EK1C2b: New species arise from reproductive isolation over time, which can involve scales of hundreds of thousands or even millions of years, or speciation can occur rapidly through mechanisms such as polyploidy in plants.

EK2A1d: Organisms use free energy to maintain organization, grow and reproduce.
  1. Organisms use various strategies to regulate body temperature and metabolism.
     ○ Example: Elevated floral temperatures in some plant species

EK2A1d2: Reproduction and rearing of offspring require free energy beyond that used for maintenance and growth. Different organisms use various reproductive strategies in response to energy availability.
  ● Examples:
    ○ Seasonal reproduction in animals and plants
    ○ Life-history strategy (biennial plants, reproductive diapause)

EK2B1c: Cell walls provide a structural boundary, as well as a permeability barrier for some substances to the internal environments.
  1. Plant cell walls are made of cellulose and are external to the cell membrane.

EK2C1a: Negative feedback mechanisms maintain dynamic homeostasis for a particular condition (variable) by regulating physiological processes, returning the changing condition back to its target set point.
  ● Example: Plant responses to water limitations

EK2C1b: Positive feedback mechanisms amplify responses and responses and processes in biological organisms. The variable initiating the response is moved farther away from the initial set-point. Amplification occurs when the stimulus is further activated which, in turn, initiates an additional response that produces system change.
  ● Example: Ripening of fruit

EK2C2a: Organisms respond to changes in their environment through behavioral and physiological mechanisms.
  ● Example: Photoperiodism and phototropism in plants

EK2D2b: Organisms have various mechanisms for obtaining nutrients and eliminating wastes.
  ● Example: Gas exchange in aquatic and terrestrial plants

EK2D2c: Homeostatic control systems in species of microbes, plants and animals support common ancestry.
  ● Example: Osmoregulation in aquatic and terrestrial plants

EK2D4a. Plants, invertebrates and vertebrates have multiple, nonspecific immune responses.
  ● Example: Plant defenses against pathogens include molecular recognition systems with systemic responses; infection triggers chemical responses that destroy infected and adjacent cells, thus localizing the effects
Induction of transcription factors during development results in sequential gene expression.

1. Temperature and availability of water determine seed germination in most plants.

Programmed cell death (apoptosis) plays a role in the normal development and differentiation.

- Example: Flower development

In plants, physiological events involve interactions between environmental stimuli and internal molecular signals.

1. Phototropism, or the response to the presence of light.
2. Photoperiodism, or the response to change in length of the night, that results in flowering in long-day and short-day plants

Responses to information and communication of information are vital to natural selection.

1. In phototropism in plants, change in the light source lead to differential growth, resulting in maximum exposure of leaves to light for photosynthesis.
2. In photoperiodism in plants, changes in the length of night regulate flowering and preparation for winter.
3. Cooperative behavior within or between populations contributes to the survival of the populations.
   - Biology of pollination

Some traits result from nonnuclear inheritance.

1. Chloroplasts and mitochondria are randomly assorted to gametes and daughter cells; thus traits determined by chloroplast and mitochondrial DNA do not follow simple Mendelian rules.

Signal transmission within and between cells mediates gene expression.

- Examples:
  - Ethylene levels cause changes in the production of different enzymes, allowing fruits to ripen
  - Seed germination and gibberellin

Cells communicate by cell-to-cell contact.

- Example: Plasmodesmata between plant cells that allow material to be transported from cell to cell.

Cells communicate over short distances by using local regulators that target cells in the vicinity of the emitting cell.

- Example: Plant immune response

Organisms exchange information with each other in response to internal changes and external cues, which can change behavior.

- Example: Plant-plant interactions due to herbivory

A vacuole is a membrane-bound sac that plays roles in intracellular digestion and the release of cellular waste products. In plants, a large vacuole serves many functions, from storage of pigments or poisonous substances to a role in cell growth. In addition, a large central vacuole allows for a large surface to area volume ratio.
EK4A2g: Chloroplasts are specialized organelles found in algae and higher plants that capture sunlight energy through photosynthesis.

1. The structure and function relationship in the chloroplast allows cells to capture the energy available in sunlight and convert it to chemical bond energy via photosynthesis.
2. Chloroplasts contain chlorophylls, which are responsible for the green color of a plant and are the key light-trapping molecules in photosynthesis. There are several types of chlorophyll, but the predominant form in plants is chlorophyll a.
3. Chloroplasts have a double outer membrane that creates compartmentalized structure, which supports its function. Within the chloroplasts are membrane-bound structures called thylakoids. Energy-capturing reactions housed in the thylakoids are organized in stacks, called “grana”, to produce ATP and NADPH, which fuel carbon-fixing reactions in the Calvin-Benson cycle. Carbon fixation occurs in the stroma, where molecules of CO₂ are converted to carbohydrates.

EK4A4b: Interactions between systems provide essential biological activities.
   ● Example: Plant vascular and leaf

EK4B3c: Species-specific and environmental catastrophes, geologic events, the sudden influx/depletion of abiotic resources or increased human activities affect species distribution and abundance.
   ● Examples: Kudzu, Dutch elm disease

EK4B4a: Human impact accelerates change at local and global levels.
1. Introduction of new diseases can devastate native species.
   a. Examples: Dutch elm disease, Potato blight

EK4C1a: Variations within molecular classes provide cells and organisms with a wider range of functions.
   ● Example: Chlorophylls

EK4C2a: Environmental factors influence many traits both directly and indirectly.
   ● Examples:
     ○ Flower color based on soil pH
     ○ Density of plant hairs as a function of herbivory

EK4C2b: An organism’s adaptation to the local environment reflects a flexible response of its genome.
   ● Example: Alterations in timing of flowering due to climate changes

EK4C3a: Population ability to respond to changes in the environment is affected by genetic diversity. Species and populations with little genetic diversity are at risk for extinction.
   ● Examples:
     ○ Potato blight causing the potato famine
     ○ Corn rust effects on agricultural crops