TOPIC SIX

Required reading: Chapter 20; pages 408-413, 422-423; Chapter 38; 829-834 (see also exercises for additional required reading).

Basic principle:

A genetically modified organism is one that has incorporated an engineered sequence into its genome, with the goal of improving or adding a novel trait.

Learning outcomes:

1) Explain the major technological advances that have been gained via contemporary sequencing technologies.
2) Compare and contrast the two processes used for genetically modifying plants.
3) Apply knowledge of genomics and GMOs to formulate informed opinions on the advantages and/or disadvantages of GMOs for society.
4) Analyze results from BLAST searches.

Key concepts:

1) Contemporary sequencing technologies rely on new chemistries to massively increase throughput while decreasing associated cost and time.
2) Agrobacterium tumefaciens is a bacterial pathogen of plants that relies on the unusual process of trans-kingdom gene transfer to genetically modify its hosts and cause disease.
3) In order to genetically engineer plants, researchers use strains of A. tumefaciens engineered to maintain the ability to infect but attenuated in their ability to cause disease.
4) Researchers can also use a particle gun to bombard DNA into plant cells.
5) BLAST is an informatic tool commonly used to infer gene function and/or origin.

Vocabulary Words

1) Agrobacterium tumefaciens

Causes Crown Gall Disease. Weird bubbly lumpy things on trees.

2) Arabidopsis thaliana

Small flowering plant. Used as a model organism for research.

3) Artificial selection

Selective breeding for specific genes.

4) Bacillus thuringiensis

GM crops contain this bacteria that encodes the protein BT Toxin, which is toxic to insect pests (alkaline guts).

5) BLAST

An algorithm for comparing primary biological sequence information, such as the amino-acid sequences of different proteins or the nucleotides of DNA sequences.

6) Gene Gun

The **gene gun** is a good example of a creative idea being developed into a practical technology. Microscopic gold particles are used as 'bullets' to deliver DNA into callus cells. The gold particles are coated with hundreds of copies of the **gene** of interest.

7) Genetic Engineering

The direct manipulation of genes for practical uses.

8) Genome

A **genome** is an organism's complete set of DNA, including all of its genes. Each **genome** contains all of the information needed to build and maintain that organism.

9) Golden Rice

GM rice that contains vitamin A. Combatting blindness in Chinese children.

10) Model Organism

A **model organism** is a non-human species that is extensively studied to understand particular biological phenomena, with the expectation that discoveries made in the **organism model** will provide insight into the workings of other **organisms**. Arabidopsis thaliana is a model organism.

11) Dr. Norman Borlaug

Father of the Green Revolution. Developed semi-dwarf, high-yield, disease-resistant wheat varieties. Often credited with saving over a billion people worldwide from starvation.

12) Rainbow Papaya

Most all papayas are genetically modified.

13) Rice

14) Seedless watermelon

15) Transgene

A **transgene** is a gene or genetic material that has been transferred naturally, or by any of a number of genetic engineering techniques from one organism to another. The introduction of a **transgene** has the potential to change the phenotype of an organism.

16) Transgenic

Organisms that have been engineered to express a trait from another organism.

Exercises:

1. Read article on Norman Borlaug (available on Blackboard).
2. Visit http://www.genome.gov/25019879 (also linked via Blackboard). Read, "How to sequence a genome" (introduction, assembling the results, and working draft sequence) and "bioinformatics".
3. Do the BLAST search homework (instructions are provided as text and as a video and are available on Blackboard).

TOPIC SEVEN

Required reading: Chapter 10; pages 185-209.

Basic principle:

Photosynthesis is a two-staged process that converts light energy into chemical energy. This process is fundamental to life on this planet because the primary producers fix the carbon from CO_2 into organic molecules and generate oxygen as a waste product.

Learning outcomes:

1) Explain the properties of light and the absorption of light by pigments.
2) Describe the structures and functions for each of the components that participate in the light reaction.
3) Describe how each of the processes in the light reaction are related and how they function together to convert light energy into ATP and NADPH.
4) Identify the key enzyme, molecules, inputs, and outputs of the Calvin cycle.
5) Associate the key enzyme, molecules, inputs and outputs to each of the three phases of the Calvin cycle and the light reaction.
6) Explain how the three phases of the Calvin cycle are related and function in the synthesis of a molecule with high potential energy.
7) Describe the two enzymatic functions of Rubisco.
8) Compare and contrast the outcomes for the two enzymatic functions of Rubisco and differentiate between C3, C4, and CAM plants.

Key concepts:

1) Light is energy.
2) Photosystem II harvests light energy to power proton pumps and generate a gradient for the synthesis of ATP.
3) In noncyclic electron flow, Photosystem I harvests light energy to reduce NADP+ to generate NADPH.
4) H_2O is split and the electron are used to reduce "special" chlorophyll a in PSII and the oxygen is released as a waste product of photosynthesis.
5) The Calvin cycle fixes CO_2 to ribulose bisphosphate (RuBP), a five-carbon molecule.
6) The Calvin cycle uses ATP and NADPH, generated in the light reaction, to generate glyceraldehyde-3-phosphate (G3P), the starting material for other sugars that contribute to

sustaining life on the planet.
7) Rubisco is the key enzyme that fixes CO2 to RuBP.
8) Rubisco can also catalyze the addition of O2 to RuBP and an energetically and carboncosting process must follow in order to regenerate RuBP.
9) C4 and CAM plants have evolved alternative strategies to limit the effect of O2 on photosynthesis.

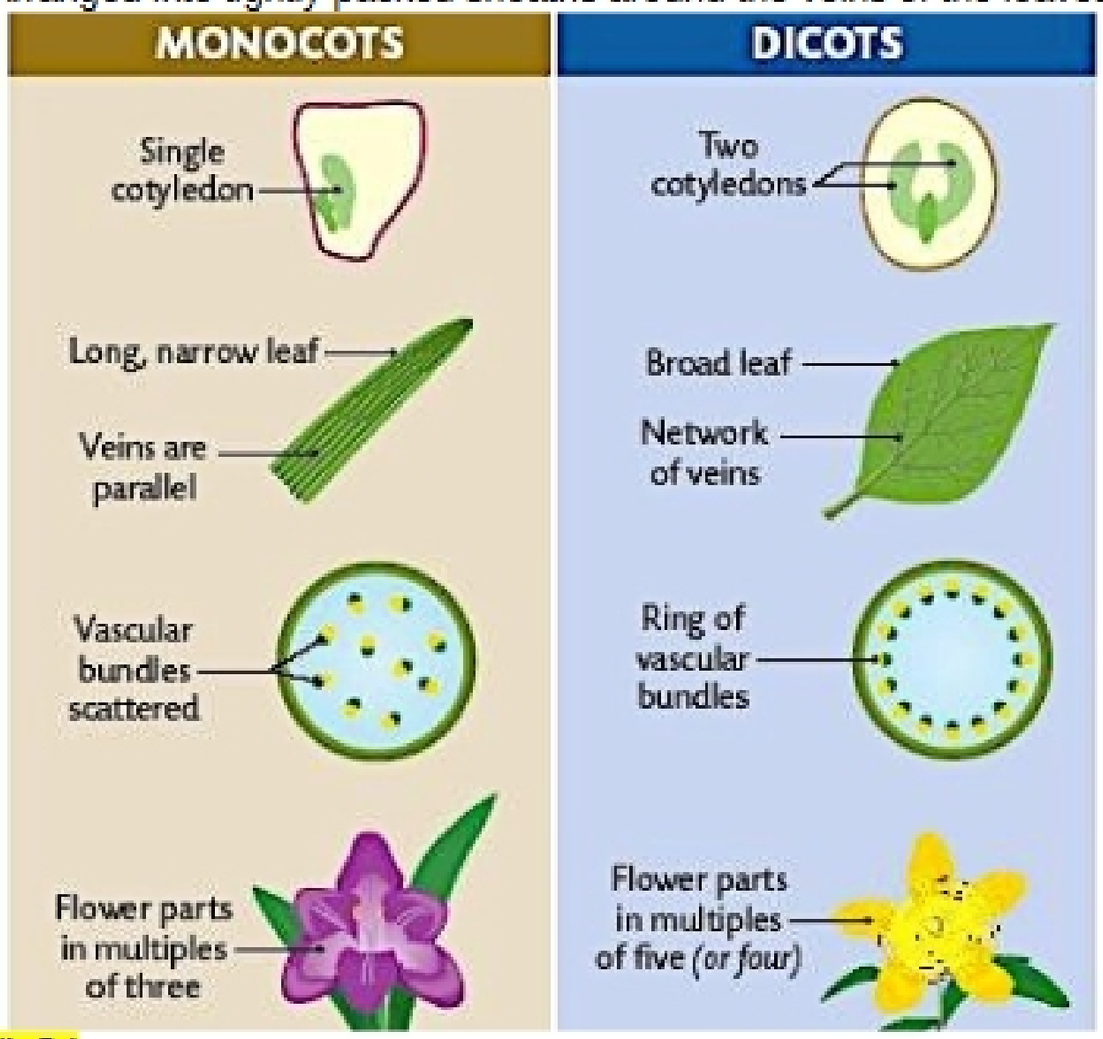
Vocabulary Words

1) ATP

2) ATP Synthase

3) Bundle Sheath Cells

Arranged into tightly packed sheaths around the veins of the leaves.



4) C4

They begin the Calvin Cycle with a different mode of carbon fixation-form 4 carbon compound as first product. Contains 2 types of photosynthetic cells: bundle-sheath cells and mesophyll cells.

5) Calvin Cycle

CO2 from air incorporated into organic molecules already present in chloroplasts (carbon fixation)-C made into carbohydrates by adding Es. Makes sugars with power from ATP and NAPH from Light Cycle.
1) Carbon Fixation 2) Reduction 3) Regeneration of CO2 Acceptor.
Occurs in the Stroma of the Chloroplast.

6) CAM

Their mesophyll cells store organic acids they make at night to in their vacuole once the stomata closes. During the day, when ATP and NADPH can made, CO2 will be released and incorporated into sugar in the chloroplasts.

7) Carotenoid

Accessory pigments. They reflect yellow and orange and absorb violet and blue-green light. They function in photoprotection: They absorb/disperse extra light that might damage chlorophyll or interact with oxygen-they function as antioxidants.

8) Chlorophyll (& special ones)

Chlorophyll A (blue green) and Chlorophyll B (olive green). The Special Pairs are in PSI and PSII. They are special because they can transfer electrons. The electrons in PSI are from PC and the electrons in PSII are from water being split.

9) Chloroplast