

PLANT SCIENCE

High School
AGRICULTURAL EDUCATION

MINNESOTA

INTRODUCTION

This course of study is one of four courses that have been approved by the University of Minnesota Twin Cities and Duluth campuses to meet the three-year science preparation requirement. The course will be used to fulfill the one-year biological science component and/or the general science component of the three-year science requirement for admission to the University.

This guide should be used as the basis for the Plant Science course. Teachers of secondary agricultural education have a unique opportunity to provide a science-based course in the context of agricultural plants and plant products. The course should not be viewed or taught from a traditional vocational context. Each unit has been organized around a lesson plan which provides a basic set of facts around a science concept. The teacher is expected to use this lesson as a basis for class discussion. Following the basic lesson are a series of lesson plans focused on activities which illustrate and present basic science principles or concepts in the context of plant science. These activities may be presented as laboratory exercises or research activities. Teachers are encouraged to reproduce these activity packets and provide one for each student as they each complete the activity. Prior to working on the activity, students are expected to make predictions as to what they expect will occur as they complete the activity. At the close of the activity, the teacher should revisit each student's prediction and determine the differences of agreements students had with their final observations.

Teachers of agricultural education have a unique opportunity with this course. It should NOT be a duplicated biology course. It should NOT be a traditional vocational crop production course. Instead, it should be a unique course designed around various science concepts within a context of plants that are a part of the broad context of agriculture. Some programs may wish to focus on agronomic plants, whereas others may wish to use the context of horticultural plants or forestry. The teacher should be continually ready to respond to students who may ask "Why should we study and learn this stuff?" It is the context of every day agriculture across the state of Minnesota that provides reality and meaningful learning experiences in the use of plants.

This course guide should have real value in improving secondary agricultural education programs.

Roland Peterson
Professor & Head
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Thanks is due a number of Minnesota teachers who have prepared the teaching materials presented in the course. First, Mr. Kent Janssen of Martin County West High School, who reviewed, word processed and brought uniformity to the course. He spent countless hours revising and bringing together the work of various teacher teams. The following teachers have also spent time and effort in providing the lessons and activities:

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|-------------|-----|------------------|---|
| 1994 | 1. | Glen Boettcher | Stillwater High School |
| | 2. | Bob Bowman | Blaine High School |
| | 3. | Kristi Ruen | Maple River High School |
| | 4. | Brad Burklund | St. Cloud Technical College |
| | 5. | Lance Hagman | Hinckley-Finlayson High School |
| | 6. | Kent Janssen | Martin County West High School |
| | 7. | Bob Marzolf | Forest Lake High School |
| | 8. | Jim Naggatz | North Branch High School |
| | 9. | Darrel Ober | Barnum High School |
| | 10. | Kevin Plante | Waterville/Elysian/Morristown High School |
| | 11. | Nate Thompson | Hayfield High School |
| | 12. | John Zimmerman | Kenyon-Wannamingo High School |
| | 13. | R. Todd Hartle | Graduate Student |
| | 14. | Andrea Nthole | Graduate Student |
| | 15. | Jo Ann Young | Graduate Student |
| 1995 | 1. | Robert Bowman | Blaine High School |
| | 2. | Eric Gunderson | Fridley High School |
| | 3. | Joel Larson | South Central Technical College |
| | 4. | Robin Raudabaugh | Elk River High School |
| | 5. | Carla Travis | Northeast Metro Technical College |
| 1996 | 1. | Dene Byers | Milaca High School |
| | 2. | John Dewall | Hastings High School |
| | 3. | Richard Finger | Lewiston High School |
| | 4. | Kent Janssen | Martin County West High School |
| | 5. | Wayne Kroneman | Truman High School |
| | 6. | James Naggatz | North Branch High School |
| | 7. | Michael Reeser | Brainerd High School |
| | 8. | Bruce Rohne | Austin High School |
| | 9. | Daniel Sorum | Murray County Central High School |
| | 10. | Marc Tadych | BOLD High School |

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COURSE TITLE: Plant Science

COURSE DESCRIPTION:

This course will investigate scientific concepts relating to economic plants. Specific topics will include scientific methods, taxonomy and classification, distribution and adaptation, cell structure and function, anatomy and physiology, inter relationship of environmental factors, reproduction, genetics and plant breeding, health and pathology, and the study of plants used by human kind in a managed environment. Laboratory activities will provide opportunities for problem solving through practical applications to learn scientific concepts. Whole plant system applications to current issues will also be presented.

COURSE OBJECTIVES:

1. Apply the scientific method to the study of plants.
2. Evaluate classification systems, distribution and adaptations of economic plants.
3. Analyze the relationships between cell structures and functions.
4. Compare morphology, growth, and development of economic plants.
5. Analyze the biological, physical and chemical processes involved in plant growth, development, and reproduction.
6. Evaluate the inter relationships between plants and their environment.
7. Evaluate the processes involved in the transfer of genetic traits.
8. Analyze the interdependence of plants, people, and the environment.
9. Select appropriate scientific techniques to solve problems relating to plants.
10. Analyze plants for the utility of humans whether it be ornamental, food, or manufacturing uses.

Plant Science

The scope and sequence of this course will be determined by the local school district.

Unit I	Introduction to Plant Science (1 week)
Unit II	Introduction to the Scientific Method and Techniques (1-2 weeks)
Unit III	Taxonomy and Classification (1-2 weeks)
Unit IV	Plant Anatomy and Physiology (3-5 weeks)
Unit V	Cell Structures and Functions (2-3 weeks)
Unit VI	Growth and Development (2-4 weeks)
Unit VII	Plant Propagation (3-5 weeks)
Unit VIII	Genetics and Plant Breeding (1-3 weeks)
Unit IX	Soils and Media (2-3 weeks)
Unit X	Plant Health (2-4 weeks)
Unit XI	Environmental Factors Affecting Plants (2-4 weeks)
Unit XII	Plants in Managed Environments (2-4 weeks)
Unit XIII	Science of Plant Products (1 week)

Teacher note:

Seasonality should be a consideration in determining an order for teaching the units.

Plant Science

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Unit I: Introduction to Plant Science (1 week)

Lessons:

- What is the Global Importance of Plants?
- How important are plants in relation to the other four kingdoms?
- What are features of the latest technological advances in plant science?

Unit II: Introduction to the Scientific Method and Techniques (1-2 weeks)

Lessons:

- Why are observation skills important to researchers?
- What is the scientific method?
- How do we use a microscope to observe items around us?
- What are the most common measurement instruments and units of measurement in agriscience?

Unit III: Taxonomy and Classification (1-2 weeks)

Lessons:

- What are the features of plant taxonomy and classification?
- What are the features of plant keys used in classification?
- What are the features of adaptation in plants?
- How are cultivars developed?

Unit IV: Plant Anatomy and Physiology (3-5 weeks)

Lessons:

- What are the functions of various plant parts?
- What are the features of plant roots?
- What function does each part of a root serve?
- How does a stem of a daisy plant stem differ from that of an oak tree?
- How do stems grow?
- What are the internal features of a leaf?
- What variations are there in leaves?
- What are the features of the flower on a plant?
- Why does a plant produce a fruit?

Unit V: Cell Structures and Functions (2-3 weeks)

Lessons:

- What procedure should we follow when using a light microscope?
- What are key components and functions of plant cells?
- What are the characteristics of a DNA molecule?
- What are the key factors involved in DNA replication & protein synthesis?
- How do cells differ in structure and function?

Unit VI: Growth and Development (2-4 weeks)

Lessons:

- What are the factors involved in tissue growth and development in plants?
- What are the features of the photosynthesis process in a plant?
- What are the features of respiration and its comparison to photosynthesis?
- What effect does water loss have on plant growth and development?
- What are the functions of plant hormones?

Unit VII: Plant Propagation (3-5 weeks)

Lessons:

- What are the features of plant propagation?
- What are the advantages and disadvantages of sexual and asexual propagation?
- What are the features of sexual propagation?
- What are the key features in asexual plant propagation?
- What are the features of grafting and budding and their uses in the asexual propagation of plants?
- What are the features of layering?
- What are the features of tissue culture?

Unit VIII: Genetics and Plant Breeding (1-3 weeks)

Lessons:

- What are the key terms used in genetics?
- What are the features of mitosis and meiosis?
- What are the key factors to consider when determining offspring traits?
- What are the features of hybrid plants?

Unit IX: Soils and Media (2-3 weeks)

Lessons:

- What are the features of soil texture?
- What are the features of soil structure?
- What are the characteristics of soil aeration?
- What are the features of soil amendments?
- What are the features of artificial and specialty growth media?

Unit X: Plant Health (2-4 weeks)

Lessons:

- What are the features of various plant pests?

Unit XI: Environmental Factors Affecting Plants (2-4 weeks)

Lessons:

- What are the environmental factors that effect plant production?
- What effect does moisture have on plant growth and development?
- What are the effects of temperature on plants?
- What effect does light have on plant growth and development?
- What are the affects of air quality of plant growth?

Unit XII: Plant in Managed Environments (2-4 weeks)

Lessons:

- What are the features of a managed environment?
- What factors are essential when growing fruit crops?
- What are the features of growing vegetables in a controlled environment?

Unit XIII: Science of Plants Products (1week)

Lessons:

- What are the features of the science of plant products?
- What are the effects of microorganisms in food preservation?

Plant Science

I Introduction to Plant Science

Science Concepts

Adaptation
Biology
Botany
Comparison
Distribution
Selection
Systems
Observation

Plant Science Practices

Growing Plants
Eating Plants
Production Areas
Uses of Plants
Seasonal Requirements
Analyzing Research Problems
Reporting Research Results

Laboratory Activities

1. Construct a Collage of Plant Uses
2. Design Posters of Plant Species
3. A World Without Plants
4. Diagram World Plant Uses
5. Conduct a Community Survey on Variety of Plants

II Introduction to the Scientific Methods and Techniques

Science Concepts

Analysis
Calibration
Comparison
Control
Conversion
Experimental Design
Measurement
Observation
Reliability
Replication
Validity
Variables
Probability

Plant Science Practices

Collecting Data
Conducting Research
Designing Research
Identifying Research Problems
Interpreting Research
Reporting Research Problems
Using Scientific Instruments
Take Scientific Measurements

Laboratory Activities

1. Converting from English to Metric
2. Using a Scale
3. Using a Microscope
4. Design a Laboratory/ Research Experiment
5. Identify parts of the Microscope
6. Tangible Object Comparison
7. Drawing Conclusions from Research Data
8. Preparing a Wet Mount Slide
9. Item Comparison using a Microscope
10. Using a Stereoscopic dissecting Microscope

III Taxonomy and Classification

Science Concepts

Adaptation
Classification
Cultivar
Distribution
Domestication
Family
Genus
Kingdom
Observation
Selection
Species
Taxonomy
Variety
Comparison
Keys

Plant Science Practices

Classification of Plants and Insects
Identifying Plants and Insects
Observation of Plants
Origin of Plants
Determining Similarities
Uses of Plants
Cultivar Selections

Laboratory Activities

1. Identifying Seeds and Plant Specimens
2. Plant Origin and Domestication
3. Classification of Cultivars
4. Classify Plants Using a Key

IV Plant Anatomy and Functions

Science Concepts

Pollination
Germination
Transpiration
Xylem
Phloem
Selectivity
Growing Point
Tropism
Fertilization
Absorption
Assimilation
Differentiation
Growth
Hormone
Metabolism
Reproduction
Respiration
Nodulation

Plant Science Practices

Producing Seed
Selecting Cultivars
Managing Soil Fertility
Producing Plant Products
Irrigating Soils
Hand Pollination
Producing Floral Crops
Root Pruning
Plant Selection
Fertilizing Plants
Grafting

Laboratory Activities

1. Diagramming Plant Anatomy
2. Anatomy of a Root
3. Anatomy of a Stem
4. What Grows Up?
5. Anatomy of a Leaf
6. Flowers - For Show or Food
7. Identification of Corn and Soybean Seed Parts
8. To Shrink or Not to Shrink
9. Seed Germination in a Bottle

V Cell Structure and Functions

Science Concepts

Cell Division
Differentiation
Diffusion
Excretion
Forensics
DNA Sequencing
Mutation
Osmosis
DNA Fingerprinting
Base Paring
Replication
Respiration
Synthesis
Bonding
Transport
Turgidity
Observation

Plant Science Practices

Propagation
Plant Cell Structure
Gene Splicing and Altering
Cloning
Cell Differentiation

Laboratory Activities

1. Uses of the Microscope, Hand Lens, and Stereoscope for Making Observations
2. Cell Component Activity
3. Plant Cell Model Construction
4. A Semi-Permeable Membrane
5. What are the Components of a DNA Molecule
6. Can Plants be Cloned

VI Growth and Development

Science Concepts	Plant Science Practices	Laboratory Activities	Possible Experiments
Absorption	Vegetable Production	1. Plant Transpiration	Effect of Hormones on Plant growth
Differentiation	Crop Production	2. Where's the Starch	Effect of Light on Plant Growth
Hormone	Row Spacing	3. Effects of gibberlic acid seed germination	Effect of Water on Plant Growth
Metabolism	Plant Population		Effect of Nutrients on Plant Growth
Respiration	Weed Control (shading)		Effect of pH on Plant Growth
Photosynthesis			Effect of Wavelength on Plant Growth
Transpiration			Effect of Acid Rain on Crops
Photoperiodism			Effect of Root Pruning on Plant Growth
Tropism			Effect of Pruning on Plant Development
Response			Effect of Shade on Plant Growth
Stimuli			Effect of Plant Population on Growth
Photosynthetic Component			Effect of Hail Damage on Growth
Light Interception			
Plant Pigment			
Turgor Pressure			

VII Plant Propagation

Science Concepts	Plant Science Practices	Laboratory Activities	Possible Experiments
Differentiation	Evaluate Germination	1. Propagation by Tissue Culturing	Effect of Temperature Germination
Pollination	Propagate by Cuttings	2. Propagation by Cuttings	Effect of Moisture on Germination
Reproduction	Grafting	3. Plant Propagation by Grafting	Effect of Light on Germination
Germination	Budding	4. Propagation by Layering	Effect of Sterility on Germination
Fertilization	Divide Rhizomes (iris)	5. T-Bud Grafting	Effect of Pollination on Seeds (Fast Plants)
Biotechnology	Seed Production	6. Introduction to Plant Propagation	
Rooting		7. Sexual Propagation	
Growing Point			
Anatomy			

VIII Genetics and Plant Breeding

Science Concepts	Plant Science Practices
Cell Division	Hybrid Seed Production
Chromosomes	Evaluation of Cold Hardiness
Dominant	Development of Disease Resistance
Gamete	Producing Seedless Varieties
Genes	Developing Color Variations
Genotype	Evaluating Plant Vigor
Heritability	Evaluating Storability
Hybrid Vigor	Increasing Nutritional Value of Crops
Meiosis	Plant Selection
Mitosis	Hybridization
Mutations	Seed Production
Phenotype	
Probability	
Recessive	
Selection	
Traits	
DNA	

Laboratory Activities

1. Plant Breeding
2. Introduction to genetics
3. Interaction of genetics and the environment.

IX Soils and Media

Science Concepts	Plant Science Practices	Laboratory Activities	Possible Experiments
Texture	Conduct Soil Tests	1. Determining Soil Texture	Effect of Fertilizer Levels on Plant Growth
Infiltration	Mix Soils for Greenhouse Use	2. Settling Soil Texture Once and for All	Effect of pH on Plant Growth
Temperature	Apply Fertilizer	3. Soil Structure and Profile	Effect of Organic Matter on Plant Growth
Permeability	Recommend Fertilizer Program for Crops	4. Water Capacity	Effect of Plant Residue on Plant Growth
Saturation	Determine Soil Types	5. Infiltration Rate	Effect of Soil Texture on Water Movement
Capacity	Aerate Soil	6. Determining Bulk Density	Effect of Soil Structure on Root Growth
Nutrients	Control Soil Organism Levels	7. Living Organisms in Soil	
Ion Exchange	Select Proper Tillage Methods		
Translocation	Determine Soil Permeability		
Absorption	Compost Materials		
pH	Use of Mulch or Groundcovers		
Diffusion	Determine Soil Profile		
Macro-nutrients	Determine Soil Capacity		
Micro-nutrients			
Nutrient Balance			
Deficiency			
Nutrition			
Nitrogen Fixation			
Adhesion			
Cohesion			
Capillary			

X Plant Health

Science Concepts	Plant Science Practices	Laboratory Activities	Possible Experiments
Host	Entomology	1. Grains that are most desirable for weevils.	1. Calibrating sprayers
Life cycles	Weed Identification	2. What is a disease and how it affects plant health?	2. Analysis of pesticide labels.
Pathology	Disease Identification	3. Features of insects.	3. Determining levels of pesticide damage.
Transmission			

XI Environmental Factors Affecting Plants

Science Concepts	Plant Science Practices	Laboratory Activities	Possible Experiments
Evaporation	Irrigation and Watering	Diagram a Greenhouse	Effect on Light Intensity
Absorption	Controlling Temperature	Design a Hydroponics	on Plant Growth
Photoperiodism	for Plants	System	Effect of Temperature on
Respiration	Measuring Temperature	Interaction of	Plant Growth
Photosynthesis	Maintaining Water Quality	Environmental factors	Effect of Moisture on
Tropism	Water Quality Testing	and their Effect on	Plant Growth
Wavelengths	Calculation of Growing	Plant Growth and	Effect of Light Quality on
Convection	Degree Days	Development:	Plant Growth
Transpiration	Light Management	*control	
Precipitation	Growing Condition	*moisture	
Phototropism	Air Quality	*temperature	
		*light	
		*air	

XII Plants in Managed Environments

Science Concepts	Plant Science Practices	Laboratory Activities	Possible Experiments
Nutrient Cycles	Designing Landscapes	1. How are fruit species	
Photosynthesis	Plant Selection	propagated?	
Germination	Growing Field Crops	2. How are vegetables grown	
Replication	Growing Plants	in a controlled environment?	
Pollination	Hydroponically		
	Growing Degree Days		
	Pruning		

XIII Science of Plant Products

Science Concepts	Plant Science Practices	Laboratory Activities	Possible Experiments
Bacteriology	Processing Plant Products	1. Fermentation of Food	Effect of Temperature
Nutrition	Storing Plant Products	Products	on Bacteria
Preservation	Marketing	2. Recycling Plant	Effect of Ethylene on
Sanitation	Packaging	Products	Ripening
Carbohydrate	Recycling Plant Products	3. Test for Carbohydrates,	Effect of Moisture on
Oil		Fats, and Proteins	Fungus
Protein		4. Food Preservation	Effect of Insects on
Starch		5. Keeping foods fresh	Storage Loss
Fiber		6. Food Dehydration	Identify Common Plant
Fermentation			Products
Bleaching			Analyze Food Products
Recycling			for Nurtrients
Fats			Evaluate Food Product
Metabolism			Quality
Dehydration			Evaluate Methods of
Mass/Weight			Storage