

SUBJECT OUTLINE DETAILS

1. Subject: Plant physiology

- Code: CS465C
- Credits: 2
- Hours: 30 theory and exercise hours.

2. Management Unit:

- Department of Molecular Biotechnology
- Biotechnology Research and Development Institute

3. Prerequisites: Cells and Molecules I (BS110C), Organism and Populations (BS111C), Biochemistry I & II (BC461C & BC462C) .

4. Subject objectives:

Plant physiology is a subdiscipline of botany concerned with the functioning or physiology of plants. Closely related fields include plant morphology, plant ecology, biochemistry, cell biology, genetics, biophysics and molecular biology. This course helps students understand the fundamental processes such as photosynthesis, respiration, plant nutrition, plant hormone functions, tropisms, nastic movements, photoperiodism, photomorphogenesis, circadian rhythms, environmental stress physiology, seed germination, dormancy and stomata function and transpiration, both parts of plant water relations which plays important roles in plants. Many exciting natural phenomena will be explained in this course. The achievements and prospects of plant physiology really plays important roles in many areas of life, science, biotechnology and agricultural production.

4.1. Knowledge:

After completing this course, the students were expected to gain knowledge about:

- 4.1.1. The structure of plant cells and their physiological functions.
- 4.1.2. Photosynthesis, respiration, assimilation and metabolism in plants. Their function in plant growth and development.
- 4.1.3. The roles of water, micro and macro nutrients, endogenous and exogenous factors on plant growth development.

4.2. Skills:

- 4.2.1. Students will be trained to have professional skills and competence to practice in plant physiology and biotechnology.
- 4.2.2. Students can design, implement, analyze and evaluate experiments.
- 4.2.3. Students will be trained to get these skills: teamwork skills; scientific information search skills; synthesize, analyze and evaluate information skills; writing skills and presentation skills.

4.3. Attitude:

- 4.3.1. Students should understand the important role of plant physiology in life science.

- 4.3.2. Students should be developed attitudes relevant to the application of plant physiology in practical such as plant production science, agriculture and biotechnology.
- 4.3.3. Students must have a positively sense in their self-learning.

5. Brief description of subject content:

This course includes 7 chapters. Students will study about cell physiology, water and plant cell, nutrient of plant, solute transport, photosynthesis, respiration. And plant growth and development. The field of plant physiology includes the study of all the internal activities of plants, those chemical and physical processes associated with life as they occur in plants. The students will study the molecular interactions of photosynthesis and internal diffusion of water, minerals, and nutrients. The students are also explained about the processes of plant development, seasonality, dormancy, and reproductive control.

6. Subject content structure:

| | Content | Hours | Objectives |
|-------------------|---|-------|-----------------|
| Chapter 1. | Plant cell physiology 1. Structure of plant cell 1.1. Components of plant cell 1.2. Cell wall 1.2.1. Protoplast 1.2.2. - Cell Membrane - Plasmodesm - Endoplasmic reticulum - Bô Golgi - Plastid - Cytoplasm - Ribosome - Mitochondrion - Leucoplast - Vacuole - Nuclear | 3 | 4.1.1, 4.2, 4.3 |
| Chapter 2. | Water and Plant 2. Water and plant cell 2.1. Characteristics of water 2.1.1. - Hydrogen bonds - Polar of water and good solvent - Adhesive characteristic of water - Strong tension of water Water transport 2.1.2. - Diffusion + Fick law + Diffusive velocity - Water movement in long distance - Osmotic pressure | 3 | 4.1.3, 4.2, 4.3 |

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| | <ul style="list-style-type: none"> - Chemical potential or water potential + Pressure + Gravity Water balance of plant 2.2. Soil water 2.2.1. - Water potential in soil - Water movement in soil as mass flow Water absorption by root 2.2.2. - Root pressure - Water conduction - The velocity of water moving - Boundary Layer Resistance - Stomata open and closure Water movement from soil-plant-air 2.2.3. Evapotranspiration 2.3. Evapotranspiration 2.3.1. - Solar radiation - Temperature - Relative humidity - Wind Factors affect Evapotranspiration 2.3.2. - Stomata open and closure - Stomata number and size - Leaf number - Leaf roll - Rapid growth and deep root development Water tress 2.3.3. | | |
| <p>Chapter 3</p> | <p>Mineral nutrient and nitrogen</p> <p>3. Introduction</p> <p>3.1. Chemical components of plant</p> <p>3.2. Mineral amount in plant</p> <p>3.2.1. Research method</p> <p>3.2.2. - Leaf analysis</p> <p>- Soil anlysis</p> <p>Physiological role of minerals</p> <p>3.3. Physiological role of macro elements</p> <p>3.3.1. - Nitrogen</p> <p>- Phosphorus</p> <p>- Potassium</p> <p>- Sulfur</p> <p>- Magnesium</p> <p>- Calcium</p> <p>Physiological role of micro elements</p> <p>3.3.2 - Iron</p> <p>- Chlorine</p> <p>- Manganese</p> <p>- Boron</p> | 4 | 4.1.3, 4.2, 4.3 |

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| | <ul style="list-style-type: none"> - Zinc - Copper - Molybdenum <p>Mineral absorption of plant</p> <p>3.4. Root role</p> <p>3.4.1. Fundamental of mineral absorption of plant</p> <p>3.4.2. Foliar mineral absorption</p> <p>3.4.3. Nitrogen assimilation of plant</p> <p>3.5. Nitrate reduction</p> <p>3.5.1. NH₄ assimilation</p> <p>3.5.2. Nitrogen fixation</p> <p>3.5.3.</p> | | |
| Chapter 4. | <p>Solute transport in plant</p> <p>Transport pathway</p> <p>4.1. Isotope experiments</p> <p>4.1.1. Phloem structure</p> <p>4.1.2. P- protein and Callose</p> <p>4.1.3. Source and Sink</p> <p>4.2. Transport mechanism</p> <p>4.3. Phloem transport</p> <p>4.4. - Transport from leaf to sieve elements - Transport from sieve elements to sink cell</p> <p>Assimilate allocation</p> <p>4.5. - Allocation - Assimilate portioning to using site</p> | 2 | 4.1.2, 4.2, 4.3 |
| Chapter 5. | <p>Photosynthesis</p> <p>Introduction - Brief summary of photosynthetic research history</p> <p>5.1. research history</p> <p>Photosynthetic organ</p> <p>5.2. leaf</p> <p>5.2.1. Chloroplast</p> <p>5.2.2. Photosynthetic pigments</p> <p>5.2.3. Photosynthetic process</p> <p>5.3. Emerson enhancement effect</p> <p>5.3.1. Components and functions of photosystem I and photosystem II in thylakoid</p> <p>5.3.2. - PS I (Photosystem I) - PS II (Photosystem II)</p> <p>Electron transport from H₂O to NADP⁺</p> <p>5.3.3. - Noncyclic electron transport - Phosphorylation - Cyclic electron transport</p> <p>Products of CO₂ fixation</p> <p>5.3.4. - First product - Substance bound CO₂ - Reaction of CO₂ fixation</p> <p>Calvin cycle</p> | 6 | 4.1.2, 4.2, 4.3 |

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| <p>5.3.5.</p> <p>5.3.6.</p> <p>5.3.7.</p> <p>5.3.8.</p> <p>5.3.9.</p> <p>5.4.</p> | <p>- Carborylation</p> <p>- Reduction</p> <p>- RuBP regeneration</p> <p>Photorespiration</p> <p>Photosynthetic pathway of C-4</p> <p>Systematic Comparison of C3 and C4 Plants</p> <p>CO₂ fixation of CAM plants</p> <p>Biosynthesis of sucrose and starch</p> | | |
| <p>Chapter 6.</p> <p>6.1.</p> <p>6.2.</p> <p>6.2.1.</p> <p>6.2.2.</p> <p>6.3.</p> <p>6.4.</p> <p>6.5.</p> <p>6.6.</p> <p>6.7.</p> <p>6.8.</p> <p>6.9.</p> | <p>Plant respiration</p> <p>Introduction</p> <p>Typical parameters of respiration</p> <p>Respiratory Quotient, RQ</p> <p>Respiratory rate</p> <p>Glycolysis and its function</p> <p>Fermentation</p> <p>Krebs cycle</p> <p>Electron transport system and phosphorylation oxydation</p> <p>Pentose phosphate pathway</p> <p>Production of molecular used in biosynthesis process</p> <p>Biocontrol of respiration</p> <p>- Energy charge</p> <p>- Regulation of glycolysis</p> <p>- Pentose phosphate pathway</p> | <p>6</p> | <p>4.1.2, 4.2, 4.3</p> |
| <p>Chapter 7.</p> <p>7.1.</p> <p>7.1.1.</p> <p>7.1.2.</p> <p>7.2.</p> <p>7.3.</p> <p>7.3.1.</p> | <p>Plant growth and development</p> <p>Introduction</p> <p>Manifestation of growth and development</p> <p>Life cycle</p> <p>- Annual plant</p> <p>- Perennial plant</p> <p>Cell growth and development</p> <p>Cell division</p> <p>Cell extension</p> <p>Cell differentiation</p> <p>Interior and exterior factors affect on plant growth</p> <p>development</p> <p>Interior factors</p> <p>- Nuclear acid and enzyme</p> <p>- Plant growth regulators</p> <p>* AUXIN</p> <p>- Auxin destroy</p> <p>- Synthetic auxin</p> <p>- Functions of auxin</p> <p>+ Cell extension</p> <p>+ Rooting</p> <p>- Apical dominance and lateral bud inhibition</p> <p>- Abscission</p> <p>- Auxin acting mechanism</p> | <p>6</p> | <p>4.1.2, 4.1.3, 4.2, 4.3</p> |

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| | <ul style="list-style-type: none"> * GIBBERELLIN - Functions of gibberellin - Gibberellin acting mechanism * CYTOKININ - Functions of cytokinin - Cytokinin acting mechanism * ABSCISIC ACID - Functions of cytokinin - Cytokinin acting mechanism * ETHYLENE C₂H₄ - Functions of cytokinin - Cytokinin acting mechanism | | |
| 7.3.2. | Exterior factors <ul style="list-style-type: none"> - Temperature - Flight - Oxygen and CO₂ - Humidity | | |
| 7.4. | Movement of plant | | |
| 7.4.1. | Phototropism | | |
| 7.4.2. | Gravitropism | | |
| 7.5. | Dormancy and germination of seed | | |
| 7.5.1. | Dormancy | | |
| 7.5.2. | Germination | | |
| 7.6. | Photoperiode and flowering physiology | | |
| 7.7. | Physiology of flowering, pollination, fruiting | | |
| 7.7.1. | Physiology of flower formation and development | | |
| 7.7.2. | Physiology of pollination, fertilization, seeding and fruiting formation | | |

7. Teaching method:

- Teaching theories in class
- Group and individual home assignments
- Discussion in class
- Tests/ quizzes
- Final examination

8. Duties of student:

Students have to do the following duties:

- Attending at least 80 % hours of the course
- Participating in group and individual assignments
- Taking the tests/ quizzes
- Proactively implementing self-study
- Taking the final examination

9. Assessment of student learning outcomes:

9.1. Assessment

| No. | Point components | Rules and Requirement | Weights | Objectives |
|-----|--------------------|---------------------------------|---------|--------------|
| 1 | Overall attendance | - Attend at least 80 % hours of | 5% | 4.3.2, 4.3.3 |

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| | | the total hours in the classes | | |
| 2 | Group/individual assignments/ Discussion in class | - Report of the group/individual - Discuss in group or in class | 10% | 4.1, 4.2, 4.3.3 |
| 3 | Tests/ quizzes | - Taking the quick tests/ quizzes | 15% | 4.1 |
| 4 | Final examination | - Taking the final examination (90 minutes) | 70% | 4.1 |

9.2. Grading

- Grading components and final test scores will be marked on a scale of 10 (0 to 10), rounded to one decimal place.
- Subject score is the sum of all the components of the evaluation multiplied by the corresponding weight. The subject score is marked on a scale of 10 and rounded to one decimal place then is converted to A-B-C-D-F score and score on a scale of 4 under the academic provisions of Cantho University.

10. Materials:

| Materials information | Code number |
|--|---|
| [1] Hand-out | Students are received hand-out in class |
| [2] Frank B Salisbury, Cleon W Ross. 1991. Plant physiology. Belmont, California: Wadsworth. | 581.1/ S167 |
| [3] Lincoln Taiz, Eduardo Zeiger. 1991. Plant physiology. California: The Benjamin - Cummings Publishing Company, Inc, | 581.1/ T129 |
| [4] Le Van Hoa, Nguyen Bao Toan. 2005. Hand book of plant physiology. Cantho University. (Vietnamese) | 571.2/ H401 |
| [5] William G Hopkins. 1995. Introduction to plant physiology. New York: John Wiley. | 581.1/ H796 |

11. Self-study Guide:

| Week | Content | Theory (hours) | Practice (hours) | Students' duties |
|------|---|----------------|------------------|--|
| 1 | Chapter 1. Plant cell physiology 1.1 Structure of plant cell 1.2 Components of plant cell 1.2.1 Cell wall 1.2.2 Protoplast - Cell Membrane - Plasmodesm - Endoplasmic reticulum | 2 | 0 | - Previous research and reference: +References/materials: Chapter 1, [1], [2], [3], [4], [5] - Review the contents of the modules studied in class |
| 2 | - Bộ Golgi - Plastid - Cytoplasm - Ribosome - Mitochondrion | 2 | 0 | Previous research and reference: +References/materials: Chapter 1, chapter 2, |

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| | <ul style="list-style-type: none"> - Leucoplast - Vacuole - Nuclear <p>Chapter 2. Water and Plant</p> <p>2.1 Water and plant cell</p> <p>2.1.1 Characteristics of water</p> <ul style="list-style-type: none"> - Hydrogen bonds - Polar of water and good solvent - Adhesive characteristic of water - Strong tension of water <p>2.1.2 Water transport</p> <ul style="list-style-type: none"> - Diffusion + Fick law + Diffusive velocity - Water movement in long distance - Osmotic pressure - Chemical potential or water potential + Pressure + Gravity | | | <ul style="list-style-type: none"> - Review the contents of the modules studied in class |
| 3 | <p>2.2 Water balance of plant</p> <p>2.2.1 Soil water</p> <ul style="list-style-type: none"> - Water potential in soil - Water movement in soil as mass flow <p>2.2.2 Water absorption by root</p> <ul style="list-style-type: none"> - Root pressure - Water conduction - The velocity of water moving - Boundary Layer Resistance - Stomata open and closure <p>2.2.3 Water movement from soil-plant-air</p> <p>2.3 Evapotranspiration</p> <p>2.3.1 Evapotranspiration</p> <ul style="list-style-type: none"> - Solar radiation - Temperature - Relative humidity - Wind <p>2.3.2 Factors affect Evapotranspiration</p> <ul style="list-style-type: none"> - Stomata open and closure - Stomata number and size - Leaf number - Leaf roll - Rapid growth and deep root development <p>2.3.3 Water tress</p> | 2 | 0 | <p>Previous research and reference:</p> <p>+References/material s: Chapter 2, [1], [2], [3], [4], [5]</p> <ul style="list-style-type: none"> - Review the contents of the modules studied in class - Make homework assignments |
| 4 | <p>Chapter 3. Mineral nutrient and nitrogen</p> <p>3.1 Introduction</p> | 2 | 0 | <p>Previous research and reference:</p> <p>+References/material</p> |

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| | <p>3.2 Chemical components of plant</p> <p>3.2.1 Mineral amount in plant</p> <p>3.2.2 Research method</p> <ul style="list-style-type: none"> - Leaf analysis - Soil analysis <p>3.3 Physiological role of minerals</p> <p>3.3.1 Physiological role of macro elements</p> <ul style="list-style-type: none"> - Nitrogen - Phosphorus - Potassium - Sulfur - Magnesium - Calcium | | | <p>s: Chapter 3, [1], [2], [3], [4], [5]</p> <ul style="list-style-type: none"> - Review the contents of the modules studied in class - Tests/ quizzes |
| 5 | <p>3.3.2 Physiological role of micro elements</p> <ul style="list-style-type: none"> - Iron - Chlorine - Manganese - Boron - Zinc - Copper - Molybdenum <p>3.4 Mineral absorption of plant</p> <p>3.4.1 Root role</p> <p>3.4.2 Fundamental of mineral absorption of plant</p> <p>3.4.3 Foliar mineral absorption</p> <p>3.5 Nitrogen assimilation of plant</p> <p>3.5.1 Nitrate reduction</p> <p>3.5.2 NH₄ assimilation</p> <p>3.5.3 Nitrogen fixation</p> | 2 | 0 | <p>Previous research and reference:</p> <p>+References/materials: Chapter 3, [1], [2], [3], [4], [5]</p> <ul style="list-style-type: none"> - Review the contents of the modules studied in class - Make homework assignments |
| 6 | <p>Chapter 4. Solute transport in plant</p> <p>4.1 Transport pathway</p> <p>4.1.1 Isotope experiments</p> <p>4.1.2 Phloem structure</p> <p>4.1.3 P- protein and Callose</p> <p>4.2 Source and Sink</p> <p>4.3 Transport mechanism</p> <p>4.4 Phloem transport</p> <ul style="list-style-type: none"> - Transport from leaf to sieve elements - Transport from sieve elements to sink cell <p>4.5 Assimilate allocation</p> <ul style="list-style-type: none"> - Allocation - Assimilate partitioning to using site | 2 | 0 | <p>Previous research and reference:</p> <p>+References/materials: Chapter 4, [1], [2], [3], [4], [5]</p> <ul style="list-style-type: none"> - Review the contents of the modules studied in class |
| 7 | <p>Chapter 5. Photosynthesis</p> <p>5.1 Introduction - Brief summary of photosynthetic research history</p> | 2 | 0 | <p>Previous research and reference:</p> <p>+References/materials: Chapter 5, [1], [2],</p> |

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| | <p>5.2 Photosynthetic organ</p> <p>5.2.1 leaf</p> <p>5.2.2 Chloroplast</p> <p>5.2.3 Photosynthetic pigments</p> <p>5.3 Photosynthetic process</p> <p>5.3.1 Emerson enhancement effect</p> <p>5.3.2 Components and functions of photosystem I and photosystem II in thylakoid</p> <ul style="list-style-type: none"> - PS I (Photosystem I) - PS II (Photosystem II) | | | <p>[3], [4], [5]</p> <ul style="list-style-type: none"> - Review the contents of the modules studied in class - Group exercise, discussion |
| 8 | <p>5.3.3 Electron transport from H₂O to NADP⁺</p> <ul style="list-style-type: none"> - Noncyclic electron transport - Phosphorylation - Cyclic electron transport <p>5.3.4 Products of CO₂ fixation</p> <ul style="list-style-type: none"> - First product - Substance bound CO₂ - Reaction of CO₂ fixation <p>5.3.5 Calvin cycle</p> <ul style="list-style-type: none"> - Carborylation - Reduction - RuBP regeneration | 2 | 0 | <p>Previous research and reference:</p> <p>+References/materials: Chapter 5, [1], [2], [3], [4], [5]</p> <ul style="list-style-type: none"> - Review the contents of the modules studied in class |
| 9 | <p>5.3.6 Photorespiration</p> <p>5.3.7 Photosynthetic pathway of C-4</p> <p>5.3.8 Systematic Comparison of C3 and C4 Plants</p> <p>5.3.9 CO₂ fixation of CAM plants</p> <p>5.4 Biosynthesis of sucrose and starch</p> | 2 | 0 | <p>Previous research and reference:</p> <p>+References/materials: Chapter 5, [1], [2], [3], [4], [5]</p> <ul style="list-style-type: none"> - Review the contents of the modules studied in class |
| 10 | <p>Chapter 6. Plant respiration</p> <p>6.1 Introduction</p> <p>6.2 Typical parameters of respiration</p> <p>6.2.1 Respiratory Quotient, RQ</p> <p>6.2.2 Respiratory rate</p> | 2 | 0 | <p>+References/materials: Chapter 6, [1], [2], [3], [4], [5]</p> <ul style="list-style-type: none"> - Review the contents of the modules studied in class - Group exercise, discussion |
| 11 | <p>6.3 Glycolysis and its function</p> <p>6.4 Fermentation</p> <p>6.5 Krebs cycle</p> <p>6.6 Electron transport system and phosphorylation oxydation</p> | 2 | 0 | <p>Previous research and reference:</p> <p>+References/materials: Chapter 6, [1], [2], [3], [4], [5]</p> <ul style="list-style-type: none"> - Review the contents of the modules studied in class |

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| | | | | - Tests/ quizzes |
| 12 | 6.7 Pentose phosphate pathway 6.8 Production of molecular used in biosynthesis process 6.9 Biocontrol of respiration - Energy charge - Regulation of glycolysis - Pentose phosphate pathway | 2 | 0 | Previous research and reference: +References/material s: Chapter 6, [1], [2], [3], [4], [5] - Review the contents of the modules studied in class |
| 13 | Chapter 7. Plant growth and development 7.1 Introduction 7.1.1 Manifestation of growth and development 7.1.2 Life cycle - Annual plant - Perennial plant 7.2 Cell growth and development Cell division Cell extension Cell differentiation | 3 | 0 | Previous research and reference: +References/material s: Chapter 7, [1], [2], [3], [4], [5] - Review the contents of the modules studied in class - Group exercise, discussion |
| 14 | 7.3 Interior and exterior factors affect on plant growth development 7.3.1 Interior factors - Nuclear acid and enzyme - Plant growth regulators * AUXIN - Auxin destroy - Synthetic auxin - Functions of auxin + Cell extension + Rooting - Apical dominance and lateral bud inhibition - Abscission - Auxin acting mechanism * GIBBERELLIN - Functions of gibberellin - Gibberellin acting mechanism * CYTOKININ - Functions of cytokinin - Cytokinin acting mechanism * ABSCISIC ACID - Functions of cytokinin - Cytokinin acting mechanism .* ETHYLENE C ₂ H ₄ - Functions of cytokinin - Cytokinin acting mechanism | 2 | 0 | Previous research and reference: +References/material s: Chapter 7, [1], [2], [3], [4], [5] - Review the contents of the modules studied in class - Tests/ quizzes |

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| | 7.3.2 Exterior factors - Temperature - Flight - Oxygen and CO ₂ - Humidity 7.4 Movement of plant 7.4.1 Phototropism 7.4.2 Gravitropism 7.5 Dormancy and germination of seed 7.5.1 Dormancy 7.5.2 Germination | | | |
| 15 | 7.6 Photoperiod and flowering physiology 7.7 Physiology of flowering, pollination, fruiting 7.7.1 Physiology of flower formation and development 7.7.2 Physiology of pollination, fertilization, seeding and fruiting formation | 2 | 0 | Previous research and reference: +References/materials: Chapter 7, [1], [2], [3], [4], [5] - Submitted exercise group - Review the entire, final exam preparation |

**ON BEHALF OF RECTOR
DEAN/ DIRECTOR**

Can Tho,/...../20...
HEAD OF DEPARTMENT