YOUR MENTOR GURU

CSIR NET Life Sciences & Biotechnology — Unit 6

System Physiology – Plant

Study & revision companion | Topic explanations, core facts, and active-recall questions

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How to use this guide

Read each topic, explain the key mechanism in your own words, then answer the self-check prompts without looking at the notes. Use your detailed textbook or class notes for full derivations and additional examples.

Topic overview

1. 1. Water Relations and Mineral Nutrition
2. 2. Photosynthesis: Light Reactions
3. 3. Carbon Fixation and Photorespiration
4. 4. Plant Respiration and Assimilation
5. 5. Plant Hormones and Signaling
6. 6. Photomorphogenesis and Circadian Responses
7. 7. Stress, Transport and Reproduction

1. Water Relations and Mineral Nutrition

Water potential $\Psi w = \Psi s + \Psi p$ in a simplified plant-cell treatment; water moves from higher to lower water potential.

Xylem water transport is driven largely by transpiration-induced tension and cohesion of water columns.

Mineral deficiencies depend on element mobility: mobile nutrient deficits often appear first in older leaves.

Mycorrhizae can improve phosphorus acquisition; nitrogen fixation converts N_2 to biologically usable ammonia.

PSII oxidizes water and releases oxygen; electron transfer creates a proton gradient, and PSI supports NADPH formation.

When solving a question, distinguish the underlying mechanism from its observable outcome. Compare the normal situation with the altered condition, and check whether the evidence supports a direct effect or only an association. The central distinction to retain is: oxygen evolved in photosynthesis comes from water.

Self-check: Explain the mechanism or relationship above; identify one common misconception; predict the effect of changing a key variable.

2. Photosynthesis: Light Reactions

PSII oxidizes water and releases O_2; electrons pass through plastoquinone, cytochrome b_6f and plastocyanin toward PSI.

PSI supports ferredoxin reduction and NADPH formation through ferredoxin–$NADP^+$ reductase.

Thylakoid proton gradients drive chloroplast ATP synthase.

Cyclic electron flow around PSI generates additional proton motive force without net NADPH production.

C3 plants fix CO_2 through Rubisco; C4 and CAM systems concentrate CO_2 using spatial or temporal separation.

When solving a question, distinguish the underlying mechanism from its observable outcome. Compare the normal situation with the altered condition, and check whether the evidence supports a direct effect or only an association. The central distinction to retain is: c4 separates fixation spatially; CAM commonly separates it by time.

Self-check: Explain the mechanism or relationship above; identify one common misconception; predict the effect of changing a key variable.

3. Carbon Fixation and Photorespiration

Rubisco carboxylates RuBP in the Calvin cycle but also catalyzes oxygenation that initiates photorespiration.

Three CO_2 molecules yield one net triose phosphate in Calvin-cycle carbon accounting, consuming nine ATP and six NADPH.

C_4 plants initially fix CO_2 with PEP carboxylase and concentrate CO_2 near Rubisco.

CAM plants separate initial CO_2 fixation and Calvin-cycle use mainly in time.

Rubisco oxygenation initiates photorespiration across chloroplasts, peroxisomes and mitochondria.

When solving a question, distinguish the underlying mechanism from its observable outcome. Compare the normal situation with the altered condition, and check whether the evidence supports a direct effect or only an association. The central distinction to retain is: photorespiration tends to increase when CO_2 relative to O_2 falls.

Self-check: Explain the mechanism or relationship above; identify one common misconception; predict the effect of changing a key variable.

4. Plant Respiration and Assimilation

Glycolysis, TCA cycle and mitochondrial electron transport supply ATP and metabolic intermediates.

Nitrate reductase converts nitrate to nitrite; nitrite reductase produces ammonium for assimilation.

GS–GOGAT incorporates ammonium into glutamine and glutamate.

Sucrose is a major long-distance transported carbohydrate in many plants.

Nitrate and nitrite reduction provide ammonium for amino-acid synthesis; GS–GOGAT assimilates nitrogen.

When solving a question, distinguish the underlying mechanism from its observable outcome. Compare the normal situation with the altered condition, and check whether the evidence supports a direct effect or only an association. The central distinction to retain is: nitrogenase fixes N_2 and is oxygen-sensitive.

Self-check: Explain the mechanism or relationship above; identify one common misconception; predict the effect of changing a key variable.

5. Plant Hormones and Signaling

Auxin regulates cell elongation, tropisms and development through TIR1/AFB-mediated degradation of Aux/IAA repressors.

Cytokinins promote cell division and shoot-related developmental programs in many contexts.

Gibberellins promote growth by stimulating DELLA repressor degradation.

ABA is central to drought responses and stomatal closure; ethylene contributes to ripening and stress responses.

Auxin, cytokinin, gibberellin, ABA and ethylene regulate development and stress responses.

When solving a question, distinguish the underlying mechanism from its observable outcome. Compare the normal situation with the altered condition, and check whether the evidence supports a direct effect or only an association. The central distinction to retain is: hormone responses depend on tissue, concentration and context.

Self-check: Explain the mechanism or relationship above; identify one common misconception; predict the effect of changing a key variable.

6. Photomorphogenesis and Circadian Responses

Phytochromes sense red/far-red light and interconvert between photochemical states.

Cryptochromes and phototropins perceive blue light and regulate distinct responses.

Photoperiodic flowering integrates circadian timing with day length; FT acts as a mobile flowering signal in many species.

The circadian clock coordinates rhythmic physiology even under constant environmental conditions.

Phytochromes sense red/far-red light; cryptochromes and phototropins respond to blue light.

When solving a question, distinguish the underlying mechanism from its observable outcome. Compare the normal situation with the altered condition, and check whether the evidence supports a direct effect or only an association. The central distinction to retain is: photoperiodism depends on light signaling and circadian timing.

Self-check: Explain the mechanism or relationship above; identify one common misconception; predict the effect of changing a key variable.

7. Stress, Transport and Reproduction

Phloem translocation is often explained by pressure-flow driven by source loading and sink unloading.

Drought induces ABA-related signaling and osmotic adjustment; salt stress imposes osmotic and ionic challenges.

Double fertilization in angiosperms forms a zygote and typically a triploid endosperm.

Self-incompatibility systems prevent self-fertilization through genetically controlled recognition.

Water-potential gradients drive water movement; xylem transports water and phloem moves photoassimilates.

When solving a question, distinguish the underlying mechanism from its observable outcome. Compare the normal situation with the altered condition, and check whether the evidence supports a direct effect or only an association. The central distinction to retain is: phloem pressure flow links source and sink tissues.

Self-check: Explain the mechanism or relationship above; identify one common misconception; predict the effect of changing a key variable.

Active-recall practice

1. Explain the essential principles of 1. Water Relations and Mineral Nutrition and give one experimental or real-world application.

2. Explain the essential principles of 2. Photosynthesis: Light Reactions and give one experimental or real-world application.

3. Explain the essential principles of 3. Carbon Fixation and Photorespiration and give one experimental or real-world application.

4. Explain the essential principles of 4. Plant Respiration and Assimilation and give one experimental or real-world application.

5. Explain the essential principles of 5. Plant Hormones and Signaling and give one experimental or real-world application.

6. Explain the essential principles of 6. Photomorphogenesis and Circadian Responses and give one experimental or real-world application.

7. Explain the essential principles of 7. Stress, Transport and Reproduction and give one experimental or real-world application.

Final revision checklist

- 1. Water Relations and Mineral Nutrition
- 2. Photosynthesis: Light Reactions
- 3. Carbon Fixation and Photorespiration
- 4. Plant Respiration and Assimilation
- 5. Plant Hormones and Signaling
- 6. Photomorphogenesis and Circadian Responses
- 7. Stress, Transport and Reproduction

Further study

Use the corresponding unit notes, topic-wise detailed lessons, MCQs, practice tests and full-length mock tests on yourmentorguru.com. This compact PDF is a revision companion, not a replacement for full syllabus textbooks.