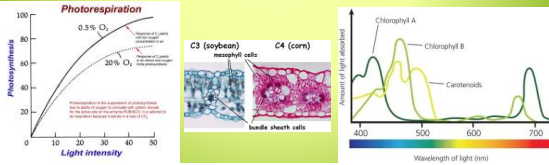


3.7 Fitness



ENDURING UNDERSTANDING

SYI-3 Naturally occurring diversity among and between components within biological systems affects interactions with the environment.

Earth → Ecosystem → Organ → Tissue → Cell → Biomolecules → Atoms → Particles → Molecules → Stems

BIOLOGICAL SYSTEMS

SYI-3.A Explain the connection between variation in the number and types of molecules within cells to the ability of the organism to survive and/or reproduce in different environments.

□ Variation at the molecular level provides organisms with the ability to respond to a variety of environmental stimuli.

- Different types of phospholipids in cell membranes allow the organism flexibility to adapt to different environmental temperatures.

Extracellular Space, Lumen of Cell, Phospholipid (hydrophilic head, hydrophobic tail).

Saturated fatty acid: CCCCCCCCCCCCCCCC

Unsaturated fatty acid: CCCC=CCCCCCCC

Trans fatty acid: CCCC=CCCC

SYI-3.A Explain the connection between variation in the number and types of molecules within cells to the ability of the organism to survive and/or reproduce in different environments.

□ Different types of hemoglobin maximize oxygen absorption in organisms at different developmental stages.

Gestational Age (weeks): 4, 8, 12, 16, 20, 24, 28, 32, 36, 40, 44, 48. Birth.

% of fetal hemoglobin: 0, 20, 40, 60, 80, 100.

Phases: Embryonic Hemoglobin, Fetal Hemoglobin, Adult Hemoglobin.

Genes: HBB, HBD, HBE1, HBE2, HBG1, HBG2, HBG3, HBG4, HBA1, HBA2, HBA3.

Regulators: BCL11A, HNF1.

SYI-3.A Explain the connection between variation in the number and types of molecules within cells to the ability of the organism to survive and/or reproduce in different environments.

□ Variation in the number and types of molecules within cells provides organisms a greater ability to survive and/or reproduce in different environments

- Different chlorophylls give the plant greater flexibility to exploit/absorb incoming wavelengths of light for photosynthesis.

Chlorophyll a, Chlorophyll b.

Amount of light absorbed vs Wavelength of light (nm). Chlorophyll A peaks at ~430 nm and ~660 nm. Chlorophyll B peaks at ~450 nm and ~640 nm. Carotenoids peak at ~450 nm.

SYI-3.A Explain the connection between variation in the number and types of molecules within cells to the ability of the organism to survive and/or reproduce in different environments.

- In hot weather, stomates close to save water; CO₂ concentration decreases in leaves; O₂ increases.
- In C₃ plants, O₂ competes with CO₂ for the active site of rubisco.
- Called "photorespiration" since oxygen is taken up and CO₂ is produced.
- No sugar or ATP is produced.
- Relic of evolution when O₂ was in short supply.

Micrograph of a plant cell showing chloroplasts.

Photorespiration vs Light Intensity

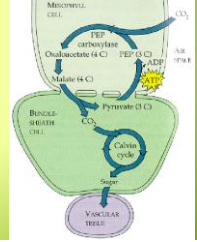
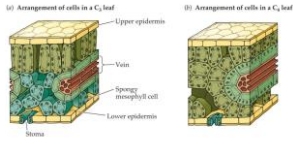
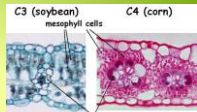
0.5% CO₂ and 20% CO₂ curves are shown. Photorespiration increases significantly at low CO₂ concentrations.

Photorespiration Pathway

- 3-phosphoglycerate + O₂ → 3-phosphoglycerate + 2-phosphoglycolate
- 2-phosphoglycolate → glycolate
- glycolate → glyoxylate
- glyoxylate + PEP → serine + PEP
- serine → glycine
- glycine + O₂ → 2-aminoethylglyoxylate + CO₂
- 2-aminoethylglyoxylate → glycylglyoxylate
- glycylglyoxylate + PEP → oxaloacetate + PEP
- oxaloacetate → malate
- malate → pyruvate
- pyruvate → PEP

C₄ Plants

- Sugarcane, Corn, Grasses
- Fix CO₂ by first forming a C₄ molecule
- Shuttle C₄ into Bundle sheath cells
- CO₂ is released and used in Calvin Cycle.
- In hot, dry climates, net photosynthetic rate of C₄ plants (e.g., corn) is 2-3 times that of C₃ plants.



CAM (crassulacean-acid metabolism) Plants

- Succulent desert plants, cacti, pineapple
- CAM plants open stomates only at night
- Store CO₂ as a C₄ molecule
- Released during the day in Calvin Cycle

