waste materials from the body
   C. Contains the Lymphatic circulatory system which operates within the blood circulatory system, and secrete disease-fighting materials into the body

4. Respiratory System
   A. Composed of the nostrils, nasal cavity, pharynx, larynx, trachea, and lungs
B. Provides oxygen to the blood of the animal, and removes waste gases such as carbon dioxide from the blood

C. Allows for breathing and makes use of the muscular and skeletal systems to draw air in and out of the lungs through processes of inhalation and exhalation.

D. Oxygen passes from the lungs to the blood, and transported by the circulatory system

5. Nervous System
   A. Consists of the brain, spinal cord, and the nerves that are distributed throughout the body
   B. Coordinates all of the other body systems
   C. Composed primarily of the central nervous system and the peripheral nervous system
      (i) Central nervous system - includes the brain and the spinal cord
          (a) It is responsible for coordinating the movements of animals and also responds to all of the senses.
          (b) Senses are hearing, sight, smell, touch, and taste.

      (ii) Peripheral nervous system - consists of all nerves that lead to and from the spinal cord, and controls the functions of the body tissues, including the organs.
          (a) Nerves transmit messages to the brain from the outer parts of the body to control functions
   D. Parasympathetic nervous system – maintains and restores normal body function
   E. Sympathetic nervous system – responsible for stress and emergency responses; “fight or flight”
   F. The nervous system is composed primarily of soft tissues, proteins are particularly important in maintaining its health.

6. Urinary System
   A. Primary parts are the kidneys, bladder, ureters, and urethra
   B. Function is to remove waste materials from the blood
7. Endocrine System
   A. Also known as the Hormone system
   B. Hormones are chemicals that helps regulate activities of the body
   C. Some activities are growth, reproduction, milk production, and breathing rate
   D. A group of ductless glands that release hormones into the body
   E. Proper levels of all nutrients, especially minerals, are important for the proper functioning of the endocrine system.

8. Digestive System
   A. Provides food for the body and for all of its systems, while also storing food temporarily, prepares food for use by the body, and removes waste products from the body
   B. Three basic types of digestive systems in animals: polygastric, or ruminant; monogastric, or non-ruminant; and avian or poultry.
      (i) Ruminants are a class of animals that have stomachs with more than one compartment. (Ex – Cattle and Sheep)
         (a) Multi-compartment with different functions
         (b) Largest compartment is known as the rumen, followed by the reticulum, omasum, and abomasum
         (c) Have the ability to break down plant fibers and to use them for food far better than non-ruminants, thanks to bacteria microbes
      (ii) Monogastric means having a stomach with one compartment (Ex. – Swine and Horses)
         (a) Most digestion takes place in the small intestines in these systems
         (b) Usually unable to break down roughages or high fibrous foods, with the exception of horses who have specialized bacterium and a cecum to aid in roughage digestion.
         (c) Most rations are delivered in the form of concentrates
      (iii) Avian/Poultry systems have a type of monogastric digestion, but their system differs with specialized components
         (a) Without teeth to perform mechanization of food sources, avian are outfitted with a crop and gizzard
         (b) Food is swallowed whole and stored in the crop, then it is passed to the gizzard for grinding via muscular force, After the gizzard, contents
move straight to the small intestine

c) They have no ‘True’ stomach

Animal Health

1. Appropriate maintenance and biosafety protocols are key to maintaining healthy animals

2. Knowing signs of good and bad health are essential to give early or proper attention to addressing issues
   A. Good Health features include –
      (i) A normal body temperature, pulse rate, and respiration, or breathing rate
      (ii) Shiny hair coat, bright eyes, pink membranes, and normal/regular urine/fecal movements
      (iii) Ruminants chewing cud is also a good sign.
   B. Bad Health features include –
      (i) High temperatures, labored breathing, and rapid pulse rate.
      (ii) Rough hair coat and dull, glassy eyes are often the first signs.
      (iii) Animals could begin to isolate themselves, hang their heads low, walk slow, pass abnormal feces, or the discharge discolored urine.

3. Common health care practices
   A. Preventative Measures such as vaccines, sanitation and balanced nutrition
   B. Treatment measures such as application of medicines, supplements and care
   C. Important health care skills include:
      (i) Administering Medications/Vaccines – Intramuscular, cutaneous, intracutaneous, subcutaneous, intraocular, intravenous, oral and intranasal
      (ii) Grooming Practices – nail/hoof trimming, bathing, ear cleaning, dental hygiene
      (iii) Apply wound dressings – bandages & braces
      (iv) Animal Identification – applying and reading ID methods such as ear tags, tattoos, ear notches, brands, electronic ids (RFID), neck chains, nose prints and DNA samples
4. Animal growth and maintenance
   A. Growth and development are a continuous processes requiring a balanced combination of biological functions influenced by:
      (i) Nutrition
      (ii) Efficiency of metabolism and respiration
      (iii) Hormonal regulation
      (iv) Immune responses
      (v) Physiological status
      (vi) Diseases and parasites
   B. Animal growth and functions can be influenced by intervention methods, such as growth stimulants and implants
      (i) Stimulants and Implants are selected based on production goals and regulated by the FDA. Examples include:
         (a) Increase in weight gain & feed efficiencies
         (b) Stimulate milk production (BST)
         (c) Increase reproductive functions (gonadotropin-releasing hormone, follicle-stimulating hormone, chemically modified hormones)
      (ii) Implants are only approved to be administered in the ear, embedded in the cartilage

Animal Nutrition
1. Classes of Major Nutrients:
   A. Water
      (i) The largest component of nearly all living things
      (ii) The muscles and internal organs of animals contain 75 percent or more water
         (a) Is the solution in which all nutrients for animals are dissolved or suspended for transport throughout the body
         (iii) Water reacts with many chemical compounds in the body to help break down food into products that can be used by the body
         (iv) The liquid solution in each cell is responsible for this rigidity
(v) Important in regulating the body temperature of animals, through perspiration and evaporation

(vi) The least expensive nutrient for animals, yet most vital

2. Protein
   A. Complex materials that are made of various nitrogen compounds called amino acids

   B. There are essential and non-essential amino acids, requiring consideration of types and quality of proteins being fed to animals
      (i) Monogastrics depend on high quality, concentrated amino acids

      (ii) Ruminants depend more on quantity of proteins vs quality, as they are able to break down and rebuild amino acids as needed in their digestive systems

   C. Continuously by animals to maintain the body, as cells are continually dying and being replaced
      (i) Essential for growth and reproduction

   D. Generally, the most expensive component of animal feed products

   E. Sources include both plant and animal products
      (i) Plant proteins include oil seeds such as soybeans, peanuts, cottonseed, and linseed, or, Good-quality legume hay like alfalfa.

      (ii) Animal protein is generally of greater quality than plant protein and includes tankage, fish meal, blood meal, skim milk, whey, feather meal, and meat products.

      (iii) Urea can be used as a supplement for some protein requirements and is a synthetic source of nitrogen made from air, water, and carbon, but it is only digestible by ruminants beyond weaning age

3. Carbohydrates
   A. Composed primarily of the elements carbon, hydrogen, and oxygen.

   B. Provide energy and heat to animals

   C. Energy obtained from carbohydrates is used for growth, maintenance, work, reproduction, and lactation

   D. Come in 2 forms – Sugars and Starches
(i) Sugars are simple (glucose, fructose, galactose) or compound (sucrose, maltose and lactose)

(ii) Starches are complex, usually fibrous and contain cellulose

E. Make up about 75% of most animal rations

F. Carbohydrates in the diet that are not used quickly are converted to fat and stored in the body

G. Can be found in all plant materials, with major sources comprised of cereal grains (Corn mostly, but also wheat, barley, oats and rye)

4. Fats/Lipids
   A. Has 2.25 times as much energy per gram as carbohydrates
   B. Only small amounts of fat are required in most animal diets
   C. Improves the palatability, flavor, texture, and energy levels of feed.
   D. Been shown to increase milk production and to aid in the fattening of meat animals
   E. Necessary in the body as carriers of fat-soluble vitamins.

5. Vitamins
   A. Available in roughages and concentrates, feeds made from animal by-products, and some are made by the body itself
   B. Required in only minuscule quantities in animals
   C. Act mostly as catalysts for other body processes
   D. Used in animals for clotting of blood, forming bones, reproducing, keeping membranes healthy, producing milk, and preventing certain nervous system disorders

6. Minerals
   A. Important parts of soft tissues and fluids in the body
   B. 15 minerals have been identified as being essential to the health of animals (calcium, phosphorus, sodium, chlorine, potassium, sulfur, iron, iodine, cobalt, copper, fluorine, manganese, molybdenum, selenium, and zinc)
C. It has become increasingly important to provide additional mineral matter to the diet of animals due to changes in natural feeding patterns

D. Mineral supplements are especially important for animals that spend their lives in confinement

7. Composition & Classification of Feeds
   A. Consists of wet and/or dry matter
      (i) Dry feeds generally contain only 10-20% of water
   
   B. Feed is classified into two categories – Concentrates and roughages
      (i) Concentrates are low in fiber and high in total digestible nutrients (TDN)
         (a) Roughages are high in fiber but low in TDN

8. Methods of Animal Feeding
   A. Animals can be fed rations, grazed or a combination of both
   
   B. If an animal is confined, they will require an appropriate fed ration to be provided for them
   
   C. Animals with access to pasture or outside nutrients should have their feed rations balanced or supplemented if not provided the optimal amount of nutrient by the natural resources they have access to

9. Formulation feed rations
   A. The Pearson Square formula can be used to calculate simple rations for animals
      (i) The Pearson square method of balancing rations is a simple procedure that allows you to calculate amount of materials needed in a feed rations.
         (a) It is best used when only two ingredients are to be mixed.

Diseases, Parasites and Disorders

1. Diseases - Can be divided into two major classes: contagious and noncontagious
   A. Contagious -
      (i) Animals must be isolated

         (ii) Caused mostly by bacteria and viruses
   
   B. Non-Contagious
      (i) May be caused by nutrient deficiencies or nutrient excesses, poisonous plants and animals, injection of foreign material, and open wounds
   
   C. Safety/Biohazard protocols should be in place for zoonotic diseases
D. Some diseases may have little or no external symptoms, or may even progress so rapidly that death of the animal precedes the occurrence of noticeable symptoms

2. Symptoms – side effects of diseases, disorders and/or parasites
   A. Poor growth, reduced production, or both
   B. Reduced intake of feed
   C. Rough, dry hair coat; loss of hair or appearance of mange
   D. Discharge from the nose or eyes
   E. Coughing or gasping for breath
   F. Trembling, shaking, or shivering
   G. Unusual discharges, such as diarrhea or blood in feces or urine
   H. Open sores or wounds
   I. Unusual swelling of the body, including lumps and knots
   J. Abortion, or the loss of a fetus before it is born
   K. Peculiar gait, or walking pattern, or other odd movements

3. Process of Immunity
   A. Protects animals from bacteria, viruses and parasites
      (i) Passive immunity antibodies come from outside the body not permanent
      (ii) Active immunity body produces own antibodies permanent

4. Pathogens –
   A. Virus - Cannot reproduce without a host
      (i) Consist of DNA and RNA
      (ii) Can take over the functions of the host cell
   B. Bacteria – Single Celled organisms
      (i) May produce toxins harmful to the body
      (ii) Multiply Rapidly without a host
      (iii) Can be identified by shape (cocci, bacilli, spirilli)
C. Parasites - can be grouped into two general classifications – internal and external  
   (i) Most common internal parasites are roundworms, followed by flukes and protozoa  
   (ii) Most common external parasites include flies, ticks, lice, mites and fleas  

D. Fungi – also known as the study of mycology  
   (i) Live in air, soil, plants and water  
   (ii) Produce transmittable spores which can cause fungal diseases  

E. Protozoa – Greek for first animal, a single celled organism  
   (i) Breath, move and reproduce similar to multi-cellular animals  
   (ii) Can be classified into many different types  

5. Nutritional Deficiencies  
   A. Generally produce observable effects in animals.  
   B. Generally caused by an imbalanced ration or diet of the animal  

6. Examples of Common Diseases –  
   A. Mastitis - An inflammation of the udder.  
      (i) Bacterial infection  
      (ii) #1 money loser for dairymen  
      (iii) Can be treated, but best prevented through proper sanitation of milking machines and bedding  
   B. Ketosis  
      (i) Results from weakening metabolisms of carbohydrates and volatile fatty acids that leads to low blood sugar.  
      (ii) Symptoms include reduced milk yield, reduced feed intake, lost body weight, and a sweetish odor on breath  
      (iii) Usually seen in cows 4-6 weeks after parturition  
   C. Milk Fever  
      (i) Caused by a shortage of calcium salts in the blood.  
      (ii) Common in older, high-producing cows or dairy animals.
D. Scours
   (i) Causes are the pathogenic bacteria E. coli K99, several viruses and stress

   (ii) Diarrhea, weakness, dehydration, and a rough hair coat

   (iii) Prevention includes dry and clean bedding areas and adequate colostrum

E. Pneumonia
   (i) Respiratory disease that occurs when other diseases, parasites, poor nutrition, or severe weather have stressed the animal

   (ii) When detected early, antibiotics are usually effective

F. White Muscle Disease
   (i) Affects two different muscle groups, cardiac and skeletal

   (ii) Treatments include: injections of selenium or oral drenches of selenium/vitamin E

   (iii) Can be prevented by: supplementing the diet of susceptible animals with selenium and vitamin E

G. Bloat
   (i) Can occur in all ruminants

   (ii) Refers to rapid fermentation, producing excess gas or foam in the rumen

   (iii) Is caused by consuming highly concentrated rations and lush legume pastures

H. Colic - is the general term referring to abdominal pain
   (i) Mainly impacts horses because they are unable to vomit

   (ii) Is caused by a wide range of conditions affecting the digestive tract, including: sudden changes in feed, a predominantly concentrate diet, cribbing, and lack of water

I. Rabies - affects the nervous system of mammals
   (i) Caused by a virus and is typically spread by an infected animal biting another animal or person.

   (ii) Considered fatal, but preventable with vaccine
(iii) Cannot be treated once symptoms appear

Medications and Preventing Animal Diseases
1. Prevention of animal diseases is always preferred to having to treat diseases
   a. Prevention requires good sanitation practices, as well as the use of routine vaccinations, accurate record keeping and frequent observation of animals.
      i. Many bacterial and fungal health issues can be avoided with proper sanitation of facilities
   b. Some methods of prevention may require direct sanitation or the application of medication or disinfectants
      i. Example: An iodine solution is often applied to dairy cattle prior to milking to prevent mastitis

Treating Animal Diseases
1. Different diseases require different methods of treatment
2. Proper safety must be observed when treating animals
   A. Squeeze chutes are often used to restrain animals for treatment
3. For animals used for meat or milk production, special care must be taken to ensure that the medications used cannot enter the food supply.
   A. Medications typically have a withdrawal time that must be followed to ensure the animal does not have any traces of the medication in their system before slaughter.
   B. Milk from animals who are being given certain medications, cannot be sold until it is free from any traces of the medication.
4. Medications are given in a variety of ways
   A. Typically, most medications are given orally, injected, or applied to the skin
      (i) Oral dosages (given by mouth) include liquids (solutions, suspensions, and emulsions), semi-solids (pastes), and solids (tablets, capsules, powders, granules, premixes, and medicated blocks)
         (a) A solution is a mixture of two or more components that mix well.
            (i) Solutions are absorbed quickly and generally cause little irritation to the stomach and intestine.
            (ii) The taste of some drugs is more unpleasant when in solution.
            (iii) Ideal for newborn and young animals.
         (b) A suspension is a mix of drug particles into a liquid.
(i) Suspensions are useful for administering drugs that do not mix completely in a liquid.

(ii) The taste of most drugs is less noticeable in suspension than in solution because the drug is less soluble in suspension.

(iii) Must be shaken vigorously just prior to administering.

(c) An emulsion consists of two non-mixable liquids, one of which is dispersed throughout the other in the form of fine droplets.

(i) Emulsions for oral administration are usually oil (the active ingredient) in water.

(ii) Emulsions help oily substances such as castor oil or liquid paraffin be more easily taken by the animal.

(d) A paste is a 2-component semi-solid medication in which a drug is dispersed as a powder into a liquid base.

(i) Pastes should be pleasant tasting or tasteless.

(ii) Pastes are a popular dosage form for treating cats and horses, and can be easily and safely administered by owners.

(e) A tablet consists of one or more active ingredients mixed with fillers.

(i) It may be a tablet that is swallowed whole or chewable.

(ii) Often used to administer drugs to dogs and cats.

(f) A capsule (bolus) is usually made from gelatin and filled with an active ingredient and fillers.

(i) Two common capsule types are available: hard gelatin capsules for solid-fill formulas, and soft gelatin capsules for liquid-fill or semi-solid-fill formulas.

(ii) Capsules have no taste and are therefore good for drugs that are otherwise hard to give because of their bad flavor.

(iii) For livestock, a bolus (or balling) gun is used to place the capsule further down the animal’s throat so it can be swallowed.

(g) A powder is a drug powder mixed with other powdered fillers to produce a final product.

(i) Most powders are added to food.
(ii) Powders have better chemical stability than liquids and dissolve faster than tablets or capsules.

(iii) Powders can taste bad to animals and can be a problem used in food if the animal does not eat all of it.
1. Sick animals may also eat less and may not eat enough of the powdered drug for it to be effective.

(ii) Injections
(a) Some medications are required to be given as an injection.

(b) Different medications require different injection methods and the correct injection location, dosage and procedures are given on the medication label.
(i) Intermuscular injections are given deep into the muscle
1. Care must be taken in livestock animal to only inject into areas that will not damage muscle tissue that will be consumed by humans.
   a. Example: In cattle, most injections are given in the neck area.

(ii) Subcutaneous injections are given under the skin

(iii) Intravenous injections are given directly into the vein

Additional Resources:
Animal Anatomy Diagrams - https://www.exploringnature.org/db/view/Animal-Anatomy-Veterinary-Diagrams
Porcine Myology - https://porcine.unl.edu/
Online Veterinary Anatomy Museum - http://www.onlineveterinaryanatomy.net/

Animal Reproduction
1. Animal production systems vary by species and function, primarily centralized on livestock species. Many production & reproduction systems utilize biotechnology concepts to increase efficiencies and support proper animal care. Production systems will highlight the types of operations and the models around raising animals, whereas reproduction systems will highlight the breeding methods used to sustain animal populations.
Animal Reproduction Terminology

1. Artificial Insemination – introduction of semen from a male into the sex organ of a female by other than natural means

2. Backcrossing – Mating of one individual to another individual with which it has one or more ancestral breeds or lines in common. Can be continued for several generations; used to incorporate specific traits found in one population into a different population while maintaining selective traits

3. Breed Association – group of breeders organized to record lineage of animals, keep breed pure, promote breed

4. Breeding systems – set of management practices used by producers to ensure transmission of certain traits from parents to offspring, particularly those traits that producer desires to be inherited

5. Castration – removing the testes to prevent unwanted breeding, leads to better meat, and results in less fighting and aggressive behavior among males

6. F1- Offspring resulting from the mating of a purebred bull and purebred cow of different breeds

7. Cloning – to reproduce a genetic duplicate from genetic material of an organism

8. Dam – a female parent, term progeny use to reference pedigree

9. Embryo Transfer – a procedure in which an embryo (an animal in the earliest stages of its development in the egg) from one female is removed from that female and implanted into another female

10. Estrous – (heat) internal reproductive and hormonal changes a female undergoes on “scheduled-basis” after puberty

11. Estrus – portion of heat interval when hormones estrogen and progesterone are secreted by ovaries

12. Expected Progeny Difference - Methodology developed by C.R. Henderson (1972) has given rise to methods of genetic evaluation. Utilizes performance data accumulated from an individual and performance values from ancestors, parents, relatives and offspring to predict genetic merit

13. Gestation Period – Length of time that an animal is pregnant, and period of fetal development
14. Grading Up – Mating purebred males to commercial females with goal of eventually creating purebred herd. Noticeable improvement in fourth generation expected; herd will carry 94% of purebred sire characteristics

15. Hormones – cause outward signs of receptivity to mating, especially estrogen produced by females in which males respond to

16. Inbreeding or Line Breeding - Mating animals that are closely related

17. Natural Breeding – To reproduce sexually under natural conditions

18. Offspring – children or young of a particular parent

19. Ovulation – expelling of egg from ovary; egg is ready to be fertilized by sperm cell; once fertilized, female’s body undergoes physical changes as fetus develops

20. Parturition – Giving birth in livestock

21. Post-birthing interval – period when reproductive tract is returning to original shape and tone following parturition; time varies with species and individual

22. Selection – Identifying desirable animals for breeding purposes

23. Sire – a male parent, term progeny use to reference pedigree

24. Three-breel Rotational Crossing – Breeding crossbred females to purebred males; Rotation of purebred males from three breeds on subsequent generations of crossbred females can be continued for several generations. Use superior males from different lines to ensure good genetic diversity. Popular with swine breeders.

Methods of Reproduction

1. Natural Breeding- Commonly used when livestock is hard to breed artificially, the most natural and widely used method of reproduction
   A. Advantages - low labor demands, natural, and relatively inexpensive

   B. Disadvantages - limits genetic material to livestock you have access to, difficult to make large genetic improvements without large investments

2. Artificial Insemination - Commonly used in swine and cattle especially dairy production, exclusive method for breeding modern production turkeys
   A. Advantages - no management of male since semen is purchased, allows for high priced genetics for a portion of the costs, producers can be trained to perform artificial insemination, less physical wear on both the male and female
B. Disadvantages - more labor than natural breeding and requires specific equipment

3. Embryo Transfer – Commonly used when you want to produce a large number of offspring from one superior female
   A. Advantage - allowing more than natural number offspring in a short amount of time
   B. Disadvantages - this procedure requires a veterinarian to perform the procedure, labor intensive, and expensive.

4. Cloning – Not widely used yet, mostly for experimental purpose. Extremely expensive and heavily regulated
   A. Advantage – creates an identical copy of an animal, creates limited genetic pools
   B. Disadvantages – very expensive, very labor intensive, ethically questionable

General Animal Reproduction Practices

1. Livestock breeding operations consider environmental, economical, technological factors that affect choices made concerning breeding systems, seasons, times, methods

2. Producers must be prepared to breed using appropriate technology, apply thorough working knowledge of animal nutrition, reproduction, and physiology

3. No one breeding system or method of breeding livestock fits all producers; systems may include crossbreeding, purebred breeding, linebreeding, and inbreeding

4. Factors to be considered in determining breeding system:
   A. Climatic conditions
   B. Types of markets
   C. Knowledge of genetics
   D. Size of operation
   E. Personal preferences
   F. Available resources
   G. Goals of the breeder

5. Types of Breeding Systems –
   A. Crossbreeding
(i) Mating of two animals of different breeds (usually purebreds)

(ii) Referred to as indiscriminate crossbreeding

(iii) Done to improve overall performance of offspring; result of mating individuals with different but complementary breed values

(iv) Produces hybrid vigor (heterosis) for traits (fertility, survivability)

(v) Can develop new breeds

(vi) Advantages of crossbreeding:
   (a) Improve or eliminate weaknesses by breeding “strong” trait to animal lacking or “weak” in trait

   (b) Average productivity increased over either parent

   (c) Crossbreds more fertile than purebred parents

   (d) Wean heavier offspring than purebreds

   (e) More vigorous than purebreds

(vii) Methods of Crossbreeding:
   (a) Grading-Up

   (b) Backcrossing

   (c) Three-breed Rotational

B. Purebred Breeding
   (i) Also known as straight-breeding

   (ii) Mating of animals within same breed that are either register in breed association or eligible for registry

   (iii) Lineage can be traced to original foundation animals of breed, those first accepted into registry

   (iv) Does not guarantee superior animal; though may be more preferred than grade animals

   (v) More difficult for purebred breeders to receive return on investment, unless demand for their lineage is created
(vi) There will always be a need for purebred animals for crossbreeding and grading up

C. Linebreeding
   (i) Less intense form of inbreeding designed to maintain degree of relationship to highly regarded ancestors without resulting in harmful level of inbreeding
   (ii) Used more often in purebred operations
   (iii) Animals closer than half brothers or half sisters are never mated
   (iv) Popular bloodlines have been developed through linebreeding; only successful in herds with high degree of excellence, possessing outstanding individuals indicated by progeny tests

D. Inbreeding
   (i) Mating of individuals over several generations that are more closely related than average for representing population
   (ii) When used appropriately, purposes are to concentrate inheritance of desirable traits, and eliminate undesirable traits for given group
   (iii) Breeder can make further improvements when starting with desirable group of animals
   (iv) Other improvements: form families, produce breeding stock, develop lines for crossing, determine genetic value of individual
   (v) Disadvantages: may decrease reproductive efficiency, vigor, survival rate, growth rate

Selection Factors for Reproduction

1. Selecting a Breeding Season
   A. Depends on desired season for birth of offspring; producers typically prefer spring or fall
   B. Producers desire similar age and weight across their young crops
   C. Ideally, offspring will be born within specified number of days; 40 to 60 days is the common time frame for cattle
   D. Factors to Consider:
      (i) Climatic conditions affecting equipment, feed, housing needed
(ii) Availability of labor or help during time of year offspring are born

(iii) “Target” dates for marketing due to price variance and demand throughout year

(iv) Availability of equipment and housing affects choice of breeding season; some species may need to be placed in barn and provided heat if birthing in the winter

(v) Availability of grazing if needed for females and offspring to sustain their needs

(vi) Livestock show stock must follow rules regarding classed ages; maximum class age may have competitive advantage

(vii) Purpose of livestock produced; replacement purpose determines the season they reach desirable breeding age, thus length of time required to bring into production

2. Puberty and Breeding Ages of Animals
   A. Puberty can be affected by season of birth, temperature, nutrition, rate of maturity, and heredity

   B. Age of puberty and breeding age are distinct benchmarks for physical development

   C. Reaching puberty does not mean capable of reproducing efficiently, yet; i.e. stage of body development is more important than age in determining when animals will reach puberty and optimal breeding age

   D. Advisable to allow animals to continue to develop and mature after reaching puberty, to ensure proper sexual development

   E. Proper breeding age may vary depending on body growth, development of individual animals within breeds and species

   F. Producer must learn to accurately determine minimum breeding age of species

   G. Sometimes it may appear to be advantageous to breed at an early age to reduce expenses, or maximize breeding capacity; sometimes it’s advantageous to delay breeding to avoid possibility of physical injury occurring, reduced potential of incidence of birthing problems associated with underdeveloped females

   H. Breeding Ages of Females:
(i) Waiting until a full maturity age or development for first time breeding stock offers producer advantages
   (a) Breeding heifers at two years of age offers physiological advantage, frequently increases heifer’s rate of milk production at calving

(ii) Early breeding can increase lifetime production of female with 1 to 1.3 calves, assuming the heifer conceives in timely fashion during second season

(iii) Supplemental feeding and good pastures, paired with proper nutrition can cause heifers to develop, mature faster, thus breed earlier

(iv) Gilts developed physically to withstand lactation stress may breed at 8-10 months. Most swine producers want gilts that weigh 225 lbs. or more at breeding

I. Breeding Ages of Males
   (i) Not as important as females breeding age

   (ii) Services vary according to male’s age, physical development, health, temperament, condition, breeding system used, and distribution of services

3. Reproductive Cycles of Livestock
   A. Factors that control reproductive cycles of females: estrus, estrous, time of ovulation within estrus period, gestation period for pregnant females

Preparing Animals for Breeding
1. Percentage of females giving birth affects success of animal operation; fastest means of increasing profits is to increase number of females giving birth

2. Breeding impacts production cost per pound of animal being produced; to ensure high conception rate, prepare both sexes for breeding

3. Factors in Preparing Females –
   a. Beginning of heat period influenced by age, post-birthing interval, nutrition, physical condition, and/or disease
   b. Age must be considered, especially in females too young for breeding; may be injured during mating, and problems may occur when nourishing fetus as she is still growing herself
   c. Body condition is very important at breeding time; provide supplemental nutrients during pregnancy and lactation; females too thin or too fat may be infertile
d. Animals with diseases that affect fertility or pregnancy should be eliminated

e. Cattle:
   (i) Goal is 100% calf crop to calve annually

   (ii) Must have plan to calve at least 45 days before beginning of next breeding season to rebreed timely

   (iii) Age influences number of days after calving that will pass before next heat; older cows come in sooner than younger ones

   (iv) Stress related to milk production affects rate of recycling first-calf heifers

   (v) 90% conception rate of first-calf heifers is possible if handled properly following birth of first calf

   (vi) Common problems are retained placenta, or a uterus that may become infected and delay next estrous

   (vii) Cows should not be rebred until 45 days after calving; 1/3 of cows with shorter post-calving rest will experience serious reproductive problems

   (viii) Female’s genetic capability influences breeding performance; selection based on regularity of breeding is effective means of increasing efficiency; determined by palpating females for pregnancy 45 days after bull removed, culling nonpregnant females

   (ix) Nutrition is the most important factor affecting reproduction abilities; breeding failures, late calving indicates lack of adequate nutrition; extra feed during gestation is a good start; after calving, feed requirements increase due to milk production; cow will mobilize body fats to compensate for deficiency, suffer weight loss; will cause cow to be out of condition and prevent cycling and rebreeding

   (x) For Bulls – general health, condition of feet, legs, age teeth, abnormalities of reproductive organs should be checked for soundness; fertility tested prior to breeding; libido good indication of reproductive ability, evaluated when bull placed with cows in heat; should become sexually aroused, eager to mate

F. Sheep
   (i) Producers goal is 200%; most ewes capable of giving birth to twin lambs; producers select and keep ewes that deliver twins

   (ii) Flushing increases rate of conception, influences twinning; four to eight weeks before breeding for good flush with high-quality green pasture and
feed additional supplements

(iii) Fertility test rams prior to breeding season

(iv) Quality and quantity of feed nutrients is important for breeding, gestation, lactation

(v) Ewes go through anestrous, tend to lamb late winter and spring; post-birthing interval not as critical as cattle, have more time to rebreed

(vi) 17-day estrous beginning mid-fall, ending early spring

G. Swine
(i) Producers want breeding stock to produce eight to fifteen pigs per litter

(ii) Females selected based on number of pigs born and weaned, mothering ability

(iii) Sows should be flushed two to three weeks prior to breeding, which increases potential for more profitable litters; stimulating females to come into estrus, causing eggs to be released during estrus makes more likely to conceive at mating

(iv) Sows of normal weight should have daily feed intake increased; gain about 1 to 1.5 lbs. daily during gestation; bred gilts should receive nutritious supplemental feed to ensure normal growth during pregnancy

(v) Boars exposed to high stress or temps may stop producing sperm; keep in cool, well-ventilated area; increase feed intake during active breeding; overfat and thin boars usually poor breeders

(vi) Boars should be purchased several months prior to breeding season to become accustomed to new environment; fertility test once established

H. Horses
(i) Mares are the most difficult to conceive

(ii) Exercise and adequate feed should be provided during mating season

(iii) Check mares for signs of venereal disease, general sickness, other types of soundness before breeding

(iv) Be certain that the mare(s) is/are in standing heat before breeding attempts

(v) Mares should be taken to stallion for service for highest conception rate, but advanced techniques are an option
(vi) Allow mare to become quiet and cooled prior to breeding; permit stallion to mount mare only when he is ready; after mating, return stallion to stall, allow mare to remain quiet for short period of time and return to quarters

(vii) Mares should receive same ration as before breeding during gestation

(viii) Will come back into heat in 21 days if not bred; may be rebred

Additional Resources:


UNIT H: Animal Meat Production, Animal Showmanship and Animal Welfare
Developed by Mrs. Brynn Wittie

STANDARDS:
LA-AGTECH: 9.2, 9.3, 16

Goal: Students should be able to analyze procedures to ensure that animal products are safe for consumption (e.g., use in a food system, etc.), identify desirable characteristics in meat production animals, analyze quality cuts of meat, and identify the proper steps to showing livestock.

Objective(s):
1. Students should identify basic terminology related to animal production
2. Students should identify the main steps in the animal production process
3. Students should be able to describe critical components to the USDA quality grading system for different livestock species
4. Students should describe the various levels of carcass yield grading
5. Students should know the various types of food, fiber and by-products provided by animals
6. Students should identify basic responsibilities of owning and showing livestock animals
7. Students should know the proper tools and procedures used in showing livestock
8. Students should be familiar with proper methods for transporting livestock
9. Students should be able to identify appropriate evaluation criteria for various animal species
10. Students should identify basic steps of animal showmanship, including proper dress, safety, and proper animal showmanship methods.
11. Students should be aware of the difference between animal rights and animal welfare and be able to describe various animal welfare issues

Agritech Guiding Questions:
1. What are some common by-products of the animal industry?
2. What is the use of a livestock cane when showing livestock?
3. What factors help reduce stress on cattle when being transported?
4. What is a yield grade used to represent?
5. What is the difference between animal welfare and animal rights?
Content:
Harvesting & Product Terms:
1. Animal product – the result of harvesting and processing an animal for consumption or use
2. Byproducts – products of considerably less value than the major product, but still utilized (ex. - hide or pelt)
3. Certified Organic Beef – cattle must be fed 100% organic feed and must be certified through USDA’s Agricultural Marketing System
4. Edible – fit to be eaten by humans
5. Grain-fed Beef – most widely produced and tends to be less expensive
6. Grass-finished Beef – cattle raised on grass pasture entire lives
7. Inedible – not edible; unfit to be eaten by humans
8. Natural – a product containing no artificial ingredients or added color and is only minimally processed
9. Organic – food produced without employment of chemically formulated fertilizers, growth stimulants, antibiotics, or pesticides.
10. Palatability – the overall eating experience of the product; including flavor, juiciness, tenderness, etc.
11. Processing – the process of converting the original, raw product into a final product ready for distribution and consumption
12. Product Grading - sorting the product based on quality, like Prime beef, Grade A milk or Grade AA eggs
13. Product Packaging - storing the food products in containers, like egg cartons, milk jugs, etc.
14. Product Preserving - prevents the food from spoiling before it reaches the consumer and extends its shelf life
15. Quality Grades - divide carcasses into groups which will provide similar eating experiences. Quality grades designate the overall palatability; refers to the inherent properties of a product that determine its relative degree of excellence or value
16. USDA - United States Department of Agriculture
17. USDA Certified – when the U.S. Department of Agriculture has officially evaluated an animal product for class, grade, or other quality characteristics

18. Yield Grading - System developed to estimate the yield of closely-trimmed, boneless retail cuts that can be obtained from the round, loin, rib, and chuck; sorted by 5 grades

Harvesting & Processing
1. Animals are selected for harvest when they have arrived at their target market weight
2. Some animals are genetically selected to serve as meat animals; meaning that their genetics are ideal for making a flavorful meat product
3. Harvesting
   A. A careful process to ensure that the animal is treated in a humane way while rendering them unconscious for processing
   B. Helps ensure the food supply is safe to eat
   C. Handling/holding areas are designed to make moving animals as stress free as possible
   D. Once animals are harvested; the carcasses are sent through a final wash and then chilled for at least 24 hours
   E. Inspection – examination or review of the animal by a USDA inspector will examine parts of the carcass to ensure that the animals is healthy and safe for human consumption
   F. From there, animals are sold in whole or half, and sent to a fabricator or butcher
4. Processing/Meat Fabrication
   A. The process of breaking down of a carcass of meat into wholesale & consumer cuts
   B. After the carcass is chilled, it is broken down into wholesale cuts and sold to market
   C. Wholesale cuts are then broken down into retail cuts/products for resale during the fabrication process
      (i) Wholesale cuts – the sale of goods in quantity for resale (i.e. beef wholesale cuts include the round, chuck, short loin, etc.)
(ii) Retail cuts – the sale of goods in small quantities to consumers (i.e., pork retail cuts include tenderloin, chops, ribs, etc.)

(iii) Value-added products – a change in the physical state or form of the product; the production of a product in a manner that enhances its value (i.e., sausage, chicken patties, etc.)

References:
2. Video Tour of a Beef Plant Featuring Temple Grandin - https://www.youtube.com/watch?v=VMqYYXswono&list=PLkBbso1kwZ3bZTqN5MBLqHWGpRqPCH7gK&index=3
3. Video Tour of a Pork Plant Featuring Temple Grandin - https://www.youtube.com/watch?v=LSEbvwMipJl&list=PLkBbso1kwZ3bZTqN5MBLqHWGpRqPCH7gK&index=2
4. Video Tour of a Lamb Plant Featuring Temple Grandin - https://www.youtube.com/watch?v=BoB3tf9Q2AA&list=PLkBbso1kwZ3bZTqN5MBLqHWGpRqPCH7gK
5. Video Tour of a Turkey Farm and Processing Plant Featuring Temple Grandin - https://www.youtube.com/watch?v=VMqYYXswono&list=PLkBbso1kwZ3bZTqN5MBLqHWGpRqPCH7gK&index=3

Quality Grading
1. Beef Quality:
   A. There are two components to quality grading – Marbling & Maturity
   B. Degrees of Marbling:
      (i) Prime (High, Average, or Low)
      (ii) Choice (High, Average, or Low)
      (iii) Select (High, or Low)
      (iv) Standard (High, or Low)
      (v) Commercial
      (vi) Utility
   C. Maturity Score: refers to overall age of the animal; 5 scores
      (i) A: 12-30 months
(ii) B: 30-42 months

(iii) C: 42-72 months

(iv) D: 72-96 months

(v) E: 96+ months

2. Commercial and Utility grades are not sold for retail, but instead sold to canning and various meat product users

3. Maturity Scores C – E cannot be graded higher than commercial or utility grades

4. Additional Resource:

5. Pork Quality
   A. The quality of pork depends on its color, texture, and marbling
   
   B. Determined by visual evaluation or scientific tests

   C. Five quality grades:
      (i) US No. 1
      (ii) US No. 2
      (iii) US No. 3
      (iv) US No. 4
      (v) US Utility/Cull

   D. Additional Resource:
      (i) Pork Color and Marbling Standards - http://tacdriver.com/determining-pork-quality/

6. Lamb Quality
   A. Lamb grades are based on age, conformation (carcass muscling), and lean quality factors such as color

   B. Five quality grades:
      (i) Prime
      (ii) Choice
(iii) Good

(iv) Utility

(v) Cull

C. More than 90 percent of lamb in the US will grade USDA Prime or Choice.

D. Additional Resource:

7. Goat Quality
   A. Goats are not quality graded, but instead classified by specifications into three selection classes
      (i) Selection 1 – Live goats and/or carcasses that have a superior meat-type conformation without regard to the presence of fat cover
      (ii) Selection 2 – Live goats and/or carcasses have an average meat-type conformation without regard to the presence of fat cover
      (iii) Selection 3 – Live goats and/or carcasses have an inferior meat-type conformation without regard to the presence of fat cover


8. Poultry Quality
   A. Poultry have their own standards for quality and grading classification
   B. U.S. consumer grades for poultry are U.S. Grades A, B, and C
      (i) Grade A. is the highest quality and the only grade that is likely to be seen at the retail level
      (ii) Grades B and C poultry are usually used in further-processed products where the poultry meat is cut up, chopped, or ground.
   C. Additional Resource:

**Yield Grading**

1. Four factors used in a formula to predict cutability:
A. Fat thickness over the ribeye at the 12th rib
B. Ribeye area at the 12th rib
C. Carcass Weight
D. Estimated percent of internal fat (KPH)

2. Yield Grade 1
   A. The carcass is covered with a thin layer of external fat over the loin and rib; there are slight deposits of fat in the flank, cod or udder, kidney, pelvic and heart regions. Usually, there is a very thin layer of fat over the outside of the round and over the chuck.

3. Yield Grade 2
   A. The carcass is almost completely covered with external fat, but lean is very visible through the fat over the outside of the round, chuck, and neck. Usually, there is a slightly thin layer of fat over the inside round, loin, and rib, with a slightly thick layer of fat over the rump and sirloin.

4. Yield Grade 3
   A. The carcass is usually completely covered with external fat; lean is plainly visible through the fat only on the lower part of the outside of the round and neck. Usually, there is a slightly thick layer of fat over the rump and sirloin. Also, there are usually slightly larger deposits of fat in the flank, cod or udder, kidney, pelvic and heart regions.

5. Yield Grade 4
   A. The carcass is usually completely covered with external fat, except that muscle is visible in the shank, outside of the flank and plate regions. Usually, there is a moderately thick layer of external fat over the inside of the round, loin, and rib, along with a thick layer of fat over the rump and sirloin. There are usually large deposits of fat in the flank, cod or udder, kidney, pelvic and heart regions.

6. Yield Grade 5
   A. Generally, the carcass is covered with a thick layer of fat on all external surfaces. Extensive fat is found in the brisket, cod or udder, kidney, pelvic and heart regions

7. Yield & Grading Quality Challenges
   A. Lack of uniformity and consistency
   B. Inappropriate carcass size and weight
C. Inadequate tenderness
D. Insufficient marbling
E. Growth implant issues
F. Excess external fat
G. Inappropriate USDA Quality Grade mix
H. Hide damage
I. Bruises
J. Liver condemnations

Animal Products and byproducts
1. Animal products are materials derived from the body of an animal
2. Animal parts primarily used for products include:
   A. Meat
   B. Fat
   C. Milk
   D. Eggs
   E. Skin/Hide
   F. Organs
   G. Blood
   H. Hair
   I. Bones
   J. Hooves

Additional Resources
2. Rendering is Recycling Infographic - https://renderingisrecycling.files.wordpress.com/2014/07/onepageinfographic.jpg
Animal By-Products

A. Animal byproducts include all parts of a live animal that are not part of the dressed carcass.

B. Beef/Dairy – tripe, surgical sutures, and gelatin
   (i) Beef byproducts allow 99% of every beef animal to be utilized

   (ii) Examples of byproducts:
        (a) Edible: Tripe, gelatin,
        (b) Inedible: leather goods, makeup, pharmaceutical drugs
        (c) The hide from one beef animal can be made into: 20 footballs or 12 basketballs or 18 soccer balls or 12 baseball gloves or 18 volleyballs or 144 baseballs

2. Swine – ears become dog treats, skin for skin grafts, and heart valves

3. Sheep – book bindings, bandage strips, and shampoo; the oils removed from wool is retained to create Lanolin

4. Goat – Mohair used for handbags, clothing (sweaters), milk can be used for soap

5. Poultry – fertilizer, feather meal, down for bedding and brushes; Egg shells can be used for decorative purposes

6. Specialty Animal Products
   A. Alpaca – used for fiber/hair
      (i) Produces one of the world’s finest and most luxurious natural fibers

   B. Bison – used for meat
      (i) Raised in every state of the U.S.

      (ii) Meat found in most natural food stores

      (iii) Meat is low in fat, high in protein, and iron, and has a great cholesterol profile

   C. Ostrich - for meat
      (i) Largest living bird in the world (Flightless)

      (ii) Runs at speeds of up to a constant 40mph, and can live to be 50-75 years old

   D. Emu – used for meat
      (i) Native to Australia
(ii) Commercial emu farming in the U.S. began in the late 1980s

(iii) Low fat meat has less sodium than beef, chicken, or turkey

**Animal Exhibition & Showmanship**

1. **Condition** – refers to the amount of fat the animal is carrying. The ideal condition is thin to moderate but uniform

2. **Fitting** – The preparing of animals for show, usually involves the trimming/grooming of hair or wool

3. **Judge** – The person evaluating the animal beings shown, placing them in respective order based on breed standards and/or specie specifications

4. **Shearing** – to cut or clip the hair or wool (the reason for shearing varies by species and breed)

5. **Showmanship** – skill of presenting an animal in a show ring

6. **Show Ring** – The identified space where animals are shown and judged

**Specifics Related to Animal Showmanship**

1. **Types of Show Animals**

   A. **Cattle (Beef & Dairy)**
      (i) Breeding Heifers or Cow/Calf Pairs

      (ii) Breeding Bulls

      (iii) Market/Commercial Heifers

      (iv) Market Steers

   B. **Lambs & Goats**
      (i) Breeding Ewes/Does

      (ii) Breeding Rams/Bucks

      (iii) Market Ewes/Wethers

   C. **Swine**
      (i) Breeding Gilt

      (ii) Market Gilt/Barrows
D. Poultry
   (i) Broilers

   (ii) Turkeys

E. Horses
   (i) Halter Class

   (ii) Performance Classes

F. Rabbits
   (i) Breeding

   (ii) Single Fryer

   (iii) Meat Pens

G. Small Animals
   (i) Dogs

   (ii) Cats

   (iii) Birds/Avian

   (iv) Cavies

H. Specialty Animals

2. Selection & Evaluation

   A. Beef Cattle:
      (i) Methods of selection must support goals of production system; goal of
           most cow/calf producers is to produce maximum pounds of calf at most
           economical cost; goal of purebred breeder is to produce breeding cattle for
           purchase by other breeders and commercial producers

      (ii) Visual Appraisal includes evaluating body structure, soundness of feet and
           legs, muscling and muscle structure, frame/skeletal size, reproductive
           soundness, breed character, temperament, and confirmation score

      (iii) Performance Appraisal – use of EPD’s

   B. Lambs & Goats:
      (i) Market Lambs & Goats
(a) Primarily evaluated on conformation, muscling & condition

(b) Conformation: Rectangular in appearance from the side, Straight level top and belly, Length of rump, body, and leg are important, Legs should be straight and placed squarely under the body and should show evidence of muscling

(c) Muscling: Hindquarters should have long deeply attached muscle, thick high stifle, and muscle over the hip and rump should be obvious. Loin should be wide with a symmetrically oval shape on each side of the backbone which should carry over the rack. Shoulders should have muscling increase from the withers to the point of shoulder with the thickest muscle being above the chest floor. Forearm muscle should be prominent.

(d) Condition: Smoothness and quality are important, and correctness of finish should be observable

C. Dairy Goats
   (i) Correct conformation of dairy goats is essential for a productive and successful operation.

   (ii) It is important to evaluate the differences of goats as they related to each other as well as how they relate to the breed ideal.

   (iii) Per American Dairy Goat Association - Standard Score Card
       (a) General Appearance (30%) - Impressive style and carriage, possessing attractiveness and femininity

       (b) Mammary System (30%) - Strongly attached and high quality udder, indicating high production and longevity

       (c) Dairy Character (20%) – Angularity and general openness throughout

       (d) Body Capacity (20%) – Relative to the size of the animal, providing ample capacity for feed intake and production

D. Breeding Sheep
   (i) Focus should be on structural soundness, reproductive soundness, highly productive, gain rapidly, efficiency

   (ii) Fleece Quality – evaluated in wool breeds only, not market

E. Swine:
   (i) Market Barrows/Gilts
(a) Evaluate and rank based on presence of most important traits, including:
   (i) Degree of muscling

   (ii) Growth

   (iii) Capacity or volume

   (iv) Condition/ Degree of leanness (amount of fat)

   (v) Structure and soundness

(ii) Breeding Gilts
   (a) Evaluate on breed and female characteristics, which include:
      (i) Structural correctness

      (ii) Capacity

      (iii) Leanness

      (iv) Muscling

      (v) Size and scale

      (vi) Apparent health

Judging Resources:
  2. Mississippi 4H Livestock Judging Manual -
  5. OSU Swine Showmanship - https://extension.okstate.edu/fact-sheets/swine-showmanship.html

Responsibilities of Showing an Animal

1. To be a responsible showman, you must consider the following needs of a show animal:
A. Costs & Expenses: Must understand and prepare for all potential costs associated with exhibiting an animal

B. Daily Care: Feeding, Bathing, Exercise, Training, etc.

C. Appropriate Housing: Clean bedding, ample space, grazing area if necessary

D. Supplies: Feed, Troughs, Buckets, Halterst, Show needs, medicinal needs, etc.

E. Feeding: Appropriate feed rations to meet animal needs and goals. Students should work closely with their Advisor to establish a feeding program.

F. Records: Accurate records must be maintained to track animal needs, improvements, and health concerns. Records are vital for tracking the experience

2. General Showbox Checklist
   A. Hair/Root Brush
   
   B. Wash Brush
   
   C. Soap
   
   D. Exhibitor Card Holder
   
   E. Foam, Oils and Sprays
   
   F. Water Hose
   
   G. Appropriate Medications
   
   H. Show Halter
   
   I. Show Stick
   
   J. Towels or Wipes
   
   K. Blow Dryer
   
   L. Clippers
   
   M. Adhesives
   
   N. Adhesive Remover
3. Tips for Exhibiting in the Ring
   A. Cattle:
      (i) Handling the show halter
         (a) When used correctly, the halter can be a very useful tool for controlling your animal, if you use one
         (b) Push back slightly on the halter as you use your show stick to move a foot backwards.
         (c) Pull forward on the halter as you use your show stick to move a foot forward.
      (ii) Positioning
         (a) How the showman & animal are presented in the ring
         (b) In your left hand, hold your show stick perpendicular to the ground
         (c) When leading the animal, hold the halter in your right hand and a few inches away from the animal’s head. If you hold the halter too far away, you will have less control
         (d) When setting up the animal, hold the halter in your left hand, and show stick in the right hand
      (iii) Setting Up
         (a) The position you move into for the judge to view
         (b) The most natural and easiest way to set up your animal is simply by walking the animal into position. As you prepare to stop your animal in line, position your body as if you are going to use your show stick; then pull the animal forward a step or two so that as they stop, they move into the correct position.
         (c) ‘On the rail’ – when lining up facing the rail/wall/boundary facing the away from the judge, this allows the judge to get a rear view of the animal and the legs should be square under each shoulder/hip
         (d) Side profile - when the front legs of an animal are square under the animal’s front end, and the rear legs are slightly offset, with the rear foot on the judge’s side back slightly (not over extended) and the rear leg on the showman’s side forward slightly
      (iv) How to Video Demonstrations -
         (a) Showing Beef Cattle –
             https://www.youtube.com/watch?v=Vgd7WWLSNm0
(b) Showing Dairy Cattle -
https://www.youtube.com/watch?v=QOFsKSehE9c

(c) Beef Cattle Fitting -
https://www.youtube.com/watch?v=NKbbhZJHfBU

(d) Dairy Showmanship Tips -
https://www.youtube.com/watch?v=zYnlr3fQbpq

B. Swine:
(i) Pigs are ‘driven’ using a show whip/livestock cane instead of a halter

(ii) When driving, you try to never get between your animal and the judge

(iii) Avoid allowing your pig to stay on the rails/outside of the ring, stop or lay down, or fight another pig

(iv) How To Video Demonstrations -
(a) Show Posture - https://www.youtube.com/watch?v=HjyoYZKgxEg

(b) Preparing for the Ring -
https://www.youtube.com/watch?v=Y7leoN8HPGA

(c) Showmanship Tips - https://www.youtube.com/watch?v=Fm-x8fzsmsE

C. Lambs/Goats:
(i) Using a halter for lambs is optional in most cases. Experienced showman, do not typically use one in today’s show ring

(ii) Goats are typically shown with a show collar or halter

(iii) How to Video Demonstrations -
(a) How to Set Up a Show Lamb -
https://www.youtube.com/watch?v=vSu67BCROxk

(b) Showing in the Ring -
https://www.youtube.com/watch?v=Pj6E9U9QORo

(c) Market Goat Fitting -
https://www.youtube.com/watch?v=l_vmfQBODg4

(d) Youth Market Lamb Project Guide -
https://www.ndsu.edu/fileadmin/4h/Animals/gbj166.pdf
D. Horses:
   (i) Horses are shown on a halter or under saddle

   (ii) Due to the variation in shows, details should be researched from the breed or show association you are looking to exhibit under or for

   (iii) How to Video Demonstrations -
        (a) Showmanship Tips for Halter Classes - https://www.youtube.com/watch?v=JuUp-UnDA8g

        (b) Grooming Tips for Show & Performance Horses - https://www.youtube.com/watch?v=rSff3XQpz8Q

E. Rabbits:
   (i) Rabbits are not typically handled by the exhibitor during a show, with the exception of specific showmanship classes

   (ii) Rabbits are placed in their assigned cage, and the judge will come around to them to view/handle

   (iii) Rabbits are show individual or as market pens of 3

   (iv) How to Video Demonstrations -
        (a) Showing Rabbits - https://www.youtube.com/watch?v=9krD-kddiQg

Showmanship
1. How to Dress for Showmanship:
   A. Collared shirt
      (i) Make sure that your shirt has been ironed and is tucked in.

      (ii) Some people say that a polo shirt doesn’t count as collared, check with your advisor.

      (iii) If you’re in an air-conditioned barn or at a national show, you typically wear a traditional button-up shirt.

   B. Jeans
      (i) You should show in your nicest blue jeans.

      (ii) It is important that your jeans ride high enough to keep your shirt tucked-in and backside covered. No matter what species you are showing you will need to bend over or stretch, so if your jeans are already riding low you’re going to be showing the judge more than your animal
Generally, a boot cut works better just because you don’t want your animal treading on a dangling pant leg, but jean style is a preference.

C. Appropriate Footwear
   (i) Appropriate footwear is important for safety and professionalism in the show ring.
   
   (ii) Leave your rubber boots, muck boots and tennis shoes out of the show ring. Leather boots (whether slip on or lace up) are much more professional.
   
   (iii) Jeans should not be tucked into boots

D. Belt
   (i) Are typically considered a necessity in the show ring

2. What not to wear for Showmanship
   A. Hat
      (i) It could be debated but, it is best advised to not wear a hat in showmanship. Since it could impede your view of the judge or the judge’s view of you when trying to make eye contact
      
      (ii) Try to avoid taking a ball cap off right before going into the ring. It could create hat hair or a ring around your head, resulting in an unprofessional look.

   B. Chewing Gum
      (i) Gum may be seen as being unprofessional

   C. Cell Phone
      (i) Leave it with someone outside of the ring during shows and showmanship
      
      (ii) Don’t wear your phone on your belt, even if it’s on silent.

Animal Rights & Welfare

1. Animal Rights – rights believed to belong to animals to live free from use of services to humans; insists animals have moral rights equal to those of humans
   A. Topics that are identified as questionable by animal rights groups:
      (i) Biomedical research

      (ii) Sporting events

      (iii) Clothing
(iv) Entertainment
(v) Product testing
(vi) Hunting
(vii) Food Products

2. Animal Welfare – refers to the state of the animal; the treatment that an animal receives
   (i) Covered by other terms such as animal care, animal husbandry, and humane treatment.
   (ii) Protecting an animal's welfare means providing for its physical and mental needs
   (iii) Also refers to the belief that animals should be treated as humanely as possible. Concept includes
       (a) Proper housing
       (b) Disease prevention/treatment
       (c) Nutrition
       (d) Humane euthanasia or slaughter

3. The various interpretations of animal rights & welfare have led to extreme controversies and several topics remain debated issues today
UNIT I: Soil, Air & Water Conservation
Developed by Ms. Morgan Richardson

STANDARDS:
AGRITECH: S7, S29.1, S29.3
AFNR: CS.04.01, CS.04.02

Goal: Students should be able to describe how water and soil can impact the natural environment as well as be familiar with practices used to conserve these resources and the associated processes.

Objective(s):
1. Identify the connection between natural resources and the environment
2. Define water and describe its relationship to the environment
3. Identify characteristics of land and its relationship to the environment
4. Summarize the relationship between water and land (soil) characteristics
5. Identify key factors affecting water conservation and water quality
6. Identify basic characteristics of soils
7. Describe key factors affecting soil erosion and land degradation.
8. Describe how soil can be amended to improve fertility
9. Explain soil management practices and their impact on plant growth
10. Explain important soil characteristics (structure, organic matter, pH, water-holding capacity, etc.), and their effect on plant growth and development
11. Examine water and soil conservation threats using real world examples (including local)
12. Describe how different climatic and geological activity influences air quality and agriculture
13. Describe how different climatic and geological activity influences agriculture.

Agritech Guiding Questions:
1. The buildup of heat caused by radiant energy being trapped in the earth’s atmosphere is known as what?
2. Air is what percent oxygen?
3. What soil preparation practices can be used to prevent erosion?
4. What amendments can be added to soil to change the soils acidity or alkalinity?

Content:
Natural Resources and the Environment
1. Environmental Stewardship - the responsible use of natural resources in a way that takes full and balanced account of the interests of society, future generations, and other species
   A. Sustainable development - developing for the needs of the present without hurting future generations needs
(i) The benchmark is that the environment can still replenish at least what it uses

B. Carrying capacity - the average maximum number of individuals of a given species that can occupy a particular habitat without permanently impairing the habitat in which it resides

C. Stewardship involves ethical planning and management of resources

D. Responsible use and protection of the natural environment

Water

1. Water is an essential part of our world and the natural environment.
   A. Humans need potable (drinkable) water to live. Without it, humans will not survive more than a few days.
   B. Water provides essential services within the bodies of plants and animals—transport of waste, temperature regulation, etc.

2. Most of the earth is made up of salt water; however, humans require fresh water to live.
   A. Fresh water refers to water that is located within land (or originates there) and has little to no salt
   B. Tidewater flows up the mouth of a river from the ocean during rising rides and contains too much salt for human consumption.

4. Water is considered the universal solvent because it dissolves or can change most materials over time.

5. Water is rarely considered in its pure form because it may contain a variety of other materials such as chemicals, plant/animal matter, bacteria and viruses, etc.

6. Water pollution occurs when unwanted chemicals, elements, or minerals make their way into the water system and build up over time as a result of the evaporation related to the water cycle.

7. The Water Cycle involves moisture evaporation, cloud formation, and precipitation (rainfall).
   A. Solar energy and the force of gravity act as the energy driving the cycle
   B. Water is constantly recycled as a result of the water cycle.
   C. Water can enter the atmosphere via evaporation from soil and plant surfaces.
Land and the Environment
1. Land serves multiple purposes like foundation for buildings and nutrient sources and support for plants.

2. Soil requires the appropriate proportions of minerals and nutrients to be productive.
   A. Soil needs the correct balance of nutrients, organic matter, and moisture content
   B. Only the small, top layer of the earth’s crust is considered productive.
   C. Many areas have soil with balances particles and minerals but insufficient water. Deserts are areas with a continuous water shortage.
   D. Irrigation (artificial delivery of water) can bring water to areas without it to make it productive.

The Relationship Between Land and Water
1. Related Processes:
   A. Precipitation involves moisture in the form of rain or snow and results when water in the air transforms from a gaseous state to a liquid.
   B. Evaporation occurs when warm or hot air changes water from a liquid to a gaseous state.
   C. A watershed is a large area of land that serves as a catch basin for precipitation which eventually drains into a body of water such as a stream, river, lake, etc.

2. Land can act as a container or reservoir for water.
   A. Water can soak into the soil and down through the ground to form a water table (a level of ground/soil saturated/soaked with water).
   B. At lower elevations, water can drain out as a spring from the water table.
   C. Land can also hold water outside of the water table to provide a source of water for plant roots.
   D. The usage of water by a plant (absorption through roots to evaporation from the leaves) is another part of the water cycle.

3. Types of Groundwater (And Definitions)
   A. Saturation occurs when water fills all of the pores and spaces in soil are filled. Prolonged saturation can cause plants health issues.
B. Free water (AKA gravitational water) is the water that drains from the soil after being wetted. This water feeds wells or springs.

C. Capillary water is the water that remains after free water is removed and is taken up by plant roots.

D. Hygroscopic water is water held too tightly to be absorbed by plants.

E. Groundwater is easily polluted with chemicals and animal wastes/fertilizers.

4. Benefits of Living Organisms
   A. Plants help prevent soil erosion and contribute to the water cycle by taking in water and releasing into the atmosphere via evaporation.
   B. Worms, insects, bacteria, etc. breakdown the dropped leave and materials from plants via decomposition which ultimately adds more organic matter to the soil.

Water Conservation and Water Quality
1. Water pollution, soil erosion, and preservation of soil production are important things to consider and plan for.

2. Good water quality comes about through proper land management as well as careful water storage and use.

3. Practices to reduce water pollution:
   A. Saving clean water through conserving water use in our daily lives.
   B. Disposing of household products appropriately. Many household objects and cleaners can make their way into the water supply and result in water pollution.
   C. Maintain land carefully by careful and appropriate balancing of nutrients, minerals, and organic matter.
   D. Practice sensible pest control by including, whenever possible, cultural practices instead of broad usage of pesticides.
   E. Control water runoff from land by using plant coverage to prevent erosion.
      (i) No-till cropping involves planting with no plowing or disking the soil. Minimally disturbing the land prevents excessive erosion.
      (ii) Consider contour farming (following the level of contour of the geography) to minimize erosion.
(iii) Plant a cover crop (close-growing crop) to protect soil surface.

F. Control soil erosion

G. Avoid spilling chemicals or petroleum which can cause water pollution via runoff.

H. Properly maintain your septic system.

Soil Characteristics

A. Soil Profile - undisturbed soil will have at least four horizons in the profile
(i) O Horizon – top layer composed of organic matter (plant, animal, insects, microbes) and some mineral material

(ii) A Horizon – often called topsoil and consists of organic matter, clay (fine particles), silt (medium-sized particles), and sand (larger particles)
   a. Appropriate soil components make this soil workable (tillable)
   b. Generally supports good plant growth due to presence of nutrients, chemicals, and living organisms

(iii) B Horizon – similar particle composition as A horizon but with less organic matter. This layer is often called subsoil

(iv) C Horizon – composed mostly of parent material
   a. Important for storing and releasing water to upper layers
   b. Does not contribute much to plant nutrition

B. Texture – refers to the proportion and size of soil particles
(i) Coarse-textured (sandy) soil – loose and single grained (individual grains can be easily seen or felt)
   a. Squeezed in hand while dry - Will fall apart when pressure is released
   b. Squeezed in hand while moist – will form cast, falls apart when touched

(ii) Medium-textured (loamy) soil – even mixture of sand, silt, and clay (less than 20%)
   a. Somewhat gritty feel, but smooth and highly plastic
   b. Squeezed in hand while moist – will form cast that can be handled without breaking
(iii) Fine-textured (clay) soil – very sticky when wet
   a. Forms hard lumps or clods when dry

C. Structure – refers to the tendency of soil particles to cluster together to form aggregates
   (i) Aggregates (crumbs) – contain mostly clay, silt, and sand; held together by a substance formed from organic matter
      a. Aggregates absorb and hold water together better than individual particles
      b. Better able to resist damage by falling raindrops

D. Organic Matter – soil is a living medium with a variety of living organisms
   (i) Might include roots of higher plants, algae, fungi (mushrooms, yeasts, molds), and various kinds of bacteria
   (ii) Living organisms from the animal kingdom might also exists in the soil (ex: insects, reptiles, nematodes, protozoans, etc.)
      a. These living organisms excrete wastes that ultimately become a part of the soil content

E. Soil water
   (i) Gravitational water - the water that drains out of the soil after it is wetted
   (ii) Hygroscopic water - this water is held too tightly to soil particles for plant roots to absorb
   (iii) Capillary water - the moisture that remains in the pore space and is available for plant production

F. Soil Drainage - soil drainage ensures the soil is properly aerated with oxygen
   (i) Ditching
   (ii) Subsurface drain lines
   (iii) Mole drains
   (iv) Surface drains
   (v) Raised beds/ridges

Making Soil Amendments
1. Amendments are made to soil by adding organic matter, adding specific nutrients, or modifying soil pH
   A. pH is a measure of degree of acidity or alkalinity
B. Most plants require a pH somewhere from 5.0 to 7.5

C. Cation exchange capacity (CEC) is a measure of total negative charges within the soil that absorb plant nutrients
   (i) Soil clay minerals and organic matter are typically negatively charged which attracts positively charged ions (cations)
   (ii) The cations will remain in the root and not be lost through leaching
   (iii) These absorbed cations can exchange with other cations in the soil solution
   (iv) Soils with high CEC retain more nutrients than soils with a low CEC value

2. Testing for needed amendments
   A. Petiole Test - sampling and testing of petioles of a potato plant can indicate a deficiency in nitrogen

   B. pH Test
      (i) Can be performed using a test kit or by sending a soil sample to a lab
      (ii) Laboratory analysis looks at levels of phosphorus, potash, magnesium, and pH
      (iii) The required amount of agricultural lime will be indicated by the pH test
          (NOTE: the amount of lime needed might vary depending upon the composition of the soil i.e. organic matter to clay content)

   C. Taking a Soil Sample
      (i) Select sampling tool (spade, auger, soil tube)
      (ii) Sketch out your plot and divide into sampling areas (labeling is important)
      (iii) Avoid wet spots, bare spots, or areas markedly different from target
      (iv) Remove surface litter
      (v) Take sample from correct depth
         a. 2 inches for established lawns
         b. 6 inches for gardens, beds, crop land, etc.
         c. Produce a composite sample for each distinct area (10 to 20 randomly selected samples)
(vi) Air-dry the soil and mix composite into clearly labeled boxes

(vii) Send soil sample for testing

3. Soil Acidity and Alkalinity
   A. Precipitate occurs when a solid is dropped out of a solution
   B. If soil is acidic, some micronutrients become too soluble and can build up in concentrations which might harm the plant
   C. If soil is alkaline, many nutrients precipitate out and become unavailable to the plant
   D. Improper soil/media pH will impact the on the availability of nutrients in the soil/media.
   E. Soil/media with high alkalinity are made more acidic by lowering the pH value
      (i) Gypsum is a soil amendment that can be used to reduce the alkalinity of the soil
         a. It should be added in the fall
         b. Distributed in the upper layer of topsoil
      (ii) Sulfur or aluminum sulfate can also be used to decrease the pH level
         a. Sulfur should be applied at 1.5 lb per 100 square feet
            i. Fall application to allow 3 to 6 months for the application to work
         b. Aluminum sulfate at 5 lb per 100 square feet
            i. Aluminum sulfate reduces pH rapidly (10 to 14 days)
   F. Soil/media with a high acidic level is made more alkaline by raising the value with lime.
      (i) Liming - adding lime to the soil will increase the pH
      (ii) Liming recommendations are based on standard ground limestone and a specific plowing depth
      (iii) Standard ground limestone should contain a minimum of 50% lime oxides
      (iv) Smaller particle sizes (determined by the percentage passing through a 100-mesh sieve) correct soil acidity faster
(v) Important to use a high-magnesium or dolomitic limestone if the soil test indicated a magnesium deficiency

Soil Conservation Practices
1. Good land management is a first defense against soil degradation and erosion as well as freshwater retention.

2. Types of Erosion
   A. Sheet erosion occurs as layers of soil are removed.
   B. Gully erosion occurs when soil loss leaves trenches (or gullies) in the land.

3. Recommended practices to prevent erosion
   A. Cover with soil by growing plants.
   B. Use mulch to cover soil and prevent rainfall from eroding the soil.
   C. Utilize conservation tillage to minimize soil disturbance and leave plant residue behind.
   D. Practice contour farming.
   E. Utilize strip cropping by alternating strips of row crops with strips of close-growing crops.
   F. Rotate crops.
   G. Increase and supplement organic matter in the soil.
   H. Provide the correct balance of lime and fertilizer.
   I. Establish permanent grass waterways (a strip of grass growing in an area where flowing water tends to cause soil erosion).
   J. Utilize terracing practices.
   K. Avoid overgrazing.
   L. Follow a soil conservation plan.

Land Erosion and Soil Conservation
1. Land erosion happens when soil is worm away and constitutes a huge problem worldwide.
2. Global Examples
   A. Forest clearing in China (1960s and 1970s) caused major issues with soil erosion. Huge amounts of soil was washed away with the absence of trees and can never be replaced.

   B. Slash and burn techniques in South America, Africa, and Indonesia.

   C. U. S. Dust Bowl (1930’s)
      (i) Considered to be one of the largest human-caused environmental disasters in U.S. history

      (ii) It is estimated that 100 million acres of farmland had lost all or most of the topsoil due to severe drought and poor soil conservation practices.

      (iii) Dust that resulted from high winds forced families from their homes and killed livestock and crops and in some cases caused disease and death in humans.

3. National Problems
   A. Approximately 1.6 billion tons of soil are worn away from American farmland each year.

   B. Groundwater pollution via sources of contamination as a result of manufacturing waste disposal. An aquifer (underground water-bearing rock formation) under Long Island, NY is the only supply of drinking water for 3 million people. Pollution of that aquifer would be disastrous.

4. Local Problems
   A. The Mississippi River Delta dumps huge amounts of sediment into the Gulf of Mexico each day. It’s estimated that one year’s worth of sediment is enough to cover the entire state of Connecticut.

   B. Oceans and sea-level rise can also cause soil and land erosion or disappearance. A major example of this can be found along Louisiana’s coastline.
      (i) 25-35 square miles of wetlands are lost each year

      (ii) Because the levee system prevents new sediment and, subsequent, degradation of plant life, shorelines start to collapse and give way to open water

      (iii) Programs that allow for the reintroduction of native grasses and plants can help with coastal erosion
Air Quality and Conservation

1. The air we breathe is made up of air contains approximately 79% nitrogen, 20% oxygen, 0.93% argon, 0.04% carbon dioxide, and small amounts of other gases

A. Plant and Human oxygen interaction
   (i) Carbon dioxide and oxygen are two gases that are very important to life on Earth. Carbon dioxide is found in the air. The cells of organisms, including humans and other animals, also produce it.

   (ii) Carbon dioxide is released from the body when organisms breathe out, or exhale.

   (iii) Plants need carbon dioxide to make their own food, and they release oxygen in the process.

   (iv) Oxygen is also found in the air. Organisms like plants and green algae make their own food.

   (v) During this process, the organisms release oxygen into the air. Many living things get oxygen from the air when they breathe in, or inhale. Oxygen helps the body’s cells function normally.

   (vi) The cycle of carbon dioxide and oxygen on Earth is dependent on plants and animals.

How ecosystems affect agriculture

A. Plants provide the oxygen that animals and other living things need to survive. Animals and other living things provide the carbon dioxide that plants need to make their own food.

B. Excessive Carbon Buildup of heat in atmosphere is the greenhouse effect
   (i) The greenhouse effect is a process that occurs when gases in Earth’s atmosphere trap the Sun’s heat. This process makes Earth much warmer than it would be without an atmosphere. The greenhouse effect is one of the things that makes Earth habitable.

   (ii) Human activities are changing Earth’s natural greenhouse effect. Burning fossil fuels like coal and oil puts more carbon dioxide into our atmosphere.

   (iii) NASA has observed increases in the amount of carbon dioxide and some other greenhouse gases in our atmosphere. Too much of these greenhouse gases can cause Earth's atmosphere to trap more and more heat.

   (iv) Excess heat and high nutrient levels from fertilizers and chemical run-off has also been linked to algae blooms which are toxic and can have harmful effects on people, fish, shellfish, marine mammals, and birds.
UNIT J: Plant Science
Developed by Ms. Morgan Richardson

STANDARDS:
LA-AGTECH: S8.1, S8.2, S17.1, S17.3, S18, S29.2
AFNR: PS.01, PS.02, PS.03, PS.04

Goal: Students will identify basic plant parts, processes and essential nutrients required for plant growth.

Objective(s):
1. Identify the following concepts related plant science/growth:
   A. Plant categories
   B. Plant taxonomy
   C. Plant structures and systems
   D. Photosynthesis
   E. Respiration
   F. Reproduction
   G. Nutrients required for growth
2. Recognize the major structures and systems of a plant’s physiology
3. Determine the influence of environmental factors on plant growth
4. Identify major plant processes that impact plant growth
   A. Propagation
   B. Respiration
   C. Transpiration
5. Identify major factors and processes involved in plant propagation
6. Identity the essential nutrients for plant nutrition
7. Interpret information on a fertilizer label
8. Select appropriate methods of applying fertilizer

Agritech Guiding Questions:
1. What is the series of processes in which light energy is converted to simple sugar called?
2. What do the three numbers found on a fertilizer label represent?
3. What macronutrients are essential for proper plant growth and development?
4. When are the irrigation needs of pasture grasses the greatest?
5. What is the function of flowers in sexual plant reproduction?
6. What term describes a plant that persists for many growing seasons?
7. Which method of irrigation should be utilized when water conservation is the most important factor to consider?
8. What materials can be used to make organic fertilizer?
9. What is a common method of fertilizer application for home vegetable gardens?
10. What materials can be used to make organic fertilizer?
11. What is a common method of fertilizer application for home vegetable gardens
Content:

Categories of Plants

1. Annuals
   a. Plants with a life cycle that lasts only one year.
      i. They grow from seed, bloom, produce seeds, and die in one growing season.
      ii. They then need to be replanted each spring.

2. Perennial
   a. A plant that lives more than two years.

3. Herbaceous
   a. Plant that has stems that are green and soft.
      i. These plants grow fast and produce flowers and many seeds in a short period of time

4. Woody plants
   a. These plants produce wood as its primary structural tissue. Woody plants are usually either trees or shrubs

5. Deciduous
   a. Deciduous plants, including trees, shrubs and herbaceous perennials, are those that lose all of their leaves for part of the year.

Plant Taxonomy

1. Taxonomy – the science, laws, and principles of classification
   A. Always named and classified using Latin, which can be considered the universal language of biological sciences (of which agricultural sciences has its origin)

   B. 300,000 species of plants have been identified globally

2. Binomial Classification System
   A. Genus – taxonomic category between family and species (capitalized)

   B. Species – subgroup under genus (not capitalized)

Major Plant Structures and Systems

1. Basic necessities for survival – light, water, air, and nutrients (minerals)
   A. Different plants require different levels of light, water, and nutrients to thrive in their environment.

2. Root Systems – largest part of the plant that can often be larger than the top (visible) portion of the plant
A. Types of Roots
   (i) Adventitious roots – appear where roots are not normally expected (located above the surface).
   (ii) Taproot – main root of the plant that grows straight down
   (iii) Fibrous roots – generally thin, somewhat hair-like and numerous (normally shallow).

3. Root Tissues
   A. Root cap – outermost part of the root that acts as a protective layer. It eventually wears away after root has penetrated the soil
   B. Apical Meristem - the growth region of the root tip (or the stem)
      (i) Main function is to trigger growth of new cells
      (ii) The apical meristem lays down a root (or shoot) behind itself and pushes itself forward
   C. Area of cell division – provides new cells that allow root to grow longer.
   D. Area of cell elongation – cells in this area become longer and more specialized with more specific jobs
   E. Xylem – cells responsible for carrying the water and nutrients to main plant
   F. Phloem – function as a pipeline to carry food (nutrients and minerals) upward
   G. Area of cell maturation – area where cells become fully developed and where root hairs (small microscopic roots) emerge
      (i) Food Storage
         (a) Sometimes the plant makes too much food and needs to store the extra it produced
         (b) Can be stored in the roots, stems, and seeds

4. Stems – provide the support for the main portions of the plant (leaves, flowers, fruit)
   A. Types of Stems
      (i) Woody – tough and winter hardy
      (ii) Herbaceous – succulent, often green, and not able to survive winter in colder areas
(iii) Modified Stem types – often below ground with specialized jobs to perform

(iv) Bulbs – short stems surrounded by modified leaves called scales

(v) Corms – thickened, compact, fleshy stems

(vi) Rhizomes are thick stems that run below the ground’s surface

(vii) Tubers – thickened, underground stems that store carbohydrates

5. Parts of Stems
   A. Xylem and Phloem run the length of the plant and run into all branches of the plant
   B. Vascular bundles can occur when the xylem and phloem occur together in certain plant subclasses
   C. Node is the portion of stem that is swollen where buds and leaves originate
   D. Internode – area between the nodes
   E. Axil is the angle above the leaf stem or flower stem and the stalk
   F. Axillary bud – grows out of the axil and develops into a leaf or branch
   G. Lenticels – pores in the stem that allow gas to pass in and out of plant
   H. Terminal bud – located on the top of top of the stem or branches. Can be either vegetative or flowering in nature
      (i) Vegetative bud produces stem and leaf growth
      (ii) Flowering bud produces flowers

6. Leaves – part of the plant that manufactures food by using light energy
   A. Leaf margins – leaf edges that are named according to the edge pattern
      (i) Description of leaf margins
         (a) Entire completely smooth around the edge of the leaf
         (b) Serrate – sharp teeth like edges to the margins
         (c) Crenate – rounded lobes
B. Shape and Form can vary according to species

C. Types of Leaves
   (i) Simple leaf – a single leaf arising from a stem
   (ii) Compound leaves – two or more leaves arising from a common point on the stem

D. Leaf parts – petiole (stem of leaf) and blade (the wide portion)

E. Seeds – Seeds have different shapes depending on their function and how they reproduce.
   (i) Example: Samara is a winged seed that is adapted to being carried away from the parent plant by the wind.
   (ii) Seeds are characterized by the following characteristics
       (a) Size
(b) Shape
(c) Texture
(d) Color

F. Seeds are made up of three main parts
   (i) Seed coat
   (ii) Endosperm
   (iii) Embryo

G. Internal plant structure
   (i) Cuticle – topmost layer that acts as a protective layer
   (ii) Epidermis – surface layer on lower and upper sides of leaf
   (iii) Palisade cells – give leaf strength and manufacture food
   (iv) Chloroplasts – parts of the cells that contain chlorophyll
   (v) Mesophyll – consists of the palisades and spongy tissue
   (vi) Stomata – openings that allow for exchange of CO\textsubscript{2} and O\textsubscript{2}
   (vii) Guard cells – cells that open and close the stomata

7. Flower Structure
   A. Male part of the flower contains the stamen (filament, anther, pollen)
      (i) Filament supports the anther
      (ii) Anther manufactures pollen
      (iii) Pollen is the male reproductive cell

   B. Female part of the flower is the pistil (stigma, style, ovary)
      (i) Stigma receives the pollen
      (ii) Style is the tube that connects the stigma to the ovaries
      (iii) Ovary contains ovules which are the female reproductive cells
C. Perfect (containing all flower parts) vs. Imperfect (missing one or more parts)

D. Petals – attract insects or other natural pollinators
   (i) Corolla are the collective group of petals
   (ii) Sepals act as a protective device for developing flower (collectively called the calyx)

8. Fruits, Nuts, Vegetables
   A. Fertilization occurs which causes seed ripening which becomes the fruit
   B. Vegetable – any part of a plant grown for its edible parts
   C. Nuts – considered a type of fruit

9. Plant Hormones
   A. Auxins - considered the master growth regulator
   B. Cytokinins - promote cell division
   C. Gibberellins - stimulate shoot elongation, seed germination, and fruit/flower maturation
   D. Abscisic Acid - responsible for plant dormancy
   E. Ethylene - promotes fruit ripening, flower wilting, and leaf fall

Environment Factors Impacting Plant Growth

1. Light
   A. Color – different wavelengths are used for different plant functions
      (i) Blue light – often used to encourage vegetative growth via strong root growth and photosynthesis
      (ii) Red light – used to encourage stem growth, flowering and fruiting, and production of chlorophyll
      (iii) Green/Yellow light – this range of color is less used by plants but some will still be used in the photosynthesis process
   B. Intensity – light intensity can vary at different times of the day and in different situations (indoor/outdoor, shade/sun)
      (i) Seasonal variations can have an impact on light intensity as well (ex: summer sun is more intense than winter sun because of the angle to the earth)
(ii) Intensity preference will vary depending on the plant

C. Duration
   (i) Too little light can cause some plants to grow tall and spindly (due to limited photosynthesis)

   (ii) Too much light can cause plants to wilt and lose color vibrancy

   (iii) Indoor plants typically require a minimum of 12 to 14 hours of light per day

2. Temperature – plants thrive best when the temperature is constant
   A. Temperature reacts with light, humidity, and air circulation
      (i) As the temperature rises, air becomes hotter and humidity decreases

   B. Plants will have individual temperature preferences

   C. As temperature rises (within limits), various processes including photosynthesis, transpiration, and respiration can increase

3. Water
   A. Water Quality – nutrient imbalance can occur when a plant is watered with excessive alkalinity or sodium content

   B. pH of water should be between 5.5 – 6.5 to avoid an increase in the pH of the growing medium overtime

   C. Maximum levels of dissolved solids

Plant Processes that affect growth

Photosynthesis
1. Photosynthesis is a series of processes in which light energy is connected to chemical energy in the form of a simple sugar.

2. Chlorophyll and chloroplast are essential to photosynthesis.

3. Plants use carbon dioxide to manufacture food for plant and releases oxygen necessary for animal life at the same time.

4. The rate at which the photosynthesis (food making) process occurs depends on and varies with the light intensity, temperature, and concentration of carbon dioxide in the atmosphere.

   A shortage of carbon dioxide causes a low rate of photosynthesis.
   1. An enclosed greenhouse can have a shortage of carbon dioxide
2. A carbon dioxide generator might be used to correct a shortage of carbon dioxide in the greenhouse.

3. Low light hinders plant growth and limits photosynthesis.

4. A dark room reduces the rate of photosynthesis and plants will have stunted growth and yellow leaves.

5. Plants adapt to various levels of light brightness (intensity), but all plants have a preferred range of light intensity.

6. Temperature can also affect the process of photosynthesis.
   A. The best rate of photosynthesis occurs between 65-85 degrees Fahrenheit
   B. Extremes of temperature can completely stop the process

Respiration
1. A process by which living cells take in oxygen and give off carbon dioxide

2. Can occur with or without the presence of light

3. Respiration uses sugars and starches produced by photosynthesis and makes energy

4. The process produces energy in the form of heat

5. Byproducts include carbon dioxide and water

6. The chemical equation for respiration is: C₆H₁₂O₆ + 6O₂ → 6CO₂ + 6H₂O + heat (energy)

Transpiration
1. A process by which a plant gives up water vapor to the atmosphere.

2. Occurs primarily through the stoma

3. Turgor – a swollen or stiffened condition that occurs when filled with liquid.
   A. Plant will wilt without enough water present.

4. Greatly influences by humidity, temperature, wind, and air movement
   A. As humidity in the air increases, the rate of transpiration decreases
   B. Air movement increases rate of transpiration
   C. Higher temperatures increases rate of transpiration
Plant Propagation

1. Propagation (reproduction) – the process of increasing the number of a species

2. Sexual propagation
   A. Allows most variation of any propagation method.
   B. Sexual reproduction occurs through pollination.
   C. The primary function of flowers is the production of seed
   D. Seed develops in the female part of the flower (pistil)
   E. The pistil then enlarges and becomes the fruit.
   F. Has some distinct advantages
      (i) less expensive and quicker than some methods.
      (ii) The only way to obtain new varieties and hybrid vigor
           (a) Hybrid vigor – the tendency of hybrid plants to be stronger and survive better
      (iii) Avoids passing on some diseases

3. Germination – seed sprouts and starts to grow
   A.Normally seeds are dormant (resting) when harvested
   B. Must be placed in favorable conditions to germinate

4. Four environmental factors – water, air, light, temperature
   A. Imbibition – absorption of water
      (i) Allows seed to fill cells with water
      (ii) Sometimes seeds need to be scarified (removal of hard outer coating) to start the process
   B. Respiration of air
      (i) Takes place in all viable (alive and capable of germination) seed
      (ii) Oxygen is required for germination
   C. Light - some seeds are stimulated to grow by light
   D. Temperature – heat is an important requirement for germination
LOUISIANA AGRITECH INSTRUCTIONAL GUIDE

Methods of Asexual Propagation

1. Asexual propagation – using the vegetative parts of the plant to increase the number of plants
   A. Cuttings
      (i) Requires a sharp knife or single-edge razor blade
      (ii) Flowers and flower buds should be removed from all cuttings
      (iii) Rooting hormone – a chemical that will react with the newly formed cells and encourage root development
      (iv) Cuttings are placed in a medium consisting of coarse sand, perlite, soil, a mixture of peat or perlite, or vermiculite.

2. Types of Stem Cuttings
   A. Stem tip cuttings – normally include the terminal bud with all of the unwanted portions (leaves, seed heads, and flowers) removed
   B. Stem section cuttings – prepared by selecting a section of the stem located behind the middle or behind the tip cutting.
   C. Cane cuttings – some plants have cane-like stems which are cut into sections to make cane cuttings
   D. Heel cuttings – used with woody-stem plants
      (i) A shield-shaped cut is made about halfway through the wood around the leaf and axial bud
   E. Single-eye cuttings – used when the plant has alternate leaves
   F. Double-eye cuttings – used when the plant has opposite leaves

3. Types of Leaf Cuttings
   A. Leaf cuttings – a cutting made from a leaf with a petiole cut to less than a half inch
   B. Lead Petiole cutting – a lead with a petiole about 0.5 to 1.5 is detached from the plant
   C. Leaf section cutting – leaves are cut into wedges with each containing at least one vein
   D. Split-vein cuttings – the leaf is removed from the stock plant and the veins are slit on the lower surface of the leaf. The cutting is placed in the medium lower side down.
4. Root Cuttings
   A. Root cuttings should be made in the dormant seasons when the roots have a large reserve of carbohydrates
   B. Large roots – cut 4 to 6 inches long
   C. Small roots – 1 to 2 inches long

5. Layering – stems will develop roots in any area that is in contact with the media while still attached to the parent plant
   A. Simple layering – stem is bent to the ground and covered with soil medium
   B. Tip layering – a hole is made in the soil medium and the tip of a shoot is placed in the hold and covered
   C. Air layering – An area of the stem that is still attached to the parent plant is wounded and wrapped in damp moss to encourage root growth.
      (i) Once roots are established the stem is cut from the main plant and transplanted.
   D. Division – dividing or separating the main part into smaller parts

6. Grafting – a procedure for joining two plant parts together so they grow as one
   A. Used when plants do not root well as cuttings or has inadequate root system to support plant
   B. Bud grafting – the union of a small piece of bark with a bud and a rootstock

7. Tissue culture – a new method of plant propagation that uses a small, actively growing part of the plant
   A. Must be conducted in a very clean (sterile) environment
   B. Multiple plants can be propagated from a single disease-free plant
   C. Materials required
      (i) A clean, sterile environment to work
      (ii) Clean plant tissue
      (iii) A multiplication medium
      (iv) A transplanting medium
      (v) Sterile glassware
(vi) Sterile tools

(vii) A sharp instrument for cutting

(viii) Tweezers

D. A small piece of plant material is cut from the parent plant, sterilized and then places in petri dishes or sterilized glass jars filled with agar gel that contains nutrients the plant cells need to divide

E. The plantlets are moved to new gels to encourage root growth, shoot growth, and then eventually transplanted to soil

F. Allows growers to make a large number of plant clones which can then be sold commercially

G. Used especially with hybrid plants that contain unique characteristics that cannot be maintained from sexual propagation

Plant Nutrition

1. Essential nutrients – 16 elements that are essential for normal plant growth

   A. Main Three – used in huge amounts, obtained from water and air
      (i) Carbon – used in formation and maintenance of plant structures
      (ii) Hydrogen – utilized in pH regulation, water retention, and synthesis of carbohydrates (energy)

2. Oxygen – utilized for respiration, energy production, and maintenance of plant structures

3. Macronutrients – used in large amounts, obtained from soil

   A. Nitrogen – essential aspect of protein/amino acids, chlorophyll, and cell formation
   B. Phosphorous – utilized in cell formation, protein syntheses, fat and carbohydrate metabolism
   C. Potassium – used for water regulation and enzyme activity
   D. Calcium – used for root permeability and enzyme activity
   E. Magnesium – utilized in chlorophyll formation and formation/metabolism
   F. Sulfur – essential aspects of protein, amino acids, vitamin and oil formation
4. Nitrogen (N), Phosphorus (P) and Potassium (K) are the three primary nutrients that plants need for growth. These three numbers are represented on bags of fertilizer (ex: a 20-20-20 fertilizer contains 20% nitrogen, 20% phosphorus and 20% potassium)

5. Micronutrients – used in small quantities, obtained from soil, primarily involved in enzyme activity
   A. Copper – enzyme activity
   B. Boron – enzyme activity
   C. Chlorine – chlorophyll formation, enzyme activity, and cellular development
   D. Iron – enzyme development and activity
   E. Manganese – enzyme activity and pigmentation
   F. Molybdenum – enzyme activity and nitrogen fixation in some species
   G. Zinc – enzyme activity

6. Most nutrients are absorbed as Ions (an atom that has an electrical charge)
   A. Interactions occur between anions (negative charge) and cations (positive charge) to keep the overall electrical charge of the soil the same. Keeping this balance is essential to plant growth
   B. Different elements have different electrical charges

**Soil and Media requirements for plant growth**

1. Requirements for Growth – Plants require, soil, water, air and nutrients for plant growth
2. Soil – provides air, water, and nutrients for the plant via the root system
   A. Osmosis – the process by which water moves from an area of high concentration to an area of low concentration through a semipermeable membrane
   B. Semipermeable membrane – allows certain things to pass through but not others
   C. Located in the epidermis of a root
3. Air can supply the plant with carbon dioxide
4. Water is required for plant growth
   A. Nutrients must first be dissolved in water before they can be absorbed
B. Water carries those nutrients to the leaves which then use them as a part of photosynthesis

C. Water can help with plant temperature regulation

5. Soil is the top layer of the Earth’s surface and is the primary medium for cultivated plants.

6. Media (plural for medium) – a surrounding environment in which a living organism grows, functions, and thrives
   A. Water – the practice of growing plants without soil is called hydroponics
   B. Soil – soil is the traditional (and original) medium in which to cultivate plants
   C. Other Media
      (i) Partially decomposed plant materials
         a. Decaying plant matter should be combined with lime and fertilizer to support plant growth
         b. Leaf mold – partially decomposed leaves
         c. Compost – a mixture of decaying organic matter (leaves, manure, plant wastes)
      (ii) Moss
         a. Sphagnum (pale or ashy moss) – extensively used for encouraging root growth
         b. Peat moss – partially decomposed moss found in bogs or other waterlogged areas
      (iii) Mineral matter – some mineral matters can be used as a medium for growing plants
         a. Perlite is a volcanic glass material used for starting new plants and in media mixes.
         b. Vermiculite is a mineral mica-type material used for starting plant seeds and cuttings and in media mixes.

4. Fertilizers
   A. A complete fertilizer must contain the three primary nutrients nitrogen, phosphorus, and potassium.
      (i) Fertilizers come in various forms, but most nutrients within a fertilizer must come in liquid form (soluble) to be used by plants.
(ii) Fertilizer grade indicates the proportions of nitrogen, phosphorus, and potassium
   a. Grade must be expressed on a container as percentages of the contents by weight
   b. Example: 10-10-10 contains 10% N, 10% P, 10% K
   c. The amount and grade of fertilizer are determined by: specific crop, potential yield, fertility of existing soil, physical properties of the soil, previous crop, and type/amount of manure applied

B. Organic fertilizers
   (i) include animal manures and compost made with plant or animal products. Some examples are: Dried and pulverized manures, Bone meal (phosphorus is the primary element), and Soybean meal
   (ii) Definite characteristics
      a. Nitrogen is usually the predominant nutrient (bone meal is the exception with phosphorus)
      b. Nutrients are only made available to the plants as the materials decay - usually slow acting and long-lasting
      c. Organic materials are NOT a balances source of plant nutrients

C. Inorganic fertilizers - have a higher analysis of soluble nutrients that have been blended together for a specific purpose.
   (i) include various mineral salts
   (ii) Characteristics
      a. Nutrients are in soluble form and are readily available to plants
      b. The soluble nutrients can potentially cause injury to growing plants and should not come into contact with roots or remain on foliage for any duration

D. Fertilizer Application
   (i) Broadcasting is done with a broadcast spreader and involves spreading fertilizer evenly over the entire surface of the field or growing area. Broadcast application is used on crops, as well as on turf and home lawns.
   (ii) Side-dressing is done by placing fertilizer in bands about 8 inches from the row of growing plants.
   (iii) Foliar application is the spraying of fertilizer directly onto the leaves of plants.
UNIT K: Plant Pests and Diseases
Developed by Ms. Morgan Richardson

STANDARDS:
LATECH: S8.3, S31
AFNR: PS.03.03

Goal(s): Students should be familiar with the major types of pest and causal agents as well as recognize the role of integrated pest management in control of pests.

Objective(s):
1. Define disease, pests, insect, weeds, and other terms associated with agricultural pests and diseases
2. Discuss how various types of pests can negatively impact agriculture
3. Describe the basic anatomy of insects
4. Describe the life cycle of pests
5. Identify types of damage done to plants based on insect physiology
6. Recognize the roles that plant diseases play in plant health
7. Identify various causes of plant disease
8. Describe biological, chemical and cultural methods of controlling plant pests
9. Explain the proper use of pesticides, including reading and interpreting a pesticide label

Agritech Guiding Questions:
1. What are the stages of complete metamorphosis?
2. What type of pest control is being performed when ladybugs are released to control aphids on a crop?
3. What conventional methods can be used to control insect damage?
4. What is the best method of storing pesticides?
5. What is another term for the trade name of a pesticide?
6. What type is pesticide is used to kill insects
Content:

General Definitions
1. Diseases – an infective agent that results in decreased health in living things
2. Vector – a living organism that transmits or carries a disease organism
3. Insect – a six-legged animal with three body segments
4. Arachnid – an eight-legged animal

Types of Pests
1. Pest is a general name for any organism that may adversely affect human activities.
2. An agricultural pest is one that competes with crops for nutrients and water. They can defoliate (eat the leaves) plants or transmit diseases
3. Major agricultural pests include weeds, insects, nematodes, and plant diseases
4. Weeds – plants that are considered to be growing out of place and can interfere with crop plants
5. These plants (weeds) are considered undesirable because:
   A. Competition for water, nutrients, light, and space
   B. Decrease crop quality
   C. Reduce aesthetic value
   D. Interfere with right-of-way maintenance
   E. Harbor insects and disease pathogens
6. Annual Weeds – a plant that complete its life cycle within 1 year
   A. Winter annual – germinates in the fall and grows until late spring
   B. Summer annual – germinates in the late spring and grow vigorously in the summer months
7. Biennial Weeds – a plant that will live for 2 years
   A. First year produces only vegetative growth
   B. Second year sees a production of flowers and seeds
   C. Examples include thistle, burdock, and wild carrot
8. Perennial Weeds – can live for more than 2 years
   A. Perennial plants produce vegetative growth via rhizome, stolons, and rootstocks.
      (i) Rhizome – a stem that runs on the surface of the ground and gives rise to new plants at each node

      (ii) Stolon – a stem that runs on the surface of the ground and gives rise to new plants at each node

9. Noxious Weeds – a plant that causes great harm to other organisms by weakening those around it
   A. Difficult to control or eradicate
   B. Should be handled carefully to avoid spreading seeds to new areas
      (i) Often spread via airborne seeds

Anatomy of Insects
1. Insect anatomy
   A. Exoskeleton – the body wall of the insect that provides protection and support
      (i) Head, Thorax, Abdomen

   B. Antennae – act as sensory organs

   C. Three pairs of legs attached to thorax (body)

   D. Wings (if present) – permits mobility

2. Insects are small animals that have three body regions (head, thorax and abdomen) and three pairs or six legs.
   A. Five types of mouthparts are important in identifying insects and in controlling insects.
      (i) Chewing—tear, chew or grind food.
          Examples: grasshoppers, beetles.

      (ii) Piercing-sucking – punctures plant and suck sap.

      (iii) Rasp-sucking—rasps or break surface and suck sap.
          Example: thrips.

      (iv) Siphoning—have a coiled tube they dip into liquid food such as nectar and draw it in.
(v) Sponging—have two sponge-like structures that collect liquid food and move it into the food canal.
Example: Housefly.

Life Cycle
1. Complete metamorphosis has four stages:
   A. Egg
   B. Larva—worms or caterpillars.
   C. Pupa
   D. Adult—flies, beetles, etc

2. Incomplete metamorphosis has three stages:
   A. Egg
   B. Nymph
   C. Adult.

Damage to Plants by Pests
1. Insect damage depends on types of mouthparts

2. Chewing—parts of leaves eaten away.
   (i) Beetles—eat leaves, stems, flowers, fruit and nuts.
   (ii) Cutworms—usually attack stems, but may eat other plant parts.
   (iii) Caterpillars—larva of moths and butterflies and are fuzzy or hairy. Eat young leaves and stems. Roll up in leaves making leaves curl.
   (iv) Grasshoppers—eat all parts of plants.

3. Sucking
   (i) Aphids—pierce and suck juices, known as plant lice, cause stunted growth and yellow spotted leaves, cause sticky substance and black mold with attract ants.
   (ii) Leaf bugs—cause plants to look unhealthy, lose their normal color and wilt.
   (iii) Mealy bugs—pierce and suck from underside of leaves and in leaf axils causing yellow appearance and sticky secretions.
(iv) Scale—appear as black or brown raised lumps attached to stems and underside of leaves causing yellow leaves and stunted growth. (5) Thrips—chew and then suck causing plant tissue to become speckled or whitened, leaf tip to wither, curl up or die.

(v) Whiteflies—feed on underside of young leaves causing yellowing. They will look like flying little white specks when plants are shaken. (7) Mites—attack underside of leaves causing gray to grayish—green spots, severe infestations cause webbing.

**Plant Diseases**

1. Plant Diseases – any abnormal plant growth
   A. Occurrence and severity is based on three factors:
      (i) A susceptible plant (host) must be present
      
      (ii) Pathogenic organism (causal agent) must be present
      
      (iii) Environmental conditions must be supportive of causal agent

2. Disease triangle – the relationship of the three factors

**Agents for Plant Diseases**

3. Diseases can happen through either abiotic factors or biotic agents
   A. Abiotic (nonliving) diseases – caused by environmental stress
   
   B. Biotic (living) diseases – cause by living organisms

4. Causal Agents
   A. Fungi – plants that lack chlorophyll – can cause disease by producing spores and mycelia
   
   B. Bacteria – can enter a plant only through wounds or natural openings
   
   C. Viruses – capable of altering a plant’s metabolism by affecting protein sheaths
      (i) Transmitted via seeds, insects, nematodes, fungi, grafting, or mechanical means
      
      (ii) Symptoms – visible change to the host caused by the disease
      
      (iii) Can include ring spots, stunting, malformations, and mosaics (light and dark green leaf patterns)

   D. Nematodes – tiny roundworms that live in the soil or water, within insects, or as parasites.
      (i) Can damage plants by feeding on stem or leaf tissue
(ii) Main symptoms include poor plant growth

(iii) Major plant parasitic nematode groups – root-knot, stunt, or root-lesion

Controlling Pests and Integrated Pest Management

1. History
   A. Integrated pest management – a pest-control strategy that relies on multiple control practices
   B. Early 1900s – entomologists developed an array of cultural and natural control for the boll weevil and other insect pests
   C. 1940 – 1970 – major reliance on chemical pesticides
   D. 1972 – major shift in policy that encouraged other pest-control strategies. Natural, biological, and cultural control programs were introduced

1. Principles and Concepts
   A. Key Pest – one that occurs on a regularly basis for a given crop
      (i) Important to be able to identify the key pest for a crop
      (ii) Must identify the weak link in the plant’s biology to help manage the pest
   B. Crop and Biology Ecosystem – knowledge of the ecosystem will help the integrated pest manager successfully manage for any pests
   C. Ecosystem Manipulation – influencing the ecosystem to manage for pests
      (i) Pest population equilibrium – occurs when the number of pests stabilize or remain steady
      (ii) Economic threshold level – the point where pest damage is great enough to justify the cost of additional pest-control measures
   D. Monitoring – scouting procedure performed to check for pest control

2. Strategies
   A. Regulatory Control
      (i) The controls utilized by regulatory agencies in pest management
         (a) Quarantine – the isolation of pest-infested material
         (b) Targeted pest – a pest that poses a major economic threat
         (c) Eradication – total removal or destruction of pest
   B. Host Resistance – development of plants having pest resistance
      (i) Advantages
(a) Low cost
(b) No adverse effect to environment
(c) A significant reduction in pest damage
(d) Ability to fit into any IPM program

C. Cultivar – a plant developed by humans

D. Biological Control – control by natural agents
   (i) Might include:
      (a) Predators – an animal that feeds on the pest
      (b) Parasites – live in or on another organism

E. Pathogens – organisms that will produce disease within the host (targeted to pests)

F. Cultural Control – the attempt to alter the crop environment to prevent or reduce pest damage
   (i) Clean culture – any practice that removes breeding or over-wintering sites of a pest
   (ii) Trop crop – a susceptible crop planted to attract a pest to a localized area

G. Physical and Mechanical Control

H. Chemical Control – the use of pesticides to reduce pest populations
   (i) Very cost-effective
   (ii) Types of chemical control
      (a) Herbicide – Class of chemicals used to kill other plants
      (b) Insecticide – Class of chemicals used to kill insects
      (c) Fungicide – Class of chemicals used to kill fungi
   (iii) Issues
      (a) Pesticide resistance – the genetic ability of a pest population to survive applications of pesticides
      (b) Pest resurgence – the rapid resurgence of a pest population that was, in the past, successfully controlled by pesticide (resurgence often results in higher numbers of pests than what was seen originally)
Chemical Control with Pesticides

1. Pesticide Label Information – With all pesticides. The label is the law and the chemical must be used exactly as instructed
   A. Name and address of manufacturer.
   B. Trade name - also known as the manufacturer name or trademark name
   C. Active ingredients including official common name or chemical name of each ingredient.
   D. Type of Pesticides—herbicide, insecticide, fungicide, etc.
   E. Form of substance—dust, wettable powder, fumigant, etc.
   F. EPA registration number.
   G. Storage and disposal precautions.
   H. Hazard statement including ‘Keep Out of Reach of Children’.
   I. Directions for use—mixing, application, etc.
   J. Net contents.
   K. Statement of practical treatment states what to do if a person swallows or is poisoned by spilling the chemical on the skin.
   L. Worker protection procedures including reentry time on how long before a person can enter the treated area.
   M. Signal words—toxicity levels for humans. 1.
      (i) Danger—has skull and crossbones symbol and poison on label. Highly toxic, most poison or lethal dosage.
      (ii) Warning—moderately toxic.
      (iii) Caution—slightly toxic to non-toxic.

2. The most important safety rule is “read and follow label directions” this ensures that the chemical is used correctly and safely

3. Pesticide Storage
   A. Pesticides should be stored in their original containers which are designed to both protect the pesticide and those handling the container
B. Make sure that the original labeling is intact and undamaged

C. Pesticides are typically stored best between 40 and 90 degrees Fahrenheit (read label for pesticide specifics)

D. Chemicals/pesticides should be stored in a well-ventilated, designated place (a locked cabinet or room is often best)
   (i) Pick somewhere that is kept away from pets, children, food, animal feed, and flames
Unit L: Crop Production and Harvesting

Standards:
LA-AGRITECH: S17.2, S17.4, S28, S30, S33
AFNR:

Goal: Students should be able to identify and describe the major processes of crop production, including, planting, care and maintenance, harvesting and transportation.

Objective(s):
1. Explain the processes involved in preparing for, planting, maintaining, and harvesting row crops
2. Describe care and maintenance practices for agricultural crops
3. Describe methods of preparing and protecting seedbeds
4. Compare and contrast methods of irrigation
5. Explain steps in harvesting crops
6. Identify potential harvest problems.
7. Analyze methods for processing, grading and storing agricultural products
8. Identify market outlets for agricultural products. This includes how economic factors influence the price and availability of goods sold
9. Identify basic careers in crop and food production

Agritech Guiding Questions:
1. What effect can fungi have on recently harvested crops?
2. What equipment is generally used to loosen and prepare soil for planting?
3. What type of environment should tomatoes be stored in prior to the sale?
4. Which economic factors influence how market prices for a particular crop are set?
5. Identify equipment used for preparing and planting seedbeds
6. When are the irrigation needs of pasture grasses the greatest?
7. Which method of irrigation should be used when water conservation is the most important?
8. What equipment is generally used to loosen and prepare soil for planting?
9. What type of planting is a broadcast seeder used for?
10. How should orange trees be pruned?

Content:
Operations within Crop Production
1. Preparing fields for Planting
   A. Initial preparation of fields typically begins after the last harvest or while the land is not being used
      (i) A fallow period is the period of time when usually cultivated land is not being used
B. A producer will till the fields to dig-up, mix, and overturn the soil

C. Harrowing is then done to break the soil clods into smaller mass and incorporate plant residue

D. The producer may also level the field to allow for easier planting and irrigation

E. Pre-emergent herbicides may also be applied

F. Different crops require different planting methods, so the preparation of the soil may vary among different crop types

2. Planting
   A. Planting times vary depending on the type of crop, the location, and the anticipated last frost date.

   B. Depending on the crop, small scale producers may cover crop rows in plastic or weed barriers to protect the seeds and prevent weed growth.

   C. Producers generally plant in two different ways
      (i) Direct seeding is the process of placing seeds directly into the soil
          (a) Often use seed drills or planters to place seeds directly into the fields

          (b) Broadcast seeders are used to spread seeds evenly over the planting area surface

      (ii) Transplanting is the process of planting small, already established plants into the field.

      (iii) Crops such as sugarcane are grown by taking sections of plant stems between nodes and planting them directly into the soil

3. Crop Care and Maintenance
   A. Once fields are planted, routine care and maintenance must be used to maintain high quality crops
      (i) Weeding

      (ii) Soil cultivation

      (iii) Irrigation

      (iv) Pest and disease control
Care and Maintenance Practices

1. Controlled Traffic - running farm machinery over the same paths year-after-year
   A. Causes damage to the smallest proportion of the field possible

2. Cover Crops - plants that provide ground cover between crops
   A. Reduce soil erosion
   B. Increases nitrogen availability (if using a nitrogen-fixing legume cover crop)
   C. Increases surface soil organic matter
   D. Improves water filtration
   E. Providing control of early season weeds

3. Crop Rotation - the practice of alternating between crops on the same field
   A. Manage weed, insect, and disease pests
   B. Reduce soil erosion
   C. Maintain/Increase organic matter
   D. Increases nitrogen availability (if using a nitrogen-fixing legume crop)
   E. Manages excess nutrients

4. Irrigation
   1. There are four main methods of irrigation: surface, sprinkler and drip/micro.
      A. Surface Irrigation is when water flows over the soil by gravity such as rain or flood irrigation
      B. Sprinkler irrigation applies water to soil by sprinkling or spraying water droplets from fixed or moving systems.
      C. Drip Irrigation or Micro-irrigation applies water at low rates and pressures to specific areas so irrigation water reaches the root zone with minimal loss.
         (i) Ideal for areas where water may be less available or there is an increased need for water conservation
      D. Subirrigation applies water below the soil surface to raise the water table into or near the plant root zone.
         (i) Subirrigation is not often used in arid or semi-arid irrigated areas where irrigation is often needed to germinate crops
2. Plant Conditions indicating irrigation needs
   A. Evapotranspiration – this term is used to describe the amount of water consumed by plants over a period of time
      (i) The water loss occurring from the processes of evaporation and transpiration
   B. Irrigation is often needed to supplement water availability due to environmental conditions or a slow water uptake process
   C. Why do some plants need more water than others?
      (i) Different plant species might have different water needs (example: a species used to growing in a moist environment might require irrigation in a drier climate)
      (ii) Environmental conditions can impact irrigation needs as well
           (a) Relative humidity – the amount of water vapor in the air relative to the maximum amount of water vapor the air can hold at a certain temperature
           (b) Day length
                (i) Groundwater levels fall during the day
                (ii) With longer days, the groundwater will fall more and require supplemental water via irrigation
           (c) Temperature – increasing temperatures result in increased evapotranspiration rate which results in greater water loss
           (d) Wind speed – higher wind speeds can cause plants to increase their rate of transpiration which will result in a higher water requirement
           (e) Mowing height – lower mowing heights can result in higher water requirements
           (f) Fertilization – excessive fertilization can cause roots to shrivel and make it more difficult to absorb water

5. Pruning
   A. Pruning is necessary for fruit trees, ornamental trees, and shrubs
      (i) It involves the selective cutting of a portion of a tree or a shrub
          (a) Pruning typically involves thinning or removing excessive growth to help the plant reach optimal size
          (i) If a tree gets too big and there isn’t enough new growth or light, it will decrease how much fruit the tree can produce.
          (ii) Usually pruning is done by hand using pruning shears or loppers.
(ii) Necessary for overall plant health to:
   (a) Remove dead or diseased branches

   (b) Shape plants so they can hold more fruit

   (c) Assist with growth and development of younger plants

   (d) Allow more sunlight to reach lower branches

   (e) Remove branches that are growing incorrectly or impacting other branches

   (f) Allow for easier access to harvest fruit

(iii) Types of Pruning
   (a) Raising: Raising means “raising the crown”, which means getting rid of some of the lower branches of the trees
      (i) Used primarily in landscaping and less in production agriculture

   (b) Reduction: Reduction is the practice of selective cutting to decrease height and growth rate of a tree

   (c) Thinning: Thinning allows sunlight infiltration and air flow. Usually done to overgrown trees by decreasing the edge of the crown and thinning areas of thick growth.

   (d) Cleaning: Removing all dead and diseased or unwanted wood from the tree.

   (e) Topping: Topping is when major and thick tree branches and limbs are severely and haphazardly cut leaving large stubs. It is often harmful to the tree.

6. Harvesting – means taking a product from the plant where it was grown or produced.
   A. Methods of harvesting crops
   i. Crops that are exported as fresh produce, including most of the tree fruit and vegetables, are traditionally harvested by hand.
      1. Important when damage from mechanical harvesters could bruise of damage the crops and cause them to be less desirable.

   ii. Grain crops such as wheat and maize, oil (sunflower and canola) and protein (soybean and groundnut) crops are harvested using specialized combine harvesters.
iii. Some crops such as onions or potatoes are lifted out of the soil using machines and then picked up and sorted by hand

iv. Tree nuts and fruits are sometimes collected by shaking the trees and then gathering

B. Problems related to harvesting
   i. Maturity – means the state or quality of being fully ripe or mature.

   ii. Under-ripe – means that the crop has not reached maturity.

   iii. Overripe – means that the plant is past the optimum maturity; stalks or limbs can easily break or shatter, or fruit can drop.

   iv. Spoiled – means that chemical changes have taken place in the food or food product that either can reduce in nutritional value or render it unfit to eat.

   v. Microorganisms – contribute to food spoilage, fungi, and nematodes.

7. Process and Handling
   A. Processing – The steps involved in turning the raw agricultural product into attractive and consumable food.
      i. Wheat – Wheat is cleaned, dried, weighed, and graded for quality. However, before this can happen the wheat is separated into bran and germ.
         2. Germ – Inside the bran is the endosperm, which will become the flower, and the germ, which is a new plant inside the kernel.

      ii. Tomatoes – The processing of tomatoes results in a variety of products such as (a) salsa, (b), spaghetti and hamburger sauces, relishes, catsup, among others.
         1. Tomatoes are harvested year-round around the world; however, peak harvest in North America occurs in the summer months.
         2. The processing of tomatoes permits tomatoes to be used for future use.
         3. After tomatoes are cleaned and separated for size and quality, they may be canned whole; cooked, and strained for juice, or just made into other products.
8. Grading
   A. Harvested crops are graded either mechanically or by hand.
   B. The quality of the crop and its grade will influence its final market price

9. Transporting
   A. Trucks, planes, boats, cars, trains, and bicycles are vehicles used by the food industry to transport food in various parts of the world.
   B. The efficiency of transportation can influence food quality in terms of freshness and spoilage.
   C. Insulated and refrigerated trucks enable food products in fresh forms to most parts of the country year-round.
   D. Approximately 90% of our perishable food is shipped by truck.
   E. Less perishable foods, such as wheat, potatoes, and better are shipped by rail.
   F. Air travel allows more perishable foods from distant regions to be enjoyed in various other parts of the world. For example, pineapples and papayas from Hawaii are enjoyed throughout the world today in large part due to air transportation.
   G. The consumer provides the final link from farm to table.
      i. How far the food was shipped, how the food was packaged, how long the food was in transit, and how warm the food became during transit all affect the ultimate food quality.

10. Marketing
    A. There are many types of retail stores from which consumers can purchase their food items.
    B. Superstores carrying 15,000 items or more, convention supermarkets, limited assortment and box stores, convenience stores, non-conventional food stores, small stores, corner stores, food cooperatives, farmers markets, roadside stands, pick-your-own businesses, and other farm outlets are the most common places that consumers purchase their food items.
    C. Market prices are typically set by the supply and demand for the product.
       i. Factors such as natural disasters, large scale insect or disease issues, droughts or industry trends can all impact market prices.

Career Opportunities in the Food Industry
   A. Business
      i. Accountant
ii. Buyer

iii. Distributor

iv. Financial Analyst

v. Loan Officer

vi. Marketing Specialist

vii. Salesperson

viii. Statistician

B. Communications
   i. Advertising specialist

   ii. Broadcaster

   iii. Media Specialist

   iv. TV Producer/Demonstrator

   v. Writer

C. Education
   i. College professor

   ii. Extension specialist

   iii. Industry educator

   iv. Dietician

   v. Teacher

D. Processing
   i. Butcher

   ii. Efficiency Expert

   iii. Engineer

   iv. Plant Line Worker
v. Plant Supervisor

vi. Refrigeration specialist

vii. Safety expert

E. Quality Assurance
   i. Food analyst
   
   ii. Grader

   iii. Inspector

   iv. Lab technician

   v. Quality-control supervisor

   vi. Quarantine Officer

F. Research and Development
   i. Distributor Analyst

   ii. Biochemist

   iii. Microbiologist

   iv. Packaging specialist

   v. Process engineer

G. Retailing/Food Service
   i. Baker

   ii. Cook/Pizza Maker

   iii. Counter Salesperson

   iv. Deli Operator

   v. Meat Cutter

   vi. Nutritionist

   vii. Produce Specialist
viii. Restaurant Owner/Operator

ix. Waiter/Waitress

H. Transportation
   i. Dispatcher

   ii. Truck driver

   iii. Rail operator

   iv. Merchant marine

2. Food Products from Crops
   A. Fruits, Vegetables, and Nuts

   B. Cereal Grains

   C. Oil Crops
UNIT M: Agricultural Business
Developed by Ms. Brynn Wittie and Ms. Raegan Ramage

STANDARDS
LA-AGTECH: S20, S22.2, S22.4, S22.4, S34, S35, S36
AFNR: CRP 5.02, ABS. 01-05

Goal: Students should be able to identify major sources of credit for agribusiness, including lending institutions and types of loans available, as well as basic agribusiness principles and develop an understanding of major decision-making steps in owning and operating an agricultural business.

Objective(s):
1. Investigate, compare and apply principles of agribusiness finance
2. Explain the steps in agribusiness management
3. Identify careers related to agribusiness systems
4. Identify economic principles as they relate to an AFNR business
5. Identify sources and types of credit
6. Identify information necessary to complete a loan application
7. Identify basic organizational structures of agricultural businesses
8. Describe the benefits and disadvantages of agribusiness entrepreneurship
9. Identify ways in which managers make employment decisions for agricultural businesses
10. Identify responsibilities associated with owning an agricultural business
11. Identify types of management
12. Identify essential financial records necessary to running an agricultural business
13. Identify essential elements in marketing agricultural products
14. Describe methods of commodity pricing
15. Explain the definition of a cooperative and distinguish between the main types of cooperatives and their functions
16. Identify the benefits of cooperatives

AgriTech Guiding Question(s):
1. For what purpose might a farmer take out a short-term loan?
2. What is the Law of (Increasing) Opportunity Cost?
3. For every dollar spent on food, what percentage of that dollar goes towards transportation cost?
4. What would be the job description of someone who works in agribusiness marketing?
5. What is the difference between a cooperative and a partnership?
6. What two types of plans do managers make when setting goals and objectives for their agribusiness?
7. What is the term for a financial document that records the amount of product kept on hand, how many were sold, each item’s cost, total sale, and profit?
8. How are the payments for an amortized loan structured?
9. What is a major disadvantage of owning your own agribusiness?
10. What does the distribution function of business involve?
11. Which type of cooperative receives products from its members and then resells those products for the best possible price?
12. What are the main types of cooperatives?
13. What is an advantage of selling products such as milk through a cooperative?

Content:
Agribusiness – Is the business sector encompassing farming and farming-related commercial activities. The business involves all the steps required to send an agricultural good to market: production, processing and distribution.

1. Agribusiness management – the human element that carries out a plan to meet goals and objectives in an agricultural business or enterprise. Decides the types of business or production activities included in the agribusiness, such as horticulture, aquaculture, and farm supplies.
   A. Poor management - statics have shown that 88% of businesses that fail due so as a result of poor management, commonly seen through lacking set objectives or goals for the business
   B. Good management – is presented through generally have well established goals and objectives serving as guidelines of operation

Steps in successful agribusiness management
1. Start the management process with a situation or established goal
2. Gather all available facts and information for accurate analysis of the problem
3. Analyze the available resources of land, equipment, and capital. Reevaluate your goal and adjust it if appropriate
4. Determine the possible ways or established routes of accomplishing the goal or solving the problem
5. Make an informed decision concerning the route(s) that will be taken
6. Follow through with a plan of action
7. Assume responsibility for implementing the plan
8. Evaluate the results to determine whether the goals were accomplished. If not, could a better route have been selected? Should the goals be modified?
   A. Ensure these outlined steps occur in a cyclic method
Careers in Agribusiness
1. Careers in Agribusiness Systems typically focus on utilizing innovative technology in order to increase profitability and efficiency.

2. Agribusiness is the coordination of all activities that contribute to the production, processing, marketing, distribution, financing and development of agricultural commodities and resources. This includes food, fiber, wood products, natural resources, horticulture, and other plant and animal products and services.

3. Agribusiness is a high-tech industry that uses satellite systems, computer databases and spreadsheets, biotechnology, and many other innovations to increase efficiency and profitability.
   A. Career Option Examples:
      (i) Agribusiness manager
      (ii) Grain buyer
      (iii) Equipment sales
      (iv) Farm labor contractor
      (v) Ag finance specialist
      (vi) Loan officer
      (vii) Farm business manager
      (viii) Agricultural journalist
      (ix) Agribusiness marketing

Economic Principles
1. Capital – value in the form of money or other assets owned by an individual, organization or contribution for a particular purpose such as a business start up

2. Price – the amount received for an item
   A. Price Determinants – (1) the supply of the item, (2) the demand for the item, and (3) the general price level

2. Supply – the amount of a product available at a specific time and price

3. Demand – the amount of a product wanted at a specific time and price. It is often determined largely by price

4. Credit – money borrowed from a source
5. Price of products vary depending on the supply and demand of an item. Balance in both creates an established price, while an increase or decrease may result in price dropping or rising.

6. Ability to purchase products or materials affects the supply and demand, creating an opportunity for credit to be utilized.

**Principle of Diminishing Returns**

1. Diminishing return - the amount of profit generated by additional inputs

2. Physical return – the concrete need of a limited quantity of items, the establishment of physical capacity, in which additional items could cause a negative effect if exceeded.

3. Economic return – the rate of additional inputs that require an additional cost, and their efficiency in increasing economic outputs to maximize greatest potential income.

**Law of Increasing Opportunity Costs**

1. Comparative advantage – the emphasis in a given area where the most returns can be achieved
   (i) An example is trends in livestock production within states
      (a) Example: In the state of New York, it used to be most profitable to produce sheep, but that evolved to dairy, as dairy presented a higher market value in the state compared to sheep

**Resource substitution**

1. The use of one resource or item to replace another, when the results are the same
   A. It is often possible to substitute a less expensive item for a more expensive item
      (i) Example: Substituting barely for corn as a cheaper feed supply for dairy animals

**Sources of Loans and Credit**

1. Classifications of Credit
   A. Long-Term Loans - used to purchase land and buildings, loan period ranges from 8-40 years, typically lower interest rates for this type opposed to the other types
   B. Mid-Term Loans - also known as intermediate loans; used to purchase things such as farm equipment or breeding livestock, loan period ranges from 1-7 years
   C. Short-Term Loans - also known as production loans; used to purchase things such as livestock feed, fertilizer, seed, or fuel, loan period is one year or less, when pledging for a short-term money applicants are typically required to
pledge an item of value for security of repayment to the loan source

2. Two Types of Credit
   A. Productive Credit - credit that is used to increase production or income, justifiable when the estimated increase in production will increase profit
      (i) Examples include – livestock, plants, equipment, storage facilities, seed, or fertilizer
   
   B. Consumptive Credit – credit that is used to purchase consumable items used by the individual; it does not contribute to the business income; typically easier for abuse of usage which can then result to limit availability of receiving productive credit
      (i) Examples include – vehicles, clothing, shoes, or entertainment

3. Capital Investments – money that is spent on commodities that are kept 6 months or longer; used to purchase things such as store equipment, tractors, and warehouse equipment

4. Sources of Credit
   A. Commercial Banks and Trust Companies
   
   B. Federal Land Banks
   
   C. Production Credit Association
   
   D. Farmers Home Administration
   
   E. Insurance Companies
   
   F. Individuals
   
   G. Equipment manufactures

5. Cost of Credit
   A. Interest Rates and/or Fees
      (i) Interest is an amount charged in addition to the principal by a lender.

      (ii) Interest and principal are both added together to make up a loan payment

      (iii) Loan payments are structured so that interest is typically paid in higher amounts in the beginning of the loan

      (a) This can mean that a new loan will not be paying for the item itself at first, but instead will be primarily paying back the lender first.
(b) Over time, the amount shifts so that the borrower is paying more for the item than the interest.

(c) Primarily important when considering the sale of the item before it is paid off.

B. Simple Interest, Discount Loans or Add-On loans
   (i) Simple-Interest Loan – indicates the full amount of a loan is received by the borrower and then paid back with interest for a short time

   (ii) Discount Loan – indicates the interest is subtracted from the total amount of the loan at the time the loan is made
      (a) Example – a borrower takes a $1,000 loan with a 10% interest rate which results in the borrower receiving $900

   (iii) Add-On Loan – indicates calculations for interest on consumer loans where the interest is charged for the entire amount of the principal for the entire length of time
      (a) The total principal plus total interest is divided into combined equal instalments, resulting in a very high rate of true interest

C. Amortized Loans – typically are utilized for the purchase of land, buildings, and other expensive items
   (i) Payments are made monthly and computed so that the interest owed plus the payment on the principal is equal throughout the repayment period

D. Promissory Notes – documentation utilized to represent agreeance to the terms of the loan

6. Using Credit
   A. Factors of selecting a lender –
      (i) Lending institution representative’s knowledge of agribusiness problems and practices

      (ii) Lending institution representative’s experience in handling agricultural credit of similar nature

      (iii) Reputation of lending institution

      (iv) Loan policies including interest rate, repayment schedule closing cost, penalty clause, optional repayment clause, and policy regarding failure to meet payment because of circumstances beyond borrower’s control

      (v) Date the loan would be advanced
(vi) Possibility of increasing the loan; and

(vii) Availability of credit for other purchases

B. Compare and Contrast Loan requirements (terms, methods and dates/deadlines)

(i) Agribusiness manager must be fully prepared to explain benefits and risk to potential lenders; many loans are not approved because the borrower does not present the details of the business adequately as well as not efficiently presenting benefits of the business

(ii) A borrower should investigate several sources of credit to find the one that best meets the needs of the borrower

7. Applying for Credit
   A. Information needed to apply for loans
      (i) Information that should be included in the presentation is the following:
          (a) Agribusiness plan

          (b) Business records – income statements, expense records, net worth statement, and financial history

          (c) Terms of the loan

          (d) Method of repayment

Five Main Ways American Businesses are Organized
1. Buying Function – selecting a product or service to be marketed or sold for profit

2. Selling Function – studying the product or service to determine the reasons that customers will want and need the product or service. Planning sales presentations, determining methods of overcoming objections, and planning for the close of a sale are all part of this function

3. Promoting Function – developing a plan to identify ways to make potential customers aware of the product or service to be offered

4. Distribution Function – physically organizing and delivering the selected product or service

5. Financing Function – obtaining capital for the initial inventory, recording sales, maintaining inventory, computing profit or loss, and reporting the results of the venture
Choosing Self-Employment vs. Other Forms of Employment
1. Being an Employee- advantages serve on the basis of stability; route entails typically a predictable income and weekly set workload as well as limited unknown influences

2. Being Self-Employed (Entrepreneurship) - advantages seen through primary control of business decisions resulting in business outcome and performance; route entails higher stakes into success and failure of the business, allowance for creation of specified work team as based on the preference of the employer

3. Partnerships – multiple individuals or companies go into business together to share the risks as well as the rewards for that business.

Responsibilities associated with owning your own business
1. Contracts
2. Leases
3. Deeds
4. Insurance Policies
5. Loans
6. Selecting a Product or Service
   A. Determine market demand to make informed prediction to base initial business establishments
   B. Imports vs Exports
      (i) Both products used or marketed can impact business types or strategies

Types of Management
1. Types of decisions
   A. Organizational
   B. Operational

2. Factors of decision making
   A. Frequency
   B. Urgency
   C. Options
   D. Steps in the decision-making process
      (i) Establish Goals
(ii) Gather Facts

(iii) Analyze Resources

(iv) Establish Routes

(v) Make Decision

(vi) Act on it

(vii) Assume responsibility

(viii) Evaluate Outcome

3. Planning, both short term and long term
   A. Short term plans – accomplished in several days or weeks
   B. Long term plans – accomplished over several months or years

Financial records
1. Good financial management will allow the manager to maintain control of the business venture and to increase profits or reduce losses.
   A. Balance Sheet - shows the assets, liabilities, and owner’s investment on a particular date
   B. Assets - anything the venture owns, including cash on hand, equipment, and inventory
   C. Liabilities - both current and long-term debts
   D. Net Worth - the owner’s investment in the business, including profits as they occur.
   E. Profit & Loss Statement - projects costs and other expenses against sales and revenue over time
   F. Cash Flow Statement - describes the availability of funds for the purposes of running a business
   G. Inventory Report - includes how many units of each product are on hand, how many were sold, each item’s cost, total sales, and profit.
   H. Budgets
   I. Income Statements
J. Accurate financial records are essential to agribusiness success

2. Using these records to make informed business decisions could be the difference between potential profit and net profit

Marketing
1. Consumer – the person(s) responsible for product demand

2. Consumer Demographics – categories of consumers such as population density, ethnic makeup of the population, family income, discretionary money held by individuals within the family, family size, eating preferences, who makes buying decisions in the household, occupation and work locations, tendencies to eat at home or away, clothing preferences, styles, and recreational preferences
   A. Consumers generally satisfy their needs for basic food, clothing, and shelter first, then move on to purchases that reflect group and individual tastes

3. Advertising & Promotion
   A. Product advertising focuses on the product itself
   B. Institutional advertising is designed to create a favorable image of the firm or institution offering the products or services
   C. Small Volume Producers vs. Large Manufacturers
   D. Check-off Programs
   E. Media Types

Commodity Pricing
1. Cooperatives vs Individual, private owned businesses

2. Psychological pricing is a strategy designed to make the price seem lower or less significant than it is.

3. Penetration pricing is a strategy wherein price is set below that of competitors to entice customers to try an item.

4. Skimming Pricing is the price of a new product is set for unusually high profits at first, when affluent and willing customers are available

5. Loss-leader pricing is a procedure wherein a popular commodity is offered for sale in a special sales promotion at prices less than cost

6. Prestige pricing is a procedure used to target buyers with special desires for quality, fashion, or image
7. Commodity Exchange
   A. An organization licensed to manage the process of buying and selling
      commodities under specific laws using a system of licensed brokers

2. Futures Market
   A. A procedure conducted by commodity exchanges to provide networks and
      legal frameworks for sellers and buyers to work through brokers in making
      contracts called futures contracts, or simply futures

Marketing Strategies
1. Strategies Used to Market for Maximizing Profits
   A. Determine what types of markets are available relating to demographics of
      location

   B. Determine the cost of different types of marketing

   C. Determine cost of transportations of product to market location, establish
      which is most cost effective

   D. Determine most profitable form in which to market the product (i.e. age, size,
      weight, preparation method)

   E. Advertise through sectors not yet utilized

   F. For seasonal markets, market product during peak demand (i.e. selling of
      pumpkins during the month of October)

2. Retail Marketing vs Wholesale Marketing
   A. Retail Marketing- selling of the product directly to consumers; may occur
      through a farm, roadside market, or farmers market, typically utilized for
      ready-to-eat products (i.e. produce or meat)

   B. Wholesale Marketing- marketing of a product through a middleman, who will
      then present the product to the consumer; may occur through terminal
      markets, auction markets, and direct sales, most agricultural products are
      marketed through this venue as it allows the farmer to produce high volumes
      of a product with reduce labor cost

3. Marketing Trends & Cycles
   A. The cause of general price cycling is supply and demand or government
      intervention.

   B. Futures are defined as legally binding agreements, made on the trading floor
      of a futures exchange, to buy or sell something in the future
C. Export marketing has expanded as transportation and communications improve.

Cooperatives

1. Cooperative – businesses that are owned by groups of producers who join together to market a commodity
   A. Example – approximately 75% of milk marketed in the United States is sold through farmer-owned marketing cooperatives
      (i) The cooperatives then either combine individual milk productions to process the milk and sell it directly to consumers or then sell to large processing plants

2. Main Type of Cooperatives
   A. Vertical integration – occurs when several steps in the production, marketing, and processing of animals (or other agricultural products) are joined together
      (i) Example – the same person, or group, owns the cow/calf operation, feedlot, and processing plants

3. Advantages of Cooperatives
   A. Cooperatives have the ability to maintain product quality, arrange for transportation of products from farm to market, balance supply and demand of agricultural products, and plan advertising to increase sales
   B. Cooperatives sometime exist to allow for a shared pool of equipment, resources or marketing opportunities
   C. Some pool resources to provide loans or financial support for their members

Livestock Production Businesses

1. Farms with livestock were categorized in two ways: 1) farm group according to the number and kind of livestock on the farm, and 2) farm type according to characteristics of the operation and total agricultural sales.

2. Classification of farms according to the number and kind of livestock on the farm
   A. The Census of Agriculture reports end-of-year inventories and sometimes the number of animals sold during the year for the following livestock types:
      (i) Beef cows
      (ii) Milk cows
      (iii) Heifers and heifer calves
      (iv) Steers and bulls of all ages
      (v) Hogs and pigs used for breeding
(vi) Sheep and lambs
(vii) Chicken layers 20 weeks old and older
(viii) Chicken pullets for laying flock replacement
(ix) Chicken broilers
(x) Turkeys for slaughter
(xi) Turkeys for breeding
(xii) Other poultry, including ducks, geese, pigeons, pheasants, quail, and other
(xiii) Poultry hatched and placed or sold
(xiv) Horses and ponies
(xv) Colonies of bees
(xvi) Milk, Angora, and other goats
(xvii) Mules, burros, and donkeys
(xviii) Mink and rabbits
(xix) Fish and aquaculture products
(xx) Other livestock

4. Using this information on livestock types and number on each farm, farms with livestock are uniquely categorized into the four groups
   A. Farms with few livestock are defined to be farms with less than:
      (i) 4 animal units of any combination of fattened cattle, milk cows, swine, chickens or turkeys.
      (ii) 8 animal units of cattle other than fattened cattle or milk cows.
      (iii) 10 horses, ponies, mules, burros, or donkeys.
      (iv) 25 sheep, lambs, or goats.
      (v) $5,000 in sales of specialty livestock products.
5. Farms with specialty livestock types are defined to be farms with:
   A. Few livestock but with sales of livestock products from fish, bees, rabbits, mink, poultry other than chickens and turkeys, and exotic livestock more than $5,000.
   B. Sales from specialty livestock that were more than 75 percent of the total livestock sales for the farm.

6. Farms with pastured livestock types and few other livestock are defined to be farms with:
   A. Less than 4 animal units of any combination of fattened cattle, milk cows, swine, chickens or turkeys.
   B. 8 or more animal units of cattle other than milk cows and fattened cattle.
   C. 10 or more horses, ponies, mules, burros, or donkeys.
   D. 25 or more sheep, lambs, or goats.

7. Farms with confined livestock types are defined to be farms with:
   A. 4 or more animal units of any combination of fattened cattle, milk cows, swine, chickens or turkeys.
   B. Veal or heifers that appeared to be raised in confinement

8. Classification of farms according to characteristics of the operation and gross sales
   A. The Economic Research Service (ERS), USDA, has defined a farm typology categorizing farms into eight specific types. They also identify three basic groups of farms, which they define as follows:
      (i) Commercial farms consist of large family farms with sales above $250,000 and some nonfamily enterprises that are organized as cooperatives or nonfamily corporations or have a hired manager.
      (ii) Intermediate farms have sales below $250,000 and the operator reports farming as his or her major occupation.
      (iii) Rural-residence farms have gross sales below $250,000 where farming is considered a secondary activity both in terms of resources invested in the farm and the amount of income it contributes to the farm household.
Resources:

   A. Units 1, 4, 34, 35, 36

2. FFA Agribusiness Careers - https://www.ffa.org/parliamentary-procedures/career-overview-agribusiness-systems-jobs/

3. Natural Resource Conservation Service
   https://www.nrcs.usda.gov/wps/portal/nrcs/site/national/home/
UNIT L: Agricultural Mechanics
Developed by Mr. Tyler Granberry and Dr. Joey Blackburn

STANDARDS:
LA-AGTECH: S5, S10, S19, S32
AFNR: CS.03.01-.04, PST.01.01-.03, PST.02.01-.02, PST.03.01-.02

Goal(s):
1. Students should be able to select, service and maintain and use agriscience tools, equipment and instruments including hand tools, power equipment, and safety equipment, small gas engines and welding equipment

Objective(s):
1. Define agricultural mechanics;
2. Describe the role of mechanics and mechanical applications in society;
3. Demonstrate knowledge of contributions made by mechanical applications to the development of agriculture;
4. Identify occupations in agriculture that require mechanical skills;
5. Demonstrate general safety precautions regarding agricultural mechanics;
6. Explain fire hazards and related safety procedures;
7. Demonstrate proper selection and use of fire extinguishers;
8. Identify, describe, and classify general hand tools and hardware commonly found in agricultural mechanics settings;
9. Identify, describe, and classify general power tools commonly found in agricultural mechanics settings;
10. Demonstrate appropriate setup, use, breakdown, and cleanup of a workstation;
11. Demonstrate appropriate maintenance and storage of tools;
12. Create detailed plans for agricultural equipment or facilities using measurements, scale, and drafting tools aligned with STEM concepts;
13. Demonstrate the appropriate use of carpentry measuring tools in the layout of materials;
14. Demonstrate the appropriate selection and use of hand and power tools in the cutting and shaping of wood;
15. Demonstrate the appropriate selection and use of fasteners and hardware in assembling wood projects;
16. Demonstrate the appropriate selection and use of techniques and materials in finishing wood projects;
17. Identify and describe electrical tools and components commonly found in agricultural mechanics settings;
18. Create a safe, functioning model of an effective electrical system using appropriate tools and techniques;
19. Demonstrate the appropriate use of techniques and tools in cold metalworking;
20. Demonstrate the appropriate selection and use of hand and power tools in the cutting and shaping of metal;
21. Identify and describe various processes used for cutting and welding metal (Oxy-fuel, SMAW, GMAW, GTAW, Plasma-arc, etc.);
22. Demonstrate safe and effective operation and maintenance of cutting and welding systems in metal fabrication;
23. Identify, describe, and classify fuels, lubricants, and components of internal combustion engines commonly found in agricultural settings;
24. Demonstrate basic maintenance, troubleshooting, and repair of small gas engines.
25. Identify and describe the basic tools used in surveying;

Agritech Guiding Questions:

1. When gripping wood, metal, or plastic what type of tool would you use?
2. A round device attached to a shaft and driven by a belt is known as what?
3. What is the U.S. standard unit of measurement when measuring the length of a piece of wood?
4. What type of saw can be used to cut irregular shapes?
5. What does the marking SAE 10W-30 on a bottle of engine oil indicate?
6. What is the proper procedure for replacing the blade on a table saw?
7. What type of safety equipment should be worn when welding with an oxy-acetylene torch?

Content:

Scope of Agricultural Mechanics

1. Agricultural Mechanics – the selection, operation, maintenance, service, sale, and use of power units, machinery, equipment, structures, and utilities in agriculture.

Career opportunities in Agricultural Mechanics

1. Careers that directly require skills related to agricultural mechanics: designers, engineers, operators, maintenance and repair personnel, and construction workers.
   A. Careers that require knowledge of agricultural mechanics: business and finance, publishing and sales, communication, education, and leadership.

2. The relevance of Agricultural Mechanics to modern society
   A. According to USDA data, agricultural output has steadily increased since 1948.
B. All agricultural products that are commercially available have some level of mechanical involvement in their production, processing, storage, and distribution.

C. Technological developments are the future of agricultural mechanics. Computer-controlled machinery, robotics, and other rapidly developing technologies are finding a place in agriculture.

Review of safety procedures
1. Before students can undertake experiences in agricultural mechanics, they must prove mastery of the safety concepts.

2. Appropriate dress in the Agricultural Mechanics Lab (Well-fitting clothing, long pants, closed-toed shoes, no dangling jewelry, hair pulled back)

3. Students should be familiar with and be able to demonstrate the selection and appropriate use of basic Personal Protective Equipment (PPE).

4. Mechanical Hazards (Moving parts, pinch points, sharp edges, etc.)

5. Chemical Hazards (Fuels, lubricants, paints, varnishes, solvents, exhaust gases, fumes, hazardous reactions among chemicals, etc.)

6. Electrical Hazards (Improper grounding, frayed wires, etc.)

7. Fire Hazards (Flammable materials, preparing work areas to minimize fire risk, etc.)

8. Safe Accident Response Procedures (Contingency plans for accidents / injuries, basic first aid, use of a fire extinguisher, emergency exits, etc.)

Introduction to the Agricultural Mechanics Lab
1. Basic hand tools and hardware commonly used in agricultural mechanics: hammers, screwdrivers, ratchets, measuring devices, clamps, fasteners, etc.

2. Basic power tools commonly used in agricultural mechanics: drills, saws, sanders, air compressors, stationary equipment, etc.

3. Appropriate setup of a workstation, with an emphasis on safety and efficiency.

4. Basic care and maintenance of tools and equipment.

5. Cleanup, organization, and storage in the agricultural mechanics laboratory.

Planning and Layout
1. Taking measurements – accurate measurements are vital to planning. The primary measuring device used in agricultural mechanics settings is the steel tape measure and a rafter (speed) square.
   A. Placement of the tab on the end of the tape measure is important in taking accurate measurements.
   
   B. Students should be proficient in taking measurements in feet, inches, and fractions of an inch to at least 1/8th of an inch.
   
   C. Students should be familiar with metric measurements of meters, centimeters, and millimeters and how to convert from metric to American measurements.
      (i) 1 inch = 25.4 mm or 2.54 cm.
   
   D. Rafter or speed squares are common tool for measuring angles and combine the functions of try, combination, and framing squares.

2. Creating a bill of materials
   A. Basic Bill of Materials:
      (i) Start by evaluating what materials are needed. Example: Pine 2X4, 2 ½” deck screws, 14 gauge 1” mild steel square tubing, etc.

      (ii) Measure all materials and record the quantities and dimensions in which they are needed. Make note of angles at this time. Example: 2- 4’ 2x4’s, 2 - 40” 2x4’s, 6 – 18” 2x4’s, 16 – 2 ½” deck screws, etc.

      (iii) Determine any materials needed to create a finished product and record quantities if available. Example: Paint, stain, varnish, electrical components, etc.

      (iv) Create a cut list of what pieces can be cut from the available sizes of materials. Example: 2x4’s are commonly available in 8’ lengths. 2 – 4’ pieces, 2 – 40” pieces, and 6 – 18” pieces will require 4 – 8’ 2x4’s with allowances for kerf.

         (a) Kerf is the amount of material removed by the saw blade when cutting a piece. The average saw blade removes about 1/8” of material for each cut. This is the reason an 8’ 2x4 cannot be cut into 2 pieces that are exactly 48” each.

   B. Advanced Bill of Materials
      (i) Determine the cost of materials needed to complete construction based on supplier pricing.

      (ii) Calculate labor cost per hour based on estimated time to complete at a fair wage.
After determining materials cost and labor cost, evaluate a fair profit margin and calculate it into the cost of the project to generate a complete price quote for a finished product.

3. Designing a project plan
   A. Basic sketching a drawing tools
      (i) Drafting table or board – a large, smooth, flat surface with edges that are square to one another.
      (ii) T-square – used to draw straight lines by squaring with the edge of the drafting table or board.
      (iii) Shape Templates – used to draw exact shapes, lines, and curves.
      (iv) Architect’s Scale – used to draw lines to the specified scale of a project drawing.
      (v) Paper – Blank paper large enough to accommodate an appropriately scaled drawing.
      (vi) Drafting Tape – mild strength adhesive tape used to secure the paper squarely to the drafting table or board.
      (vii) Pencils and Erasers

   B. Setting up a drawing
      (i) Squarely attach paper to the drafting table or board.
      (ii) Use the T-square to create a border and title blocks that provide the necessary information about the project name, who is working on the project, dates, versions, scale, etc.
      (iii) Determine the projection of the drawing.
         (a) Orthographic – a set of 2 dimensional drawings from multiple angles. Generally easier to draw and can provide measurements from multiple angles. Time must be taken to draw all angles that provide a different appearance or measurements. Example: Top, sides, bottom, front, back, etc.
         (b) Isometric – a single, 3 dimensional drawing of the project as if it was viewed from an angle. While more complex to create accurately, isometric drawings are often easy to interpret quickly, providing detail about how the finished product will be shaped.
         (c) In many settings, orthographic drawings provide detailed measurements to scale in 2 dimensions and are accompanied by a less-
detailed isometric sketch to show the shape and layout in 3 dimensions.

(iv) Determine the scale of the drawing.
   (a) Scale – the degree to which a measurement in a technical drawing or model represents the actual measurement of the finished product.

   (b) Small items may be drawn in a 1:1 scale, meaning the measurements of the drawing are the same size as the actual measurements. For most drawings, this is not feasible. Common scales used in drafting a project plan include 1/8":1’, ¼":1’, ½":1’, ¾":1’, 1":1’, 1 ½":1’, 3":1’, etc. In the case of 1":1’, one inch in the drawing would represent one foot in the actual project.

   (c) To make drawing to scale easier, an architect’s scale is frequently used.

(v) Using architect’s scale
   (a) While they are available in a variety of shapes and sizes, the most common architect’s scale is the triangular scale, which resembles a 3-sided ruler.

   (b) On each end of the sides of an architect’s scale, a fraction or number is given, indicating the measurement that corresponds to one foot. Example: 1/2 would indicate that one half of an inch in the drawing would be equivalent to a foot. Starting at zero on the scale, the larger set of marks indicates the number of feet, while the small marks on the opposite side of the zero indicate inches. The inch marks should be interpreted as a 12 inch ruler that has been “shrunken down” and the marks read accordingly.

   (c) It is important to note that most architect’s scales have more than one scale per side and may be read in opposing directions. Locate the fraction or number that indicates the scale you wish to use and read the scale from zero to the highest number, ignoring the marks that do not fit with the direction you are working.

C. Computer-aided design (CAD)
   (i) A wide variety of Computer-aided Design (CAD) programs exist today to bring the concepts of drafting into a digital space.

   (ii) Each CAD program is different based on publisher and intended use but the concepts associated with traditional drafting are common throughout.
Physical Science and Agricultural Mechanics

1. Simple Machines – Simple machines are devices with few, if any, moving parts that utilize the physics of motion and force to perform work. Simple machines are found throughout agricultural mechanics and are often used in conjunction with one another to create more complex tools and machinery.
   
   A. Inclined Plane – an angled surface that transfers horizontal force into vertical movement in a given direction. Example: Ramps, slides, chisels, etc.
   
   B. Wedge – a piece of material with a thick edge that tapers to a thin edge that can be forced between parts to separate or secure them. Example: axes, knives, nails, etc.
   
   C. Lever – a beam resting on a fulcrum that can be pushed or pulled to move a load. Example: pry bars, wheelbarrows, bottle openers, etc.
   
   D. Wheel and Axle – a beam (axle) that is attached to a larger wheel in a way that, when torque is applied to one, they both turn. Example: screwdrivers, axle assemblies in automobiles, doorknobs, etc.
   
   E. Screw – a threaded device that uses torque to create linear movement. Examples: bolts, augers, twist-off lids, etc.
   
   F. Pulley – a wheel, attached to a shaft, with a groove that holds a cable, rope, or belt and changes the direction of force applied to it. Example: the raising mechanism on a flag pole, elevators, the belts and pulley on an automobile engine.
   
   (i) Pulleys can be fixed, moveable, or compound.

Introduction to Woodworking

1. Selecting wood
   
   A. Softwood – the wood from gymnosperm trees. Softwoods are generally lighter in weight and have a less prominent grain. The trees that produce softwoods are fast growing and can typically be harvested quicker than hardwood trees. Example: Pine, Cedar, Fir, Spruce, etc.
   
   B. Hardwood – the wood from angiosperm trees. Hardwoods are generally heavier in weight and have a more pronounced grain. Hardwood trees are much slower growing than softwoods and require very long growth times before being suitable for harvest. Example: Oak, Walnut, Maple, Hickory, etc.
   
   (i) Selection and use – Softwood is less expensive and easier to work with. Because of this, softwood is frequently used in construction framing. Hardwoods are more expensive but are much more durable and often more aesthetically pleasing without the need for staining. Hardwoods are used in furniture, flooring, and implements.
C. Cut and grain – Lumber can be sawn from harvested trees in four primary methods, each resulting in a different grain, which is the direction that the growth rings of the tree are situated in the piece of lumber.

(i) Plain sawn – Lumber as large as possible is cut lengthwise from a side the saw log and it is turned as necessary to make the next cut as efficient as possible. The process is repeated until all sides have been sawn. Plain sawn lumber has long, wide, “cathedral peaked” grain. This is the most common modern method for producing lumber in saw mills, as it is cost effective and has very little waste.

(ii) Quarter sawn – a saw log is divided into quarters lengthwise and each quarter is sawn parallel into lumber, without turning the quarter. This produces a narrow, slightly wavy grain. This is an older way of sawing lumber that produces high quality. There is quite a bit of waste, however, making quarter sawn lumber expensive.

(iii) Rift sawn – a saw log is divided into sections and each section has a piece cut, then repositioned to cut the next piece perpendicular to the growth rings. This method produces the highest quality lumber with a tight grain that is very consistent throughout. This is the most wasteful method, however, and therefore produces very expensive lumber.

(iv) Live sawn – a saw log is cut whole, in parallel lengths. The log is not turned and the live edge is left on each piece, with bigger pieces termed “slabs.” The grain is generally very similar to plain sawn lumber. This method is not usually found in large scale production but is common among operators of small band saw mills and individuals using chainsaw mills.

D. Sizing – It is important to note that lumber has a nominal size, sometimes called a “rough” size, which is slightly larger than its actual thickness. This is due to the surfacing process that each piece goes through after sawing. Example: A 2x4 is actually 1 ¾” x 3 ¾” if it has been surfaced on all sides.

E. Defects and quality

(i) Identify defects

(a) Warping – the board is not straight and flat, generally. Warping happens during the drying process and presents itself in different types:

   (i) Bowed – the board is flat, but curves to one side or the other.

   (ii) Crooked / crowned – the sides of the board are straight, but it is not flat due to curling down the face of the board.

   (iii) Cupped – The board is straight down the face and sides, but it is not flat due to the edges curling in towards one another.
(iv) Twisted – a board is twisted if it has any combination of two or more types of warps listed above.

(b) Knots – dark spots in the wood that are formed at the location of branches during the growth process. A “tight” knot is typically less than 1” in diameter and is smooth with the grain, showing no cracks. A “dead” knot is larger, cracked, or may be encircled by a black ring and may fall out of the board or cause a weak spot.

(c) Separation – defects that may cause the board to come apart. Separation defects include:

(i) Splits – cracks at the ends of boards that go all the way through.

(ii) Checks – cracks along the grain of boards that do not go all the way through.

(iii) Shakes – separation between the growth rings in the grain along the face of the board.

(d) Waning – missing wood or untrimmed areas along the edge.

(ii) Quality Grading – Most lumber is graded by strength and appearance, both judged by defects. Numbered grades indicate strength and are used in structural lumber over 2” rough thickness. #1 is the highest quality, #2 a little less, etc. Letter grades are for appearance of select lumber. A is has the best appearance, B has a few small defects, C has a few more, etc.

2. Measuring and marking
A. Reading a tape measure in 1/8 inch increments

B. Using speed and framing squares to mark lines correctly at measured marks

C. Calculate board feet – board feet is the measurement by which lumber is priced for sale. The formula for board feet is based on the nominal width multiplied by the nominal thickness multiplied by the length in feet, divided by 12. If the length is given in inches, it is then divided by 144. Example: An 8’ long 2x4 would be calculated as (2x4x8)/12= 5.33, meaning that an 8’ long 2x4 contains 5.33 board feet. If we used inches for the length, the calculation would be (2x4x96)/144=5.33.

3. Hand woodworking
A. Cutting and shaping with handsaws

(i) Saw selection – saw blades are classified by their pitch, represented as teeth per inch (TPI). The higher the TPI, the finer the cut. A finer cut looks better but takes longer. For cutting wood:
(a) 1-7 TPI – Coarse Toothed Saw

(b) 7-10 TPI – Medium Toothed Saw

(c) 10+ - Fine Toothed Saw

B. Using chisels, files, and rasps

C. Using a hand plane and sanding

D. Fastening wood with adhesive and nails
   (i) Nail types and uses
      (a) Common nails – also called wire nails, they have a smooth shank and round head. They are used for general wood fastening and framing.

      (b) Casing nails – slightly smaller than common nails, with a small, tapered head. They are used to attach trim in areas where a moderate amount of holding power is needed.

      (c) Finishing nails – small, thin nails with a head only slightly larger than the shank. They are used to attach trim when only a slight hold is needed. The head of the nail is generally buried in the wood surface.

      (d) Box nails – similar to common nails in shape but thinner. They are used to attach thin siding to wood frames, like the sides of small wood boxes.

      (e) Tacks – Short shank nails with relatively wide heads. They are used to attach thin material to wood.

      (f) Duplex nails – Large nails with two heads, one on top of the other, that are used to create temporary framing. The second head stays above the wood surface and allows the nails to be easily removed.

   (ii) Adhesive types and uses
      (a) Polyvinyl Acetate (PVA) glue – the most common type of wood glue. Usually off-white to beige in color. Inexpensive and readily available but has an extended hardening time and can interfere with finishes.

      (b) Hide glue – derived from animal hides. It has good quality holding power and will not interfere with most finishes. Most types must be heated and applied with a brush to be used effectively. It will degrade if it gets wet.

      (c) Epoxy – a two part system (resin and hardener) that must be carefully mixed together to create a bond. Epoxies come in a wide range of
holding powers and curing times. Most epoxies give off harmful fumes.

(d) Cyanoacrylate glue – Usually referred to as “Super Glue”. These glues generally inexpensive and have a very quick cure time. They cure very brittle and should not be used on wood for anything other than temporary bonds. Many varieties produce harmful fumes.

(e) Polyurethane glue – quick and hard curing glue that is waterproof. There are many varieties available. Most provide a strong bond, but the glue swells as it dries and may interfere with finishes.

E. Tool Sharpening/reconditioning

(i) Sharpen twist bits – twist bits should be sharpened to their manufactured angle (usually 60 degrees) using a bench grinder with a fine stone or a belt grinder with a fine grit belt. Take care not to overheat the bit or it will lose its hardness and ability to hold and edge.

(ii) Sharpen wood chisel – A wood chisel should be completely flat on the back, which can be accomplished by running the back of chisel diagonally across sandpaper attached to a smooth surface until scratches are evenly distributed across the back. The bevel of the chisel can be reconditioned using a bench grinder with a fine stone or a belt grinder with a fine grit belt, taking care to keep the chisel cool during the process. Reconditioning is only necessary if the bevel is chipped or rolled-over. The bevel of the chisel should be 25 to 30 degrees. The edge of the chisel can be sharpened using sandpaper on a flat surface, with the bevel side down, taken care to keep the degree of the bevel. Starting with a coarse grit and work up to a very fine grit. Remove the wire edge that develops and the chisel should be sharp.

4. Power woodworking

A. Cutting and shaping with power saws, portable and stationary

(i) Portable Saws

(a) Circular Saw – saw with a round blade, used to make straight cuts in large material.

(b) Jig Saw – small saw with a slim blade that moves back and forth vertically. Used to cut small material and make cuts that do not follow a straight line.

(c) Reciprocating Saw – two handed saw that has blade that moves back and forth horizontally, making rough cuts.
(ii) Stationary Saws  
(a) Miter Saw – A saw with a circular blade on a pivoting arm. Used to make cross cuts at straight angles.

(b) Table Saw – A saw with a circular blade that rotates in a stationary position perpendicular to a smooth work table. Using a guide called a fence, material is pushed through the blade to make long rip cuts.

(c) Radial Arm Saw – Similar to a miter saw, a radial arm saw makes cross cuts at straight angles. Using a circular blade on a sliding track, however, allows for cutting much wider material.

(d) Band Saw – Using a long, belt-like blade, a band saw has the flexibility to make curved cuts in material.

(e) Scroll Saw – With a small, very thin blade that reciprocates vertically, a scroll saw can make very tightly curved, fine cuts in thin material.

(iii) Blade replacement  
(a) Each saw has a different procedure for replacing the blade based on the type of saw and manufacturers specifications. Refer to the owner’s manual before replacing components on any power equipment.

B. Drilling and boring holes with a power drill and drill press  
(i) Chuck types  
(a) Key-type – uses a key with a toothed wheel that is inserted and turned to loosen and tighten the chuck. Generally found on large drills and drill presses.

(b) Keyless type – by turning part of the drill attached to the chuck, the chuck can be loosened or tightened. Usually found on hand-held drills.

(c) Collet – a round gripping apparatus that, when tightened, forms a firm collar around the bit. Found on older or high-precision equipment.

C. Using a router, portable and stationary  
(i) Bit selection – router bits come in a variety of shapes and sizes that allow for shaping, grooving, and specialty cutting of wood.

D. Using a power sander, portable and stationary  
(i) Grit selection  
(a) Below 100 grit – Coarse, removes a lot of material but leaves marks.

(b) 100-150 grit – Medium, removes a moderate amount of material but leaves a lightly marred surface.
(c) 160-220 grit – Fine, removes little material but leaves a relatively smooth surface.

(d) Above 220 grit – Ultra fine, removes almost no material but can leave an ultra-smooth or near polished surface. Frequently used in wet-sanding techniques.

E. Fastening wood with screws, nail guns, and other fasteners

(i) Screws- threaded fasteners that are comprised of a head, shank, threads, and a tip. They are classified by use, drive type, diameter, and length.

(a) The use varies based on the conditions in which the screws are designed and dictate the materials that they are made of. Wood screws are usually steel that is coated with a finish to prevent corrosion in either indoor or outdoor environments.

(b) Drive type is the bit or screwdriver needed to effectively turn the screw-head. Common wood screw drive types are Philips and Torx (star). Flat and Robertson (square) can also be found but are more common in a hybrid drive with Philips. Drives are sized in accordance with systems specific to the type of drive (ex. #2 Philips, T20 Torx, etc.) Screw heads and bits must be matched to prevent stripping of the screw and damage to the bit.

(c) Wood screw diameters follow a numbered system that is based on the diameter of the threads and shank and the diameter of the screw head. The larger the number, the greater the diameter. Example: A #2 wood screw has a shank diameter of about 3/32” and a #14 wood screw has a shank diameter of about a ¼”. Specific measurements can be found on a standard screw dimension table.

(d) Screw lengths are given in fractions of an inch. Example: ½”, 1 ¼”, etc.

(ii) Common types of wood screws

(a) Standard wood screws – the most common type of wood screws. They are generally made of electroplated steel and have a medium thread. The most common type have a head that is angled from the shank, with a flat top, which is designed to be securely countersunk flush with the wood surface.

(b) Pocket screws – usually small, medium to coarse threaded screws with a rounded head that is mounted flat to the shank. They are designed to be used with pocket-hole jigs in furniture making.

(c) Deck screws – Designed for outdoor applications, deck screws have coarse threads and are made of corrosion-resistant hardened steel or
copper alloys. They usually have heads similar to standard wood screws.

(d) Drywall screws – Thin screws that are designed to have a light hold between drywall and wood studs.

(iii) Nail guns – devices that use force or pressure to drive a nail automatically, without the need for a hammer. Nail guns may be electric or pneumatic, with electric nail guns generally being used to smaller finishing nails and staples and pneumatic guns servicing a wide range of nail sizes and output strengths.

(iv) Other methods – wood can be attached without the use of metal fasteners. Using these methods requires a higher level of skill than metal fasteners and is generally reserved for special applications like furniture making and decorative woodwork. Many of these methods use only friction to join pieces, but are sometimes supplemented with adhesive.
(a) Mortise and Tenon – a type of joint in which the end of one piece of wood (the tenon) is fashioned to fit tightly into a corresponding space cut into another piece (the mortise.) Mortise and tenons are sometimes used with pegs or wedges to secure them.

(b) Dovetails – angled cuts and matching grooves designed to fit together in a way that resists being pulled directly apart. Frequently used in cabinet making.

(c) Box joints – series of square cuts made on alternating ends of two pieces of wood so they may fit together as a secure 90 degree corner. Often found on decorative boxes and furniture.

(d) Dowels – round pieces of wood that are inserted into holes drilled in the pieces that are to be attached. A common technique for joining wood when fasteners would not be aesthetically pleasing. Often supplemented with adhesive.

(e) Biscuits – thin wood ovals that can be inserted into specially cut grooves in wood pieces. Generally only used on thin material and requires special equipment. Often supplemented with adhesive.

5. Finishing wood
   A. Finish sanding – Final sanding of wood using a high grit sandpaper.

   B. Trim and accents – attaching additional pieces, often detailed, to wood projects for aesthetic appeal.

   C. Stain and varnish
(i) Stains are designed to be brushed or rubbed into the surface of the wood to change the color without covering the grain of the wood.

(ii) Varnishes are oils or urethanes that are applied to the wood surface to provide a decorative or protective finish on top of the wood.

Introduction to Electricity

1. Basic electrical principles

A. Conductivity and insulation

(i) Conductivity – the degree to which electricity can pass through a material. A highly conductive material (a conductor) like copper, allows electricity to pass through easily. This is due to the larger number of free electrons in conductors.

(ii) Insulation - A low conductivity material (an insulator), like rubber, is very difficult for electricity to pass through. Insulators have a very low number of free electrons, creating large amounts of resistance to electrical flow.

B. Current, amperes, volts, watts, resistance, power

(i) Current – the rate of flow of electricity as it moves past a point.

(ii) Resistance – the amount of opposition that a material has to the flow of electrical current.

(iii) Power – the rate of electrical energy used over a given time.

(iv) Ampere – also called amps, an ampere is the unit for measuring electrical current.

(v) Volt – the unit of measurement of electrical force.

(vi) Watt – the unit of measurement of electrical power.

(vii) Ohm – the unit of measurement of electrical resistance.

C. Ohm’s law – in an electrical system, the current in the system is equal to the voltage divided by the resistance, frequently represented as I=V/R, in which I= the current in amps, V= is the voltage, and R= resistance in ohms. The importance of this law is that, if any two of the values are known, the third value can be easily calculated.

D. Magnetism and electricity

(i) Magnetism – a phenomenon of attractive and repulsive forces that is produced by the motion of an electric charge.
(ii) Electromagnet – a magnet created by coiling conductive wire around a piece of metal. When an electrical current passes through the coil, it creates a magnetic field which is transferred to the metal piece, creating a magnet. When the current is disrupted, the magnet ceases to function. This principle is the foundation of the electric motor.

E. Alternating vs Direct Current
(i) Direct Current (DC) – a flow pattern of electrical current in which the electrons in the system only move in one direction. This is the form that battery power takes.

(ii) Alternating Current (AC) – a flow pattern of electrical current in which the electrons in the system alternate directions based on the repeated reversal of polarity. This is the form of household power.

F. Electrical Safety
(i) Working with electricity comes with risks associated with electrical shock. Minor electrical shocks can be painful and cause seizures or irregular heart rhythm. Major electrical shocks can produce serious burns and even death. Open electrical discharges can produce sparks that can ignite fires. When working with any electrical components, always ensure that the components are in safe, working order and that the power source to the components is disconnected.

2. Electrical Tools
A. Meters
(i) Voltmeter, Ammeter, multimeter
   (a) Voltmeter – a device designed to measure the voltage in an electrical system.

   (b) Ammeter – a device designed to measure the amperage in an electrical system.

   (c) Multimeter – a multipurpose electrical device that can do the work of a voltmeter and ammeter in AC and DC systems, along with other functions that vary among different models and manufacturers.

(ii) Cutters, pliers, strippers
   (a) Diagonal Cutters – similar to pliers, but with a pair of pincer-like shearing jaws designed to cut wires.

   (b) Lineman’s Pliers – pliers with square, block jaws designed to hold wires securely. Lineman’s pliers often have an integral wire cutter.

   (c) Needle-nose Pliers – pliers with rounded jaws that taper to a small point. Used to bend wires in tight applications, such as the creation of terminal loops. An integral wire cutter is often part of the pliers.
(d) Wire Stripper – a device used strip the insulation from various sizes of common electrical wiring. Though different in design across manufacturers, most are similar in design to pliers.

(e) Cable Ripper – a relatively simple tool composed of a sheath with a metal tooth that is designed to rip the outside layer of insulation from electrical wiring cable.

3. Uses of electricity
   A. Electric motors
      (i) Principles and basic design – Electric motors function by using the principles of electromagnetism to generate motion. On a basic level, a current is sent though a set of coils near a rotor on a shaft. The charged coil creates a magnetic field with polarity, causing the rotor to turn the shaft to align the magnetic poles. Halfway through the rotation, the polarity is reversed, causing the rotor to continue spinning to attempt to align the poles. This process is repeated rapidly to produce a continuous turning of the rotor and shaft, generating mechanical power.

      (ii) Application in agricultural settings – electric motors are found throughout agricultural settings. Many types of portable equipment incorporate DC electric motors to power tools, pumps, power drives, starters for large equipment, etc. Any item with moving parts that connects to a battery most likely uses a DC electric motor. Stationary equipment is frequently powered using AC electric motors. Any item with moving parts that plugs into an outlet or is wired into a standing power source most likely uses an AC electric motor.

   B. Circuit – A circuit is a complete path in which electrical current can flow from a power source to a device, with a path of return or ground. Circuits can be relatively simple or extremely complex based on their intended use. In order to function correctly and safely, a circuit must be complete, with no unintended breaks in electrical flow.

4. Electrical Materials
   A. Transformers, service drops, meters, and service entrance panels
      (i) Transformer – a device that uses primary and secondary coils around a magnetic core to step up or step down current or voltage. In home power settings, transformers are used to convert the high voltage from powerlines to lower voltages needed in residential wiring.

      (ii) Service drop – the connections from a utility electrical system to the wiring systems of homes and businesses.

      (iii) Meter – a device that measure the amount of electric energy consumed by devices wired behind the meter, usually measured in kilowatt hours
(kWh).

(iv) Service Entrance Panel (SEP) – frequently referred to as a “breaker box,” an SEP is a metal box containing the wiring setup that distributes the electrical current from the service drop and meter to the wiring system of the building via circuit breakers.

B. Circuit breakers
(i) Circuit breakers are electrical safety devices that are designed to shut off the electrical current to a circuit when it exceeds the specified amperage limit of the breaker. A 15 amp circuit breaker would allow up to 15 amps of current to flow but would interrupt or “break” the current if it exceeded 15 amps to prevent overload on the wiring of the circuit. This prevents electrical shocks, fires, and damage to appliances.

(ii) 15 amp circuits are common in residential wiring where only lighting and a small number of low-load appliances are intended to be used, like bedrooms.

(iii) 20 amp circuits are also common in residential wiring and are used where large numbers of appliances with higher loads will be used, like kitchens.

(iv) Circuits larger than 20 amps are generally reserved for specific applications that are higher load than standard appliances, like A/C units, clothes dryers, etc.

C. Cable and wire
(i) Gauge selection – The diameter of wire is given in a numbered measurement system called gauge. The larger the number of wire gauge, the smaller the diameter of the wire.

(ii) In residential wiring, 14 gauge wire is the minimum size required for 15 amp circuits. 12 gauge wire is the minimum required for 20 amp circuits. Sizes larger than 12 gauge are generally reserved for special applications.

(iii) Residential wiring uses cable that contains insulated wires and possibly a bare ground wire in a shielding. 2 wire cable contains 2 insulated wires. 2 wire cable with a ground contains 2 insulated wires and a bare ground wire. The number of wires and gauge determine the type of cable. Examples: 14-2 would be a cable containing two 14 gauge insulated wires. 12-2wg would be a cable containing two 12 gauge insulated wires and a single 12 gauge bare ground wire. 14-3wg cable would contain three 14 gauge insulated wires and a single 14 gauge bare ground wire.
D. Switches, receptacles, and fixtures
   (i) Receptacles – Sometimes called outlets, receptacles serve as the point of power for devices that need to plug in.
      (a) Duplex Receptacle - the most common form of receptacle, which has two points of access for two devices.

      (b) Ground Fault Circuit Interrupter (GFCI) receptacle – a special receptacle that contains a device that shuts the receptacle off in the event that a fault or short occurs at the receptacle or with the item plugged in.

   (ii) Switches – Switches serve as manual interrupters of electrical circuits.
      (a) Single Pole Switch – The simplest and most common switch in residential wiring applications. It serves as the only switch in a circuit

      (b) Three-way Switch – A switch that is used in circuits requiring two switches that can function independently of one another.

      (c) Four-way Switch – A switch that is used in circuits that require three or more switches that can function independently of one another.

      (d) Double Pole Switch – A single switch that is used to control two circuits, used in special applications only.

   (iii) Light fixtures – electrical devices that allow for the use of light bulbs. There are a wide variety of types and sizes of lighting fixtures that can be tailored to specific applications.

E. Conduit and boxes
   (i) Conduit – a material that allows electrical cable to pass through it to protect the cable from damage or exposure. Conduit usually takes the form of a pipe that can be metal or plastic, depending on the application.

   (ii) Electrical Boxes – plastic or metal boxes that house electrical connections. The specific characteristics of boxes are determined by their intended use. Example: Switch boxes are designed to secure a switch and house the electrical connections of the switch, while junction boxes house connections from multiple wires that diverge from a single location.

5. Installing Branch Circuits
   A. Installing boxes, conduit, and running cable

   B. Wiring a duplex receptacle

   C. Wiring a single-pole switch and light

   D. Wiring a three-way switch
E. Wiring a basic four-way switch

Metalworking

1. Identifying metal – in order to be worked effectively, materials must be known. In metalworking, metals can be identified by their color, density, and other properties. The most important determination of a metal is to identify whether it is ferrous or non-ferrous.

A. Ferrous metals – metal alloys that contain iron. These include wrought iron, high-carbon steel, mild steel, cast iron, etc.
   (i) Spark testing – because many ferrous metals appear similar, spark testing is sometimes used. The material is briefly introduced to a grinding wheel and the resulting sparks are examined for color, shape, and pattern to determine the material. Effective spark testing require practice with known materials.

B. Non-ferrous metals – metal alloys that do not contain iron. These include copper, aluminum, bronze, brass, etc.

C. Metal characteristics
   (a) Wrought iron – an iron alloy that contains very little carbon. Wrought iron is fairly ductile and is most commonly found in decorative iron work.

   (b) Mild Steel – an iron alloy that contains a moderate amount of carbon. The uses of mild steel are varied depending on the dimensions of the piece. Mild steel is very common and can be used where solid, but not hardened structure are needed.

   (c) High-carbon Steel – an iron alloy that contains a high amount of carbon. There are many varieties of high carbon steel, all of which vary in the specific ingredients of the alloy. Each type of high carbon steel has a specific intended use, but all varieties are can be hardened due to their high carbon content.

   (d) Cast Iron – an iron alloy that is very high in carbon content. Cast iron is a very dense material that is known for its strength and heat distribution abilities. However, cast iron is very brittle due to the high carbon content.

   (e) Copper – a naturally occurring metal that is very ductile and malleable. Because it is very malleable, copper is easily worked but is very weak. Copper is known for its ability to conduct electricity

   (f) Brass – an alloy of copper and zinc. Brass is a highly malleable, gold-colored metal that is commonly made into fittings and small parts.
Brass is also often found in decorative metalwork.

(g) Bronze – an alloy containing copper and tin. Bronze is a hard, brittle, reddish-brown metal that is often made into decorative pieces or corrosion resistant parts. Bronze is not very malleable and is usually cast, meaning that it is melted and poured into a mold to create a part.

(h) Aluminum – a dull silver colored metal that is known for its low density. Aluminum is very ductile and highly corrosion resistant. Despite being lightweight, aluminum is fairly strong.

(i) Stainless Steel – an iron alloy that contains at least 10% chromium for corrosion resistance. Different stainless steel alloys contain other elements depending on their intended application, resulting in a wide range of characteristics.

D. Shape of material
   (i) Round – solid cylinder shape, sometimes called “round-stock”

   (ii) Flat – solid rectangular shape that is wider than it is thick, sometimes called “flat-bar”

   (iii) Square – solid cube shape, equal in width and thickness, sometimes called “bar-stock”

   (iv) Hex – solid with six equal sides, also called “hex-bar”

   (v) Channel – rectangular box shape with one open side. Generally, the open sides taper in thickness. Also called “C-channel”

   (vi) Beam – Beam can be manufactured in a variety of shapes. The most common types include L-beam, known as “angle iron,” I-beam, and H-beam.

   (vii) Tube – Tube is a length of hollow metal that can be round, square, or rectangular.

   (viii) Pipe - Pipe is a hollow cylinder.

   (a) Though round tube and pipe appear similar, they are have a number of differences. While tubing comes in different shapes, pipe is always round. Pipes are designed to transport fluids or gases and are meant to withstand internal pressure, where tubes are used for structural applications. Round tubing is described by outside diameter and gauge of metal thickness (i.e.: 14g 1 ½” round tube.) Pipe, on the other hand, is described by inside diameter and schedule (i.e.: 2” Schedule 40 pipe.) Pipe schedule is a system for describing the wall thickness of
pipe, which must increase with pipe diameter to maintain a consistent internal strength. The two most common pipe schedules are schedule 40 and schedule 80. For specific information on pipe dimensions, refer to a pipe schedule reference table.

2. Metalworking Safety
   A. PPE (Personal Protective Equipment) – Working with metal includes risks associated with sharp edges, heat, and flying debris. (i) While specific PPE can be associated with certain procedures, all metalworking applications require:
      (a) Eye protection – minimum of Z87 rated safety glasses
      (b) Leather gloves – to protect the hands from sharp edges, abrasions, and heat
      (c) Long sleeves, long pants, and close-toed shoes – to protect the body from sharp edges, abrasions, and metal debris.

   B. Tool identification and usage
      (i) Hand Tools
      (a) Hammers – Smooth-faced and Ball-pee hammers are the most common general metalworking hammers but cross-pee and other specialty hammers are often used in various settings. Hammer weights vary greatly based on intended use.
      (b) Cold chisels – stout, hardened chisels that are used with a hammer to shear metal.
      (c) Hacksaw – a removable blade, tension style saw. Hacksaw blades can be designed to cut specific types of metal. Most hacksaw blades are designed to cut on the forward (push) stroke only and should be installed with the teeth facing forward.
      (d) Files – a tool with a hardened, sharply grooved face that is designed to smooth or shape metal. Files are usually designed to work with pressure applied in only one direction.
      (e) Snips/shears – similar to scissors, snips or shears are designed to cut thin metal.
      (f) Tap and Die set – tools of varying sizes that are used to cut threads into metal parts. A tap is used to cut female threads, like a nut, and a die is used to cut male threads, like a bolt.

   (ii) Power Tools
(a) Brakes, Benders, and Presses – machinery used to bend or form metal. They may be hydraulic or manually operated.

(b) Shears and Saws – machinery used to cut metal. Hydraulic shears push a hardened metal blade through metal to cut it cleanly. Saws are electrically driven and may use fine hardened teeth or abrasive material to cut through metal. Bandsaws and abrasive cutoff saws are two common types of metal cutting saws.

(c) Grinders – used shape or smooth metal through abrasion. Stand grinders and belt grinders are common stationary tools. Portable angle grinders are very common metalworking power tools. Grinders can be used for a variety of purposes based on the properties of the wheels, belts, or discs that are attached to them.

(d) Oxy-fuel equipment – a setup that uses a combination of oxygen and a fuel gas to heat steel to high temperatures for cutting, bending, or welding purposes.

(e) Plasma Arc Cutting – a process that uses compressed air and an electrical arc to cut metal.

3. Measuring and marking
   A. Reading tape measures
   B. Using squares
   C. Marking steel
      (i) Soapstone – a talc based mineral that is frequently used for marking metal due to its ability to withstand heat. It makes marks that look similar to chalk but have a smooth, slick feel.
      (ii) Scratch awl – a piece of hardened steel that has been sharpened to a fine point. It is used to score or scratch lines in metal.
      (iii) Other tools for marking steel included using markers or paint pens. Care should be taken to ensure that these are appropriate for the job and safe to use in metalworking applications.

4. Cold metalwork
   A. Cutting and shaping metal with hand saws and files
      (i) Saw Blade Selection – sawblades that are designed for cutting metal have a greater average pitch (number of teeth per inch) than those for cutting wood. Like in woodworking, a higher pitch creates a finer cut. For cutting metal, most hacksaw blades are available in the 14 to 32 TPI range, with
14 being coarse and 32 being very fine. The thicker the material being cut, the lower the TPI required to cut effectively. In general:
(a) 14 TPI – for cutting steel around ¼” thick
(b) 18 TPI – for cutting steel around 1/8” thick
(c) 24 TPI – for cutting thin steel and soft metals
(d) 32 TPI – for cutting soft metals and steel tubing

B. Using snips, shears, and cold chisels

C. Bending, shaping, and fastening sheet metal
   (i) Hammer types and selection

D. Drilling, tapping, and threading metal
   (i) Drilling – drilling into metal requires bits that are rated for the particular type of metal being drilled. Most drill bits specialized for metal are made of high speed steel and coated with a tough material like black oxide, titanium, or cobalt. Drilling is best performed at a low speed, with the aid of a lubricating cutting fluid. If the bit gets too hot due to friction, the bit will dull very quickly or break.
   (ii) Tapping – tapping metal is the process of putting female threads on the inside of a hole. This would be used to allow for a threaded bolt to be secured in the hole. A set of taps, usually part of a tap and die kit, is used to select the appropriate size and thread tap that is needed for the job. The hole and tap are lubricated and the tap is manually turned to cut the threads into the material, taking care to not allow filings to build up.
   (iii) Threading – threading is the process of cutting male threads onto a piece of metal round stock. This is the opposite practice of tapping and uses a tool called a die, which is usually found in a tap and die set. After selecting the appropriate die, the workpiece and the die are lubricated and the die is then turned on the workpiece to cut the threads.

5. Metalwork with power tools
   A. Cutting metal with power saws and shears
      (i) Electric – electric saws may cut metal using abrasion to grind through the material or hardened teeth to cut through. Electric saws to cut metal are found in both stationary and portable versions. Common stationary electric saws are abrasive cutoff saws (also known as chop saws) and metal cutting band saws. Common portable saws are portable band saws, metal cutting circular saws, and cutoff wheels on angle grinders. Electric shears are also an option for cutting sheet metal.
      (ii) Pneumatic - pneumatic tools are operated by compressed air. The most common pneumatic tools for cutting metal are cutoff wheels on pneumatic
grinders and pneumatic shears for cutting sheet metal.

(iii) Hydraulic – large stationary hydraulic shears for cutting metal are common in metalworking shops. Various manufacturers offer a number of different hydraulic tools that allow for the punching of holes, notching, bending, and cutting many different shapes and sizes of material.

(iv) Blade/wheel replacement – each type of saw uses a specific type and size blade. Care should be taken to replace parts according to the manufacturers’ specifications.

B. Shaping metal with grinders, portable and stand

C. Bending metal with power tools

D. Oxy-fuel cutting, brazing, and welding
   (i) Start up, adjust to neutral flame, shutdown
   (ii) Tip cleaning

E. Plasma-arc cutting
   (i) Setup, startup, adjustment of torch
   (ii) Parts, uses, maintenance, tip replacement
   (iii) Air compressor maintenance and air quality

6. Finishing metal
   A. Preparation and painting
      (i) To hold paint, steel must be prepared to a bare surface, free of rust, grease, scale, and protective coatings. Other metals may require special primers, paints, or preparation methods.

      (ii) Ideally, steel will be treated with an abrasive (sandblasting or an angle grinder with a wire attachment or flap-wheel) and washed with a solvent (i.e. acetone) before being coated with a primer. After priming, paint can be applied in the necessary amount of coats.

   B. Brushes vs air
      (i) Brushes provide more control and can be used in most areas. However, brushes do not leave a smooth surface and do not deposit paint evenly.

      (ii) Paint spray guns leave a smooth surface and provide even coverage. However spray guns have special ventilation requirements, must be carefully controlled, and have more complex maintenance than brushes.
C. Troubleshooting paint failures

D. Alternative metal finishes
   (i) Powder coating – a method in which an electrostatically charged, powdered resin is sprayed on a piece and baked on in a special oven. Powder coating leaves a hard, smooth, wear resistant finish.

   (ii) Galvanizing – a process in which steel is dipped in molten zinc to produce a corrosion resistant finish. Galvanized steel should not be heated as the fumes are toxic.

   (iii) Electroplating – a coating process in which a piece of steel is attached to an electrode and dipped in a bath containing dissolved metal cations. Another electrode passes a charge through the bath to the piece being plated. The electric charge forces the dissolved cations to cover the steel. Chrome plating is one type of electroplating.

Welding

1. Principles of welding
   A. Role of electricity in welding

   B. Equipment identification and selection

   C. Safety concerns specific to welding
      (i) Electrical and fire safety

      (ii) Ultraviolet light safety

2. Shielded Metal Arc Welding (SMAW)
   A. Equipment

   B. Electrode Selection
      (i) Number coding

   C. Striking and maintaining an arc
      (i) Tap and scratch methods

   D. Control, technique, and positioning
      (i) Electrode angle for position welding

   E. Running effective and consistent weld beads

   F. Cleaning SMAW welds
G. Troubleshooting SMAW weld defects

3. Gas Metal Arc Welding (GMAW)
   A. Equipment
      (i) Compressed gas safety
   B. Wire and gas selection
   C. Wire feed, voltage, technique, and positioning
   D. Effective GMAW welds
   E. Troubleshooting GMAW weld defects

4. Gas Tungsten Arc Welding (GTAW)
   A. Applications of GTAW
   B. Equipment
   C. GTAW positioning and technique
   D. Striking and maintaining a GTAW arc
   E. Creating a GTAW bead

Internal Combustion Engines
1. Fundamentals of Engines
   A. Safety with engines and equipment
   B. Four-cycle engines
      (i) Common Applications
      (ii) 4 Cycle Theory
   C. Two-cycle engines
      (i) Common applications
         (a) Two cycle theory
   D. Critical components of engines
      (i) Internal parts
      (ii) External parts
   E. Fuel System
      (i) Carburetor theory
(ii) Fuel selection

F. Ignition System
   (i) Spark Plug replacement/maintenance

   (ii) Points and condenser vs solid state

G. Cooling and lubrication
   (i) Air Cooled vs Liquid Cooled

   (ii) Engine oil selection
      (a) Oil viscosity ratings for temperature
      (b) Conventional vs Synthetic

2. Maintenance of Small Gas Engines
   A. Tools and equipment

   B. Fuel system maintenance
      (i) Change fuel filter

      (ii) Clean tank

   C. Carburetor maintenance
      (i) Disassembly and cleaning

   D. Maintenance of ignition components
      (i) Cleaning flywheel

      (ii) Set Air gap

   E. Lubrication
      (i) Types of lubricants, greases, and oils

      (ii) Change and dispose of oil

   F. Maintenance of other components
      (i) Sharpen blades

   G. Appropriate storage

3. Repair of Small Gas Engines
   A. Basics of troubleshooting

   B. Ignition system
      (i) Identify common faults
(ii) Replace spark plug

C. Fuel system
   (i) Identify common faults
   
   (ii) Clean carburetor

D. Compression system
   (i) Identify common faults
   
   (ii) Replace piston rings
   
   (iii) Set valves

E. Starting systems
   (i) Identify common faults
   
   (ii) Repair recoil starter

Large Agricultural Machinery

1. Introduction to Agricultural Equipment
   A. Mobile Equipment
      (i) Tractors
      
      (ii) Combines
      
      (iii) Bulldozers, Skid Steers, and Earth-moving Equipment
      
      (iv) Forestry Equipment

B. Power Take-Off (PTO)
   (i) Part of a tractor that can attach to equipment via a spinning shaft and, using torque supplied from the tractor’s transmission, can operate the mechanical components of the equipment.
   
   (ii) Examples of PTO operated equipment: cutters, mowers, balers, pumps, augers, rotary tillers, etc.

C. Hydraulics – the use of moving liquids under pressure through cylinders of varying diameters to generate movement and force via hydraulic rams.
   (i) Hydraulic equipment operates by applying Pascal’s Law, which states that, in a sealed environment, pressure change exerted on an incompressible fluid will be evenly distributed throughout the fluid and to the walls of the container.
   
   (ii) Length and diameter of rams and pressure ratings on pumps and fittings play a major role in hydraulic equipment operation.
Land Measurement, Surveying, and Agricultural Structures

1. Role of land measurement in agriculture
   A. Legal land descriptions
   B. Acreage

2. GPS and GIS in agricultural land management

3. Basic tools of surveying: transit level, tripod, rod, measuring tape, GPS receiver, etc.

4. Drone technology in surveying, crop layout, and harvesting

5. Taking measurements and shooting slopes

6. Layout of agricultural structures: shops, barns, storage buildings, fences etc.
UNIT O: Building Blocks of Life and Biotechnology
Revised by Ms. Raegan Ramage

STANDARDS:
LA-AGTECH: S6.2, S6.3, S6.4
AFNR: BS. 01.01 - B.S. 03.06

Goal: Students should be able to assess factors that have influenced the evolution of biotechnology in agriculture as well as demonstrate the application of biotechnology to solve problems in Agriculture, Food and Natural Resources (AFNR) systems

Objective(s):
1. Evaluate the scope and implications of regulatory agencies on applications of biotechnology in agriculture and protection of public interests (e.g. health, safety, environmental issues).
2. Identify individual achievements in biotechnology
3. Investigate and explain the relationship between past, current and emerging applications of biotechnology in agriculture (e.g. major innovators, historical developments, potential applications of biotechnology).
4. Analyze the essential elements of safety and ethics relevant to laws and public perceptions on applications of biotechnology in agriculture (e.g., ethical, legal, social, cultural issues).
5. Identify potential problems and concerns related to biotechnology
6. Identify steps in the scientific method and related terminology
7. Describe genetic terminology related to the biotechnology and heredity
8. Use Punnett squares to identify potential traits in offspring
9. Describe types and processes in genetic heredity
10. Identify uses of heredity in agriculture
11. Analyze DNA structure and function
12. Describe the relationship between genetic terminology
13. Identify characteristics of heredity
14. Identify methods of determining and influencing heredity in agriscience
15. Identify the parts and functions of plant and animal cells
16. Identify the types and stages of cell reproduction
17. Identify methods of DNA analysis
18. Describe the uses of cloning in Agriscience
19. Identify methods of developing transgenic organisms

Agritech Guiding Questions:
1. What is mitosis?
2. What are the steps of the scientific method?
3. What type of breeding involves choosing specific parents to obtain desirable characteristics in the offspring?
Content:

Scope and implications of biotechnology

1. Biotechnology is the application of living processes to technology. the use of microorganisms, animal cells, plant cells, or components of cells to produce products or carry out processes with living organisms.
   
   i. Past - Living organisms have been used for centuries to alter and improve the quality and types of food for humans and animals. Examples include the use of yeast to make bread rise, bacteria to ferment sauerkraut, bacteria to produce dozens of types of cheeses and other dairy products, and microorganisms to transform fruit and grains into alcoholic beverages
   
   ii. Current - Biotechnology is an important tool in agriscience, but there are real dangers that this new power over life processes can lead to unmanageable consequences in careless, uninformed, or criminal hands. Therefore, governments, scientists, agencies, corporations, and individuals have moved cautiously in the pursuit of new benefits through biotechnology.

2. Genetically modified organisms are consumed by millions of people (especially Americans) almost EVERY DAY.

   A. Over half of all soybean plantings worldwide are genetically engineered. (much higher in the US)
   
   B. Genetically modified crops were produced on over 500 million acres in 26 countries in 2018, a significant increase from 100 million acres in 18 countries in 2003.
   
   C. The USA remains the top producer of biotech crops. Producing almost 40% of the global biotech crop plantings.
   
   D. Brazil landed on the second spot with just under 30% of the global output.
   
   E. Future – The future promises unprecedented advancements in plant and animal improvement, pest control, environmental preservation, and life enhancement.

3. General Relationship Between Biotech & Agriscience
   
   A. Increased activity and research between different agricultural areas with common research techniques and goals.

4. Relationship of Biotechnology to Specific Fields of Agriscience
A. Biotechnology in Agricultural Production
   (i) Wide scale production of transgenic plants impacting horticulture.

B. Biotechnology in Environmental Science
   (i) Immunoassay tests are methods used to test for the presence of contaminants in soil, water, and even blood.
   (ii) Installation of biological barriers to prevent the transfer of harmful microorganisms between production facilities. Ex: Tire wash channels.
   (iii) Microorganisms between production facilities. Ex: Tire wash channels.

C. Biotechnology and Health / Agri-medicine
   (i) The use of biological barriers to prevent the spread of harmful microorganisms that could contaminate food sources.
   (ii) Pharming- The creation of plants and animals capable of producing medical substances.

Individual Achievements in Biotechnology
1. Leeuwenhoek discovers bacteria using a simple microscope. (1675)
2. Gregor Mendel- Austrian monk who conducted the first genetics experiments using pea plants in the mid 1800’s (1863). Often considered the founder of genetics.
3. Louis Pasteur- disproved the notion of spontaneous generation, describing the role of bacteria in spoilage and the scientific basis for fermentation. Created the rabies vaccine in the 1870’s
4. Robert Hooke- invented the compound light microscope, first to observe cells in cork (1665)
5. James Watson & Francis Crick- Englishman responsible for the discovery of the double helix structure of DNA using X-ray photographs. (1953)
6. Paul Berg- Stanford university scientist who first developed recombinant DNA technology, a method for the insertion of genetic material from one organism into another. (1972)

Historical Development of Biotechnology
1. Origins of “biotechnology” emerge in methods of food production and plant and animal breeding. Early Civilizations (1750 B.C.)
   A. Examples:
      (i) Use of bacteria to produce cheese. (food preservation)
      (ii) Use of natural enzymes in yogurt.
(iii) The use of yeast to produce bread.

(iv) The process of fermentation is developed for producing wine & beer.

(v) DNA is discovered in trout sperm by the German Miescher. (1869)

(vi) The word biotechnology is first used by a Hungarian agricultural engineer. (1919)

(vii) Wide-spread work is undertaken to investigate the structure and function of DNA (1940’s- 1950’s)

(viii) The U.S. Supreme Court approves the patenting of genetically altered organisms. (1980)

(ix) A variety of Genetically Modified Organisms (CMOs) and biotechnology techniques are introduced in fields from agriculture to medicine. (1980’s - 1990’s)

B. Recombinant DNA Technology- extracts DNA from one organism for use in another, allowing more rapid and specific improvements in plants and animals.

C. Plant Tissue Culture- gains widespread acceptance as a method to quickly and cheaply produce genetically identical plants.

2. First transgenic organisms (GMO’s), are introduced in widespread agricultural production, particularly in the area of crops. (1990’s)
   A. BT corn and soybeans are introduced offering “natural” insect resistance by the introduction of a gene from the bacterium Baccillus thuringensis.

3. Dolly the first animal cloned from diploid cells is produced in Scotland. (1997)

4. Human cloning is outlawed in the US and the first concerns over the use of human stem cells in research begin to arise. (late 90’s- early 00’s)

5. Cloning- the production of a genetically identical organism(s) from cells removed from a single parent.

6. Clonal Offspring- organisms produced through the process of cloning- always genetically identical to each other and the parent.

7. Deoxyribonucleic Acid (DNA)- a nucleic acid with a double helix structure responsible for the transmission of genetic material in all living organisms.
8. Genetics - the study of the inheritance in plants and animals.

9. Genetic Engineering - the process of removing and/or inserting genetic material in order to change an organism’s traits.

10. GMO - Genetically modified organism, another name given to transgenic organisms.

11. Ribonucleic Acid (RNA) - a nucleic acid smaller than DNA (no double helix), responsible for the production of proteins in a cell.

12. Transgenic Organism - a genetically altered organism with DNA altered by the removal of genes or the insertion of genes from another organism.

Safety in Biotechnology
1. Federal and state governments monitor biotechnology research and development
   A. Fear has been expressed about the perceived dangers of genetically modified organisms, resulting in – appropriate policies, procedures, and laws
   B. Regulations have been developed by the Environmental Protection Agency (EPA).
   C. Products are tested in laboratories, greenhouses, and other enclosures before being approved for testing outdoors and in other less controlled environments.

Ethics
1. Ethics – a system of moral principles that defines what is right and wrong in society

2. The ability to manipulate the genetics of living organisms raises important ethical questions about how the technology should be used

Applications of Biotechnology in Agriscience
1. Use of biotechnology techniques in environmental science for cleaning contaminants and protecting endangered species.
   A. Ex: bioremediation - use of natural organisms to clean improvements

2. The production of improved plants and animals resistant to insects, diseases, or even harsh environmental conditions.
   A. Ex: Immunoassay tests used for testing pollution.

3. Increased use of methods of in vitro fertilization and artificial insemination improves selective breeding programs in plants and animals.
4. The production of beneficial medical and nutritional substances in transgenic plants and animals.

5. DNA analysis / paternity testing has emerged as a technique to test the genetic ancestry of animals.

Problems with Biotechnology in Production Agriculture
1. Concerns of transfer of genes found in transgenic organisms to natural populations.
   A. Terminator genes have been used to minimize this risk.

2. Unexpected impacts of genetically modified organisms and biotechnology processes on other organisms and the environment.

3. Expense of the cost to develop new biotechnology products or techniques.

4. Concerns over the safety and ethics of incorporating GMO’s into food for human consumption.
   A. Ex: the use of a genetically modified corn (Starlink) not approved for human consumption in taco shells, GMO Soybeans, GMO apples

   B. Concerns over the ethics of biotechnology company business practices

5. Lack of education among both consumers and producers concerning biotechnology processes and products.

6. Concerns about the ethics of business practices of GMO development companies

7. The unlawful use of genetically altered crops by producers
   A. Several legal cases have resulted from producers suing biotech companies.
      (i) Many times, these lawsuits have resulted in charges that the producers illegally used genetically engineered crops without paying the company for their use

The Scientific Method
1. Stating the problem
   A. Defines the topic of the experiment, and discusses the importance and applicability of the issue.

2. Formulate a hypothesis
   A. Often called an educated guess, better defined as the use of research to predict the result(s) of the experiment

3. Research
   A. The researcher conducts a literature review to determine if their experiment has already been done, and to find the best methods to conduct their
experiment. Materials list and experimental procedures should be produced at the end.

4. Conduct Experiment
   A. follow the plan laid out in the procedures, and be sure to KEEP CAREFUL RECORDS using log books or computerized records.

5. Results
   A. Collect and analyze data, both quantitative and qualitative. Be sure to note both large changes and small details with differences between treatment groups.

6. Conclusion
   A. Summarize the research findings in relation to the hypothesis and previous research. Assess the impact of findings, including any issues or unexpected outcomes of the experiment. Why does the work matter?

**Scientific Experiment Terminology**

1. Validity- an experiment measures what the researcher intended it to.

2. Reliability- the results of an experiment can be repeated

3. Treatment Group- treated with different variations of the independent variable.

4. Control Group- group that serves as a norm and is used for comparison. (does not receive a treatment).

5. Independent Variable- variable the researcher changes (ex- amount of light in photosynthesis experiment).

6. Dependent Variable- variable determined by the effectiveness of the independent variable. (ex- amount of growth in photosynthesis experiment)
Genetics and DNA

1. Genetic Terminology
   A. DNA- Deoxyribonucleic Acid- the major nucleic acid in organisms- carries genetic information, and is responsible for the transmission of traits.
   B. Gene- segment of DNA that codes for a specific trait in an organism.
   C. Allele - An alternative form of a gene / trait. Ex: eye color- alleles = blue, green, hazel, brown, etc.
   D. Homozygous- Organism with identical alleles for a given trait- can be dominant or recessive. Ex: TT or tt
   E. Heterozygous- Organism with different alleles for a given trait. Ex: Tt
   F. Phenotype- the physical appearance of a trait in an organism- determined but not always indicative of the genetic makeup of the organism. Ex: tall or short
   G. Genotype- the genetic composition of an organism for a given trait- often cannot be determined by looking at an organism. Ex Tt or TT
   H. Recessive Gene / Allele- variation of a trait that can only be expressed in the absence of a dominant allele.
      (i) Heterozygous individuals are carriers for recessive alleles.
   I. Dominant Allele / Gene- variation of a trait that is expressed over other variations of the same trait.
      (i) Most common forms in natural populations.
      (ii) Some traits can be co dominant or exhibit incomplete dominance.
   J. Chromosome- long condensed strand of DNA forming in the nucleus of a cell prior to cell division. Form pairs that when split, create an exact copy of DNA in the daughter cell.
   K. Chromatid pairs- X-shaped structures that serve as the mechanism for the transmission of genetic material during cell division. They are pulled apart in the process of mitosis and meiosis.

Using Punnett Squares

1. Definition- method utilizing the known genotypes of parent organisms to predict the expression of a given trait or traits in offspring.
   A. Must know the genotype of parents and the inheritance pattern of the trait.

2. Conducting Tests
A. A box should be drawn with one space for each allele expressed by both parents. (in simple heredity, like pea plant height, boxes are 4x4)

B. The alleles for one parent should be placed above each column at the top, with the alleles for the other placed beside each row on one side.

C. The alleles of each parent should be distributed across and down the box.

D. This allows you to calculate the probability of a certain phenotype

E. For example, in the box below, if we assume that tall plant height is the dominant trait (T) the dwarf plants are the recessive trait (t). Then if we cross two heterozygous tall plants (Tt) We have a 75% chance of their offspring being tall and 25% of them being a dwarf variety.

<table>
<thead>
<tr>
<th></th>
<th>T</th>
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<tbody>
<tr>
<td>T</td>
<td>TT</td>
<td>Tt</td>
</tr>
<tr>
<td></td>
<td>Homozygous Dominant</td>
<td>Heterozygous</td>
</tr>
<tr>
<td>t</td>
<td>Tt</td>
<td>tt</td>
</tr>
<tr>
<td></td>
<td>Heterozygous</td>
<td>Homozygous Recessive</td>
</tr>
</tbody>
</table>
Example:
Cross of two genes

<table>
<thead>
<tr>
<th></th>
<th>TG</th>
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<tbody>
<tr>
<td>Tg</td>
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</table>

Process of Simple Heredity
1. Heredity is best described as the manner in which inheritable characteristics (traits) are passed from parents to offspring.

2. Heredity is a direct outcome of the RANDOM genetic recombination resulting during sexual reproduction.
   A. Only functions in sexual reproduction
   B. Ensures genetic diversity
   C. Heredity determines the genetic potential of an animal, but heredity and environment determine the overall quality of an animal.

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Types of Heredity
1. Simple Heredity
   A. One gene controls one trait- alleles are either dominant or recessive.
      (i) Ex: height & color in pea plants

2. Complex Heredity
   A. Polygenic Inheritance- one trait is controlled by several genes and possibly environmental factors- genes may even be located on different chromosomes. This is a slow process requiring many (i) generations to achieve desired results.
      (ii) Ex: height in humans

B. Incomplete Dominance
   (i) multiple alleles for a given trait are not expressed over one another, but in combination.
   (ii) Ex: RR (Red Flower) x WW (White Flower) = RW (Red & White Striped Flower)

C. Codominance- similar to incomplete dominance, except characteristics alleles blend instead of remaining distinct.
   (i) Ex: RR (Red Flower) x WW (White Flower) = RW (Pink Flower)

Heredity in Agriscience
1. Huge factor in successful agricultural selective breeding programs.

2. Processes of heredity manipulated to create high quality HYBRID offspring.
   A. Plants and animals are inbred through several generations to isolate a specific traits or traits.
      (i) Inbreeding can increase desirable genetic traits, but it also increases the risk of negative traits and can cause severe disabilities or problems in subsequent generations.

   B. The final generation of two different lines inbred for different traits are crossed producing offspring with the beneficial traits of both lines.
      (i) Resulting offspring possesses hybrid vigor.
C. Hybrid vigor usually lasts only one generation, as hybrid organisms rarely express traits true to type in offspring.
   (i) Alternative forms of the gene resurface in the new cross.

Utilizing Heredity in Selective Breeding
   1. Punnett Squares, Pedigree Charts, Genetic Mapping & DNA Analysis can be used to predict heredity.
   2. Selective breeding involves choosing specific parents to select for desirable characteristics in the offspring.

DNA Structure and Function
   1. DNA nucleotides combine in cells to form long strands in the shape of a double helix. (looks like a twisted ladder)
      A. Nucleotides bond at two spots:
         (i) Sugar / Phosphate molecules form the backbone. (outside rails)
         (ii) Nitrogenous bases bond in the middle. (steps or rungs)
         (iii) Hydrogen bonds between nitrogenous bases are MOST EASILY broken.

      B. The order of the nucleotides is the determining factor in the expression (i) of genes in organisms.
2. The sequence of DNA accounts for all genetic variation between different individuals and organisms by the use of different:
   A. Sequences of nitrogenous bases.
   B. Lengths of DNA segments.
   C. Numbers of chromosomes and amounts of DNA in an organism.

3. The amount of DNA in an organism DOES NOT relate to the size or complexity of the organism.

4. DNA replication is the process through which cells copy DNA for transmission to daughter cells during cell division.
   A. The double helix structure allows DNA to easily unzip down the center between nitrogenous bases.
   B. Free floating nucleotides attach to each of the separated DNA strands forming 2 new strands of DNA, each an exact copy of the original.

5. A mutation is an unexpected change in a DNA sequence, usually occurring during the replication / cell division.
   A. Mutations are common in most organisms (especially simple organisms) though only a small percentage produce noticeable changes in organisms.

6. DNA is passed to offspring during sexual reproduction through single chromosomes.

Relationship Between Genetic Terms
1. Genetic hierarchy
   A. A group of nucleotides = a gene / allele = 45-150 base pairs.
   B. A group of genes = 1 strand of DNA.
   C. Several condensed strands of DNA = 1 chromosome.
   D. 2 chromosomes = 1 chromatid pair.
   E. All possible gene forms in a population = Genome.

1. Mapping the genome of a species allows scientists to identify beneficial and harmful genes in a population, and is the first step in determining the location of specific genes on chromosomes.
   A. Changes in the genome of a species occur slowly in response to environmental changes.
   B. Polygenic traits are controlled by more genes and therefore it is more difficult to improve polygenic traits.
Cells and Cell Structure

1. Eukaryotic Cells
   A. Definition - advanced cells characterized by the presence of membrane bound organelles, and a distinct nucleus.

   B. Usually occur in multicellular animals, but also include a few single celled Protists.

2. Eukaryotic Cell Structures
   A. Cell membrane - selectively permeable membrane surrounding all eukaryotic cells. Protects the cell and controls the movement of substances into and out of the cell.

   B. Golgi apparatus - center for the distribution of proteins, enzymes, and other materials through the cell.

   C. Mitochondria - structures inside the cell that convert simple sugars to a useful form of cellular energy through the process of respiration.

   D. Nucleus - a large central segment of eukaryotic cells that contains the cell’s genetic information (DNA).

   E. Ribosomes - small structures in the cytoplasm of the cell that utilize RNA to produce proteins for cell functions.

   F. Vacuoles - specialized “bubbles” in cells used for storage, digestion, and excretion. Much larger in plant cells.

3. Structures Unique to Plant Cells
   A. Chloroplasts - specialized structures in plant cells that utilize chlorophyll to capture light energy for conversion to chemical energy.

   B. Cell wall - structure outside the cell membrane that helps support and protect cells. Not semi-permeable.

Specialized Eukaryotic Cells

1. Diploid cells - includes all single celled eukaryotes and every non-reproductive cell in multicellular eukaryotes. (plants and animals)
   A. Ex: skin cells, muscle cells, nerve cells, etc.

   B. Haploid cells - specialized reproductive cells in Eukaryotes that contain 1/2 the amount of genetic material of normal (diploid) cells.
      a. Also called Gametes or sex cells.
b. Haploid cells combine during sexual reproduction to create a fertilized egg.

c. 4 distinct types:
   i. male- sperm or pollen
   ii. female- egg or ovum

2. Stem cells- produced from the union of haploid cells, special cells that differentiate into all diploid cells in the body.

**Cell Division and Replication**

1. **Mitosis**
   - A. Simple cell division for growth
   - B. Function – production of replacement of cells to then serve as growth or repair of bodily tissues
   - C. Steps
     - (i) Interphase – the nucleus and the nuclear envelop move into separate ends of the cell
     - (ii) Prophase – chromosomes appear condensed, the nuclear envelope is no longer visible
     - (iii) Metaphase - chromosomes are lined up at the metaphase plate, each sister chromatid is attached to a spindle fiber originating from opposite poles
     - (iv) Anaphase – sister chromatids pull apart to begin separation process
     - (v) Telophase and Cytokinesis – cell pinches in the middle forming two identical daughter cells

2. **Meiosis**
   - A. Cell division that occurs during reproduction resulting in the formation of gametes (sex cells)
   - B. Function – division or duplication of egg and sperm cells
   - C. It differs from mitosis primarily in that instead of chromosomes dividing and moving in pairs to the opposite sides of the cell, they separate and move individually to the cell walls. When the new cells are formed, each cell contains only one of each chromosome pair rather than both chromosomes.
   - D. Allows for the male and female sex cells to combine to create one complete set of DNA
Methods of DNA Analysis

1. Paternity Testing
   A. Simple method of DNA analysis that compares the DNA of an offspring, plant or animal with a known mother and suspected father.

   B. Process:
      (i) DNA sample taken usually from saliva or blood in animals and leaf or callus tissue in plants. (Hair does not contain DNA, but the hair follicle does.)

      (ii) DNA isolated in samples through the use of protein “eating” enzymes.

      (iii) Sample run on gels or through a gene sequencer to indicate the presence of certain genes.

      (iv) Comparison of genes - anything present in the child must be present in the mother or father

      (v) 13 genes present in the child that are not in the mother, but present in the father make a 99% match.

2. Gel Electrophoresis
   A. Method used to analyze extracted DNA through the distribution of genetic markers on an agar media.

   B. Process:
      (i) An agar gel is poured into a mold to dry, then placed into an electrophoresis chamber.

      (ii) DNA extraction is placed in small wells at one end of the agar gel. Each well represents a different sample or individual.

      (iii) Electric current is run through the wells, distributing DNA across the gel.

      (a) Smaller gene segments travel further distances on the gel.

      (iv) Samples extracted through the same process can be easily compared on a single gel.

3. Advanced Methods of DNA Analysis
   C. Polymer Chain Reaction (PCR)
      (i) Method used in forensic science to amplify genetic material for identification or analysis.

      (ii) Newer technique used only in advanced laboratories.
D. Amniocentesis- method used to analyze the DNA of a mammal (occasionally other animals) prior to birth.

(i) Used widely in humans to predict the expression of lethal genes or genetic disorders in high-risk pregnancies.

(ii) Gaining favor in high expense animal breeding- (race horses, etc.)

General DNA Extraction Information

1. DNA Extraction- the process of isolating nucleic acids (DNA) from organic material.
   A. DNA can be extracted from almost any intact cellular tissue. More cells make extraction is easier, but only a few cells are needed with PCR techniques.
      (i) Skin, blood, saliva, semen, mucus, muscle tissue, bone marrow, etc.

      (ii) DNA cannot be extracted from hair, unless skin is attached at the hair root.

2. Mitochondrial DNA can often be extracted long after nuclear DNA has degraded.

3. A simple DNA extraction for viewing, but not analyzing DNA can be accomplished by:
   A. Physically breaking apart plant material, usually fruits. (smashing up a strawberry)
   B. Use of a detergent to break apart the cell membrane.
   C. Treatment with ethyl alcohol to isolate DNA from remaining proteins and sugars. (extraction for analysis would use enzymes)
   D. Spooling using a glass rod to view a large clump of nucleic acids (DNA).

DNA Extraction Process

1. The organism to be tested is chosen, and a sample is taken from which DNA can be extracted.

2. Detergents are used in simple DNA extraction procedures to break down cell membranes, blending the contents of the cell.

3. The DNA sample is treated with enzymes to isolate nucleic acids, usually both DNA and RNA.
   A. Enzymes dissolve proteins, sugars, and other materials.
      (i) Ex: protease, amylase, etc (enzymes end with the suffix- ase)

4. A second enzyme may be applied to cut DNA into gene segments for analysis.
Cloning in Agriscience
1. Allows rapid production of large numbers of genetically identical organisms.
   A. Agriculturists can quickly disseminate outstanding traits.
   B. Most often utilized for the culture of plants - cheaper, easier process, and less political opposition. (The ability to differentiate is more in plants than animals.)
   C. Tissue culture - the production of plants from small amounts of vegetative material in an in vitro environment, is an increasingly popular and effective method of plant production.

2. Animals are cloned almost exclusively by the division of embryos. In recent years, diploid cells have been cloned, but the process is extremely expensive and results in high losses.
   (i) Dolly the sheep was produced from mammary gland cells in a sheep.

3. Clones are genetically identical (the exact same DNA).
   A. Any genetic differences results from environmental factors - disease, nutrition, physical injuries, etc.

Transgenic Organisms
1. Characteristics of transgenic organisms

2. Can potentially be created using genes from ANY living organism.
   A. The trick is finding a method for insertion and successful expression.

3. Genetically modified organisms transmit inserted genes at the same rate as naturally occurring genes.
   A. Once a gene is inserted, it can be passed on through sexual reproduction.

Steps in The Creation of a Transgenic Organism
1. Develop A Purpose / Goal- the transmission of genes from one organism to another is both expensive and potentially dangerous, expectations for work should be laid out carefully.

2. DNA must be extracted from the target organism and the specific gene to be introduced isolated utilizing restriction enzymes.

3. Vectors are used for the transmission of target genes.
   A. Viruses make good vectors, as they often insert DNA into organisms they affect.
   (i) Plasmids are the viruses most often used as vectors.
(ii) Plasmids can store large strands of DNA or even one or more chromosomes.

B. Some vectors can transmit genes simply through contact with target cells in a liquid solution or by microinjection.

4. Isolated DNA is inserted into the new organism by:
   A. Micromanipulation- the isolated DNA segment is injected into a target cell utilizing a microscopic syringe under high magnification.
      (i) Most common for the creation of transgenic organisms.

      (ii) Biolistics- uses a gene gun to fire gold plated .22 caliber shells that have been covered with the target gene into a mass of plant cells.

      (iii) Most often used for plants, as cell mortality is high.

Resources: