Biology EOC Review
Florida 2015

Molecular and Cellular Biology: 20 Points
Classification, Heredity, and Evolution: 14 Points
Organisms, Populations, and Ecosystems: 22 Points

Duration of test: 160 minutes
Content Focus

Cognitive Complexity

- Question content
  - stem content

- Each question represents an historical possible point
  - Each stem represents an historical question topic

- Caution: This is historical content from 2012 – 2014
  - Based on 4 tests from each year (total: 12 tests)

Sample Questions from FL DOE (Courtesy: Escambia County)
Cognitive Complexity

- **Level 1 (Recall)** is the recall of information such as a fact, definition, or term, as well as performing a simple science process or procedure. Level 1 only requires students to demonstrate a rote response, use a well-known formula, follow a set well-defined procedure (like a recipe), or perform a clearly defined series of steps. Standards that lend themselves to simple word problems that can be directly translated into and solved by a formula are considered Level 1.
Cognitive Complexity

• Level 1 (Recall)

Some examples that represent but do not constitute all of Level 1 performance are:
• Recall or recognize a fact, term, or property.
• Represent in words or diagrams a scientific concept or relationship.
• Provide or recognize a standard scientific representation for simple phenomena.
• Perform a routine procedure such as measuring length.
• Identify familiar forces (e.g. pushes, pulls, gravitation, friction, etc.)
• Identify objects and materials as solids, liquids, or gases.
Cognitive Complexity

- **Level 2 (Basic Application of Concepts & Skills)** includes the engagement of some mental processing beyond recalling or reproducing a response. The content knowledge or process involved is more complex than in Level 1. Level 2 requires that students make some decisions as to how to approach the question or problem. Level 2 activities include making observations and collecting data; classifying, organizing, and comparing data; representing and displaying data in tables, graphs, and charts.

Some action verbs, such as “explain,” “describe,” or “interpret,” may be classified at different DOK levels, depending on the complexity of the action. For example, interpreting information from a simple graph, requiring reading information from the graph, is at Level 2. An activity that requires interpretation from a complex graph, such as making decisions regarding features of the graph that should be considered and how information from the graph can be aggregated, is at Level 3.
Cognitive Complexity

• Level 2 (Basic Application of Concepts & Skills)

Some examples that represent, but do not constitute all of Level 2 performance, are:
• Specify and explain the relationship among facts, terms, properties, and variables.
• Identify variables, including controls, in simple experiments.
• Distinguish between experiments and systematic observations.
• Describe and explain examples and non-examples of science concepts.
• Select a procedure according to specified criteria and perform it.
• Formulate a routine problem given data and conditions.
• Organize, represent, and interpret data.
Cognitive Complexity

- **Level 3 (Strategic Thinking & Complex Reasoning)** requires reasoning, planning, using evidence, and a higher level of thinking than the previous two levels. The cognitive demands at Level 3 are complex and abstract. The complexity does not result only from the fact that there could be multiple answers, a possibility for both Levels 1 and 2, but because the multi-step task requires more demanding reasoning. In most instances, requiring students to explain their thinking is at Level 3; requiring a very simple explanation or a word or two should be at Level 2. An activity that has more than one possible answer and requires students to justify the response they give would most likely be a Level 3. Experimental designs in Level 3 typically involve more than one dependent variable. Other Level 3 activities include drawing conclusions from observations; citing evidence and developing a logical argument for concepts; explaining phenomena in terms of concepts; and using concepts to solve non-routine problems.
Cognitive Complexity

- Level 3 (Strategic Thinking & Complex Reasoning)

Some examples that represent, but do not constitute all of Level 3 performance, are:
- Identify research questions and design investigations for a scientific problem.
- Design and execute an experiment or systematic observation to test a hypothesis or research question.
- Develop a scientific model for a complex situation.
- Form conclusions from experimental data.
- Cite evidence that living systems follow the Laws of Conservation of Mass and Energy.
- Explain how political, social, and economic concerns can affect science, and vice versa.
- Create a conceptual or mathematical model to explain the key elements of a scientific theory or concept.
- Explain the physical properties of the Sun and its dynamic nature and connect them to conditions and events on Earth.
- Analyze past, present, and potential future consequences to the environment resulting from various energy production technologies.
Cognitive Complexity

- **Level 4 (Extended Thinking & Complex Reasoning)** standards and assessment items have the same high cognitive demands as Level 3 with the additional requirement that students work over an extended period of time or with extended effort. Students are required to make several connections—relating ideas within the content area or among content areas—and have to select or devise one approach among many alternatives for how the situation or problem can be solved. Standards, goals, and objectives can be stated in such a way as to expect students to perform extended thinking. Many, but not all, performance assessments and open-ended assessment activities requiring significant thought will be level 4.
Cognitive Complexity

- **Level 4 (Extended Thinking & Complex Reasoning)** Level 4 requires complex reasoning, and an extended period of time either for a science investigation relevant to a standard, or for carrying out the complex analysis and synthesis required of an assessment item. For example, a standard or performance task that calls for the student to use evidence from multiple fields of scientific inquiry in supporting a scientific claim might represent a level 4, depending upon the complexity of the analysis. In any event, an activity or performance task associated with a level 4 standard will require an extended period of time for a student to accomplish. It is important to reiterate that the extended time period is not a distinguishing factor if the required work is only repetitive and does not require the application of significant conceptual understanding and higher-order thinking. For example, an activity that calls upon a student to measure the water temperature from a river each day for a month before constructing a graph would be classified as a level 2. On the other hand, an activity that calls upon a student to conduct a complex river study that requires taking into consideration a number of variables would be a level 4.
Cognitive Complexity

• Level 4 (Extended Thinking & Complex Reasoning)

Some examples that represent but do not constitute all of a Level 4 performance are:

• Based on provided data from a complex experiment that is novel to the student, deduce the fundamental relationships among several variables.
• Conduct an investigation, from specifying a problem to designing and carrying out an experiment, to analyzing its data and forming conclusions.
• Explain how a particular scientific theory (e.g., evolution, plate tectonics, atomic theory, etc.) is supported by evidence from multiple lines of inquiry.
• Produce a detailed report of a scientific experiment or systematic observation and infer conclusions based upon evidence obtained.
• Write a detailed history of the development of an important scientific concept (e.g., atomic theory, gravitation) and explain how current conceptions developed from prior ones.
Molecular and Cellular

Cell Theory 1-2 points SC.912.L.14.1

Level 2: Basic Application of Skills & Concepts

- Advances in Science
- Evaluating scientific claims
- Identifying what is science

Practice: Escambia County: L.14.1
Describe the scientific theory of cells (cell theory)

- *Describe and/or explain the cell theory.*
  - All life forms are made from one or more cells.
  - Cells only arise from pre-existing cells.
  - The cell is the smallest form of life.

*Identify what is science, what is not science, and what resembles but fails to meet the criteria for science.*
Describe the scientific theory of cells (cell theory)

- Recognize the differences between theories and laws.
- A theory is a well-supported, widely accepted, and powerful explanation for a broad set of observations.
- A theory can NEVER become a law
  - A law is a statement about an observation in nature.
Relate the history of cell theory to the process of science.

• The wacky history of cell theory (TED-ed)
• Describe how continuous investigations and/or new scientific information influenced the development of the cell theory.
  - Major events in cell theory (The Biology Project)
Relate the history of cell theory to the process of science.

- **Identify ways in which a scientific claim is evaluated (e.g., through scientific argumentation, critical and logical thinking, and consideration of alternative explanations).**

  - Three major functions of a scientific theory:
    - It allows us to meaningfully organize observations.
    - It allows us to accurately predict future observations.
    - It allows us to explain all observations in terms of causes.

  - In order for a theory to fulfill these three functions, it must be supported by a large amount of evidence that rules out other competing theories.

  - This requires that the theory has been exhaustively tested by:
    - making predictions about what should be observed if the theory is true;
    - making the observations needed to determine if these predictions come true.
Relate the history of cell theory to the process of science.

• *Explain the development of a theory.*
  - Scientific theories are subjected to repeated testing
    • until they are either confirmed beyond any reasonable doubt,
    • modified based on observations made in the repeated testing,
    • or rejected because most tests fail to support them.
Scientific Theories

- Scientific Theories are
  - NOT a guess
  - NOT developed by committee
  - NOT voted on
  - NOT judged by a review board

- Debate about a theory does NOT make it false
- Theories CAN be modified with new evidence

7 misused science words (Scientific American)
Molecular and Cellular

Cell organelles  2-5 points  SC.912.L.14.3

Level 2: Basic Application of Skills & Concepts

- Cell membrane
- Cell wall
- Comparing plant and animal cells
  - Mitochondria
  - Cell wall
  - Common structures
  - Chloroplasts
  - Cilia
- Comparing prokaryotic and eukaryotic cells
- General structures
  - Eukaryotic cells
  - Plant cells

Practice:  Escambia County: L.14.3
Cell Membrane

• Compare and contrast the general structures of plant and animal cells. Compare and contrast the general structures of prokaryotic and eukaryotic cells.
• Students will compare and/or contrast the structures found in plant cells and in animal cells.

• Students will compare and/or contrast the structures found in prokaryotic cells and in eukaryotic cells.

• Students will describe how structures in cells are directly related to their function in the cell.

• Students will explain the role of the cell membrane during active and passive transport.
Explain the role of cell membranes as a highly selective barrier (passive and active transport).

- **Cell membranes are in ALL cells**
  - Prokaryotic and eukaryotic cells have cell membranes (and cytosol)

- **Structure of the membrane**
  - Fluid Mosaic Model (You Tube)
  - The plasma membrane: (You Tube) [Great microvideos of living cells]

- **Movement across the membrane**
  - Diffusion (sumanas)
  - How diffusion works (McGraw)
  - How facilitated diffusion works (McGraw)
  - How osmosis works (McGraw)
  - Active transport: How the sodium potassium pump works (McGraw)
Cell Membrane

- Solutes “suck” the water across a membrane.
- The ratio of solutes to water is greater in the solution than the cell - the water exits the cell.
- The ratio of solutes to water in the solution is less that the solutes in the cell - the water moves into the cell.
- If the solute ratio is equal - water will continue to move across the membrane in equal proportions.
Cell Walls

- Plant cell walls are composed of cellulose
  - Cellulose is a structural carbohydrate
- Analogy: cell membrane is a balloon; cell wall is a box
- Cellulose is not digestible by animals
- Animals do NOT have cell walls
## Comparing cell organelles

<table>
<thead>
<tr>
<th>Structure</th>
<th>Plant</th>
<th>Animal</th>
<th>Prokaryote</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mitochondria</td>
<td>✓ yes</td>
<td>✓ yes</td>
<td></td>
</tr>
<tr>
<td>Chloroplasts</td>
<td>✓ yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nucleus</td>
<td>✓ yes</td>
<td>✓ yes</td>
<td></td>
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<tr>
<td>Golgi apparatus</td>
<td>✓ yes</td>
<td>✓ yes</td>
<td></td>
</tr>
<tr>
<td>Endoplasmic reticulum</td>
<td>✓ yes</td>
<td>✓ yes</td>
<td></td>
</tr>
<tr>
<td>Ribosomes</td>
<td>✓ yes</td>
<td>✓ yes</td>
<td>✓ yes</td>
</tr>
<tr>
<td>Cell membrane</td>
<td>✓ yes</td>
<td>✓ yes</td>
<td>✓ yes</td>
</tr>
<tr>
<td>Cell wall</td>
<td>✓ cellulose</td>
<td>✓ peptidoglycan</td>
<td></td>
</tr>
<tr>
<td>Cytoplasm</td>
<td>✓ yes</td>
<td>✓ yes</td>
<td>✓ yes</td>
</tr>
<tr>
<td>centriole</td>
<td>✓ Yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>vacuole</td>
<td>✓ 1 Large central</td>
<td>✓ Many small</td>
<td></td>
</tr>
<tr>
<td>Flagella</td>
<td>✓ yes</td>
<td>✓ yes</td>
<td>✓ yes</td>
</tr>
<tr>
<td>Cilia</td>
<td>✓ yes</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Comparing cell organelles
Molecular and Cellular

DNA  2-3 points  SC.912.L.16.3

Level 3: Strategic Thinking & Complex Reasoning

- DNA Replication
- Chromosomal mutation
- Gene Mutation
- Similarities in genetic codes
- Translation

Practice:  Escambia County:  L.16.3
Describe the basic process of DNA replication and how it relates to the transmission and conservation of the genetic information.

- DNA structure and replication (WEHI)
- DNA Replication (McGraw)

• DNA is a polymer of nucleotides
  
  \[ A \leftrightarrow T \]
  
  \[ C \leftrightarrow G \]

  The percent of adenine in a double-stranded DNA is 38. What is the percent of cytosine in that DNA?
Chromosomal mutation

- Changes in chromosome structure (McGraw)
- Mutations by base substitution (McGraw)
- Additions and Deletions Mutations (McGraw)

Diagram showing:
- Deletion (a)
- Duplication (b)
- Inversion (c)
- Reciprocal translocation (d)

Point mutations:
- Silent
- Nonsense
- Missense

<table>
<thead>
<tr>
<th>DNA level</th>
<th>mRNA level</th>
<th>protein level</th>
</tr>
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<tbody>
<tr>
<td>TTC</td>
<td>TTT</td>
<td>ATC</td>
</tr>
<tr>
<td>AAG</td>
<td>AAA</td>
<td>UAG</td>
</tr>
<tr>
<td>Lys</td>
<td>Lys</td>
<td>STOP</td>
</tr>
<tr>
<td>Arg</td>
<td>Thr</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Silent</th>
<th>Nonsense</th>
<th>Missense</th>
</tr>
</thead>
<tbody>
<tr>
<td>conservative</td>
<td>non-conservative</td>
<td></td>
</tr>
<tr>
<td>TTC</td>
<td>TTT</td>
<td>ATC</td>
</tr>
<tr>
<td>AAG</td>
<td>AAA</td>
<td>UAG</td>
</tr>
<tr>
<td>Lys</td>
<td>Lys</td>
<td>STOP</td>
</tr>
</tbody>
</table>
Gene Mutation

Additions and Deletions Mutations (McGraw)

Health or Disease?

<table>
<thead>
<tr>
<th>DNA Sequence</th>
<th>Normal protein</th>
<th>Low or nonfunctioning protein</th>
</tr>
</thead>
<tbody>
<tr>
<td>Person 1</td>
<td>A A A T T T T</td>
<td>Some DNA variations have no negative effects</td>
</tr>
<tr>
<td>Person 2</td>
<td>A A T T T T T</td>
<td>Other variations lead to disease (e.g., sickle cell) or increased susceptibility to disease (e.g., lung cancer)</td>
</tr>
<tr>
<td>Person 3</td>
<td>A A C T T T T</td>
<td>Low or nonfunctioning protein</td>
</tr>
</tbody>
</table>
Sickle Cell

- Point mutation leads to a different amino acid in the protein chain
- Folds incorrectly under stressful conditions
- Heterozygous condition provides resistance to malaria
- **Point Mutation: Sickle Cell**
Similarities in genetic codes

- **Students will explain how or why the genetic code (mRNA codon chart) is common to almost all organisms.**
  - All organisms use DNA code to direct protein synthesis.
  - Genetic code is nearly identical in all organisms from bacteria to humans.
    - This is why we can use insert a portion of DNA that codes for human insulin into bacteria and have them produce human insulin.

- All organisms on Earth share the same code, just like computers all over the world share the same code.

- The code is made up of 4 letters that form codons of 3 letters each.
  - Each codon codes for one amino acid.
  - Some amino acids have more than one codon, which means that a mistake in the code does not always produce a different amino acid.

<table>
<thead>
<tr>
<th>Codons Found in Messenger RNA</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>First Base</strong></td>
</tr>
<tr>
<td>U</td>
</tr>
<tr>
<td>Phe</td>
</tr>
<tr>
<td>Phe</td>
</tr>
<tr>
<td>Leu</td>
</tr>
<tr>
<td>Leu</td>
</tr>
<tr>
<td>Leu</td>
</tr>
<tr>
<td>Leu</td>
</tr>
<tr>
<td>Ile</td>
</tr>
<tr>
<td>Ile</td>
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<tr>
<td>Met</td>
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<tr>
<td>Val</td>
</tr>
<tr>
<td>Val</td>
</tr>
<tr>
<td>Val</td>
</tr>
<tr>
<td>Val</td>
</tr>
</tbody>
</table>
Protein Synthesis:
Transcription and Translation

Transcription (WEHI)
Translation (WEHI)

A ↔ U
C ↔ G
Summary of eukaryotic transcription and translation:
A gene in the DNA is transcribed into RNA molecules, including pre-mRNA. RNA processing occurs in the nucleus. Translation occurs in the cytoplasm on ribosomes in conjunction with tRNA.
A gene is a region of DNA whose final product is either a polypeptide or an RNA molecule.

Making tacos:
There is an order for tacos (proteins). Instructions for taco making are in the restaurant manager’s office (nucleus) in a file cabinet (DNA). The manager won’t let the instructions out of his office.
Mike goes into the office to make a copy of the instructions and opens up the file cabinet. The file folder (gene) in the cabinet that has the taco-making instructions has some other information in it also, but Mike makes a copy of the whole file.
After making the copy (pre-mRNA), Mike goes through and pulls out the papers that are about taco-making (exons) and leaves the rest of the papers (introns) in the office.
Mike takes the stack of papers about making tacos back together in a stack [splices the exons together] (mRNA) out of the office door (leaves the nucleus through nuclear pores) and goes into the kitchen (cytoplasm) to give directions to the taco-maker (ribosome). The taco-maker is ready to make the taco but doesn’t have any ingredients and doesn’t know how to read the instructions.
There are several workers (tRNA) in the area who rush over with ingredients in their hands and quickly read the instructions and hand the proper ingredients to the taco-maker in the correct order so that he can make the taco correctly. As the workers hand the ingredients to the taco-maker, he assembles the taco.
Since many tacos are needed, there are many taco-makers working at the same time.
When enough tacos are made, a signal comes from the office to stop making tacos and Mike goes into the office to get instructions for the next item .... Maybe milkshakes.
Cell Division  3-5 points  SC.912.L.16.17

Level 3: Strategic Thinking & Complex Reasoning

- Comparing mitosis and meiosis
- Mitosis
  - Prophase
  - Anaphase
  - Telophase
- Meiosis I and II
  - Prophase
  - Anaphase
- Cytokinesis
- Role of meiosis
  - Sexual reproduction
- Role of mitosis
  - Asexual reproduction
- Uncontrolled cell growth

Practice: Escambia County: L.16.17
Sister chromatids count as one chromosome

An unduplicated chromosome in $G_1$ of interphase,

and a duplicated chromosome in $G_2$ of interphase;

the duplicated chromosome is composed of 2 sister chromatids joined at their centromere.
Mitosis: division of the nucleus

Prophase: chromosomes condense; spindle fibers form; nuclear envelope breaks up;

Metaphase: chromosomes (sister chromatids joined at their centromere) line up on equator

Anaphase: sister chromatids separate

Telophase: chromosomes reach poles; chromosomes begin to uncoil; spindle fibers break apart; nuclear envelope begins to form.

Describe specific events occurring in each of the stages of the cell cycle and/or phases of mitosis.
Mitosis: division of the nucleus

Explain how mitosis forms new cells and its role in maintaining chromosome number during asexual reproduction.

• PMAT (prophase, metaphase, anaphase, telophase)
  
  • *Spindle fibers push and pull chromosomes to their positions.*

• Asexual reproduction for eukaryotic cells.

• Purpose is for growth and repair.

• Produces 2 genetically identical diploid daughter cells
  - Diploid means two sets of chromosomes
  - No genetic variation

• Interphase and cytokinesis are NOT part of mitosis.
Meiosis

- Occurs in testes for males; in ovaries for females
- Produces gametes (sex cells)
- Gametes have one set of chromosomes (n)
  - Somatic cells (body cells) have two sets of chromosomes (2n)
- Meiosis is the method of reducing the number of chromosomes from 2n to n (diploid to haploid)
  - Humans have 46 chromosomes in a somatic cell; 23 in a gamete
  - Meiosis (sumanas)

Explain how meiosis results in the formation of haploid gametes or spores.
Crossing Over in Meiosis

Each individual has DNA from their mom (maternal) and dad (paternal) \([2 \text{ sets } = 2n]\)

When chromosomes have the same genes in the same location (loci); they are homologous chromosomes.

A tetrad is a group of 4 strands of DNA: homologous chromosomes each composed of 2 sister chromatids.

**Crossing over in prophase I increases genetic diversity** since some of the maternal and paternal genes are now on the opposite chromosome.

Describe the process of meiosis, including independent assortment and crossing over.
Independent Assortment in Meiosis

- Random assortment during metaphase means that there are many possibilities for
- independent assortment of chromosomes during anaphase to daughter cells.

Describe the role of mitosis in asexual reproduction, and/or the role of meiosis in sexual reproduction, including how these processes may contribute to or limit genetic variation.

Increasing genetic diversity
Meiosis reduces the amount of DNA in daughter cells.

If parent cell contains 46 chromosomes, each daughter cell will contain 23 chromosomes.
Mitosis v Meiosis

Mitosis (figure “a”)
• Homologous chromosomes do not line up as tetrads in prophase
• Sister chromatids separate during anaphase
• 2 diploid daughter cells are genetically identical to parent cell

Meiosis (figure “b”)
Homologous chromosomes line up as tetrads
• Crossing over occurs
Homologous chromosomes separate during anaphase I
• Cells are haploid (one set of chromosomes) at end of meiosis I
Sister chromatids separate during anaphase II
4 haploid daughter cells are genetically different from each other and from parent cell
Uncontrolled cell growth

The Cell Cycle (McGraw)
Normal cell cycle vs Uncontrolled growth (Harvard)

A tumor is uncontrolled growth that stays in one place (benign)
Cancer is uncontrolled growth that has metastasized – or moved to a new location (malignant)

Explain how cancer (uncontrolled cell growth) may result from mutations that affect the proteins that regulate the cell cycle.
Macromolecules  2-3 points  SC.912.L.18.1

Level 2: Basic Application of Skills & Concepts

- Biochemical reactions and enzymes
- Nucleic acids
  - Primary function
- Lipids
  - Primary function
- Carbohydrates
  - Primary function
- Proteins
  - Molecular structure

Practice:  Escambia County:  L.18.12
**Lipids**

- Composed of carbon, hydrogen, and oxygen
- Fats
- Oils
- Waxes
- Phospholipids
  - form membranes around cells
- Steroids
  - include cholesterol and the sex hormones.

Identify and/or describe the basic molecular structure of carbohydrates, lipids, proteins, and/or nucleic acids.

overview of lipids (Carnegie Mellon)
Macromolecules: Lipids and Carbohydrates (mhhe)
Lipids (mhhe)
Phospholipids

- The two fatty acids on the tail portion of the molecule are not water soluble (hydrophobic), whereas the head portion is water soluble (hydrophilic).

- **Hydrophobic** - A non-polar substance; literally, water-hating.
- **Hydrophilic** - A polar substance; literally, water-loving.

Phospholipids form the membrane around the cell and around the organelles within cells.
Steroids

- four carbon rings joined together

- Steroids include cholesterol and the sex hormones, testosterone and estrogen.
Proteins

- A polymer
  - Monomers of amino acids
- Macromolecules: Proteins and Nucleic Acids (whfreeman) choose "animated tutorial 3.1"
- A long chain of amino acids
- Must be folded correctly in order to function

Proteins Shape Dictates Function

- "Receptors" with binding sites that recognize chemical signals
- Collagen fibers for structure
- Cylindrical tubes to transport large molecules across the cell membrane
- Enzymes that join or split other molecules
- Hemoglobin to transport oxygen
- Antibodies - chains bound with binding sites for antigens

Primary structure
- amino acid sequence

Secondary structure
- regular sub-structures
- alpha helix
- beta sheet

Tertiary structure
- three-dimensional structure
- hemoglobin
- P13 protein

Quaternary structure
- complex of protein molecules
Denatured proteins do not function

- A denatured protein is unfolded

- Protein Denaturation (McGraw)
- Frying an Egg (sumanas)

- Proteins can be denatured by heat or a change in pH

Identify and/or describe the effect of environmental factors on enzyme activity.
Proteins transport materials across membranes

- Passive transport does NOT require ATP as energy
- Active transport requires energy in the form of ATP

**Transport across the membrane (sumanasinc)**

Small uncharged particles cross by **diffusion**. Large molecules or charged particles that move from an area of high concentration to an area of low concentration use **facilitated diffusion**. Anything that moves against the concentration gradient uses **active transport**.
Enzymes lower activation energy

Explain how enzymes speed up the rate of a biochemical reaction by lowering the reaction’s activation energy.

Enzymes can be used over and over again.

Increasing enzyme concentration will increase the rate of reaction.

How Enzymes Work (McGraw)
Carbohydrates

- **Monosaccharide** (One sugar)
  - Glucose
  - Fructose
  - Galactose

- **Disaccharide** (Two sugars)
  - Sucrose
  - Maltose

- **Polysaccharide** (Many sugars)
  - Starch
    - Energy storage for plants
    - Digestible by animals
  - Cellulose
    - Structural component for plants (cell walls)
    - Not digestible by animals
  - Glycogen
    - Energy storage for animals
    - Muscles and liver
  - Chitin
    - Structural component for animals (exoskeleton)
Nucleic Acids

Polymers
Composed of nucleotides
Molecular and Cellular

Cellular Energy  1-3 points  SC.912.L.18.9

Level 2: Basic Application of Skills & Concepts

- Cellular respiration
  - Anaerobic
  - Aerobic
  - Products
- Role of ATP
- Photosynthesis and cellular respiration relationship
- Photosynthesis
  - Reactants
  - Products

Practice:  Escambia County L.18.9
Identify the reactants, products, and basic functions of aerobic and anaerobic

**Cellular Respiration**

- **3 stages**
  - Glycolysis
  - Krebs cycle
  - Electron transport chain

- [Cellular Respiration (mhhe)]
- [The Big Picture (and more detailed explanations) (Sumanas)]

- **Glycolysis**
  - Does use oxygen
  - Takes place in cytosol

- **Krebs cycle and ETC**
  - Take place in mitochondria
  - Uses products of glycolysis
ATP

Connect the role of adenosine triphosphate (ATP) to energy transfers within the cell.

- Energy for the cell
- Most of it is produced in mitochondria
- You eat food and breathe oxygen to make ATP

(a) ATP consists of three phosphate groups, ribose, and adenine.
Anaerobic respiration aka Fermentation

- If no oxygen is present
  - Pyruvate will not go into mitochondria
  - Animals will make lactic acid
  - Plants and yeast will make ethyl alcohol and carbon dioxide
- Fermentation (Central Michigan Univ)
Identify the reactants, products, and basic functions of Photosynthesis

- Photosynthesis (mhhe)
- Photosynthesis (sumanasinc)
Cellular respiration can not take place without photosynthesis

- Explain how photosynthesis stores energy and cellular respiration releases energy.
- Explain how the products of photosynthesis are used as reactants for cellular respiration and vice versa.

Overview of Photosynthesis and Cellular Respiration (Emory)
Molecular and Cellular

Water 1-2 points SC.912.L.18.12

Level 2: Basic Application of Skills & Concepts

- Properties of water
  - Moderating temperature
  - Solvent
  - Cohesive behavior
  - Freezing

Practice: Escambia County: L.18.12
Water and Hydrogen Bonding

- Water molecules are covalently bonded
- Hydrogen bonds are the attraction between the positively charged hydrogen and negatively charged electrons.
**Water** has the ability to moderate temperature

- It takes a lot of energy to disrupt hydrogen bonds
- Water changes temperature more slowly than land
- Water (sweat) takes away heat from animals
  - Evaporative cooling
- Water is able to absorb a lot of heat without a large increase in temperature
  - Hydrogen bonds break and energy is absorbed.
- When water cools it releases heat
  - Hydrogen bonds form
- Ice has more hydrogen bonds than liquid water
  - H2O expands as it cools due to hydrogen bonds
- **Ocean currents affect land temperatures** (springer)
Water as a solvent:
Water has polar covalent bonds

Ions dissolve easily in water

- Nutrients dissolve in water and are transported to all cells in an organism.

Polar molecules dissolve easily in water.
Water sticks together

- Water's cohesiveness allows transport from roots to leaves (Pearson)
- Water and minerals transported in a plant through xylem (BFW)

The properties of water are essential for life on Earth.
Water expands upon freezing

If H$_2$O became more dense when solid, ice would sink, and never thaw out.

Floating ice allows organisms to thrive in the liquid water underneath the ice.
Level 3: Strategic Thinking & Complex Reasoning

- Designing scientific investigations
- Evaluating scientific explanations
- Evaluating scientific investigations
- Analyzing data
- Making inferences
- Defending conclusions

Practice: Escambia County: N.1.1
Classification, Heredity, and Evolution

Evolution 2-4 points SC.912.L.15.1

Level 3: Strategic Thinking & Complex Reasoning

- Evidence
  - Comparative embryology
  - Fossil record
  - Molecular biology
  - Comparative anatomy
  - Biogeography
  - Observable Changes

- Trends in hominid evolution
  - Jaw size
  - Skull shape
  - Brain size

- Evaluating scientific claims

Practice: Escambia County: L.15.1
Evidence for Evolution

- **Direct Observations**
  - Intense predation of wild guppies results in more drably colored males
  - Evolution of drug-resistant viruses and antibiotic-resistant bacteria
- **The fossil record**
  - Fossils are remains or traces of organisms from the past. They are found in sedimentary rock.
    - Becoming a Fossil (PBS)
  - Paleontology is the study of fossils.
    - Show that evolutionary changes have occurred over time and the origin of major new groups of organisms.

Sex and the single guppy (PBS)
bacterial antibiotic resistance
(Harvard)
Evidence for Evolution

- Homology
  - Characteristics in related species can have an underlying similarity even though they have very different functions.

- Homologous structures
  - Anatomical signs of evolution
  - Example: forelimbs of mammals that are used for a wide variety of purposes.
Homologous Structures:
the same or common ancestor
may or may not have similar function
develop from similar embryonic structure

• Each leaf has a very different shape and function, yet all are homologous structures, derived from a common ancestral form.
  • The pitcher plant and Venus' flytrap use leaves to trap and digest insects.
  • The bright red leaves of the poinsettia look like flower petals.
  • The cactus leaves are modified into small spines, which reduce water loss and can protect the cactus from plant-eaters.
Evidence for Evolution

• Embryonic homologies
  • Anatomical homologies in embryos that are not visible in adult organisms.
Evidence for Evolution

• Molecular homologies
• Shared characteristics on molecular level

The Genetic Code is Universal: Proteins indicate degree of relatedness.

Number of different amino acids found in human cytochrome C as opposed to selected organisms

<table>
<thead>
<tr>
<th>Organism</th>
<th># of amino acids that are different</th>
<th>Where they are compared to humans in the phylogenetic tree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human</td>
<td>0</td>
<td>Self (Family Hominidae, Order Primates)</td>
</tr>
<tr>
<td>Monkey</td>
<td>1</td>
<td>Different Family (Pongidae), same order (Primates)</td>
</tr>
<tr>
<td>Pig, bovine, sheep</td>
<td>10</td>
<td>Different order (Carnivora), same class (Mammalia)</td>
</tr>
<tr>
<td>Horse</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Dog</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>Rabbit</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Chicken, Turkey</td>
<td>13</td>
<td>Different class (Aves), same phylum (Chordata)</td>
</tr>
<tr>
<td>Duck</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>Rattlesnake Turtle</td>
<td>14</td>
<td>Different class (Reptila), same phylum (Chordata)</td>
</tr>
<tr>
<td>Tuna</td>
<td>21</td>
<td>Different class (Ostheichthys), same phylum (Chordata)</td>
</tr>
<tr>
<td>Moth</td>
<td>31</td>
<td>Different phylum (Arthropoda), same Kingdom (Animalia)</td>
</tr>
<tr>
<td>Candida fungus</td>
<td>51</td>
<td>Different Kingdom (Fungi)</td>
</tr>
</tbody>
</table>
Biogeography:
The geographic distribution of a species

- Species in a discrete geographic area tend to be more closely related to each other than to species in distant geographic areas.
  - In South America, desert animals are more closely related to local animals in other habitats than they are to the desert animals of Asia.
- Continental drift and the break-up of Pangaea can explain the similarity of species on continents that are distant today.
  - Breakup of Pangea (classzone)
  - Breakup of Pangea (Wiley)
- Endemic species are found at that certain geographic location and nowhere else.
  - Marine iguanas are endemic to the Galapagos Marine Iguana (BBC - The Blue Planet; 4 min)
Darwin’s theory of evolution through natural selection explains the succession of forms in the fossil record.

Transitional fossils have been found that link ancient organisms to modern species, just as Darwin’s theory predicts.

Heritable variations exist within a population. These variations can result in differential reproductive success. Over generations, this can result in changes in the genetic composition of the population.

Individuals do not evolve!!!

Populations evolve!!!
Trends in Hominid Development

- Skull size increases with brain cavity getting larger
- Forehead is less sloping; more vertical
- Jaw becomes less protruding
- Teeth become smaller
- Eyebrow ridge becomes less prominent
- As brain size increases, more tools are developed, and more language capability develops
Scientific Theories and Scientific Laws

• A scientific theory is an *explanation* for a wide range of observations and experimental results.
  – For instance: The theory of evolution

• A scientific law is a *statement* about observations in nature. Scientific laws explain things, but they do not describe them.

• A theory can NEVER become a law.

• [Scientific Explanations [first 1:52] (bozeman) for AP Bio - but easy to understand...](bozeman)
Classification, Heredity, and Evolution

Classification  2-3 points  SC.912.L.15.6

Level 2: Basic Application of Skills & Concepts

• Changes in organism classification
• Distinguishing characteristics
  – Archaea
  – Eukarya
  – Animalia
  – Plantae
  – Protista
  – Fungi
• Understanding classification

Practice: Escambia County: L.15.6
Classification of organisms

• changed over time as we have gained knowledge.

Approaches to Classifying Organisms

A two-kingdom system—Linnaeus
- Plantae
- Animalia

A five-kingdom system—Whittaker
- Monera
- Protista
- Fungi
- Plantae
- Animalia

A six-kingdom system—Woese
- Eubacteria
- Archaeabacteria
- Protista
- Fungi
- Plantae
- Animalia

A three-domain system—Woese
- Bacteria
- Archaea
- Eukarya
Classification of organisms
Moves from most broad to most specific

- Kingdom
  - Plantae (plants)
  - ± 280,000 species

- Phylum
  - Angiospermae (flowering plants)
  - ± 250,000 species

- Class
  - Dicotyledonae (dicots)
  - ± 235,000 species

- Order
  - Rosales (roses and their allies)
  - ± 18,000 species

- Family
  - Rosaceae (rose family)
  - ± 3,500 species

- Genus
  - Rosa
  - ± 500 species

- Species
  - Moss rose
  - Rosa gallica
Classification of organisms
Three Domains; Six kingdoms

SIX KINGDOMS

Eubacteria       Archaea-bacteria       Protista
               Protista                      Plantae
               Plantae                      Fungi
               Fungi                        Animalia

BACTERIA           ARCHAEA                EUKARYA          THREE DOMAINS

Common ancestor
Distinguish characteristics of the domains and kingdoms of living organisms.

<table>
<thead>
<tr>
<th></th>
<th>Plantea</th>
<th>Animalia</th>
<th>Fungi</th>
<th>Protista</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cell wall</td>
<td>Cellulose</td>
<td></td>
<td>Chitin</td>
<td>Some have cellulose</td>
</tr>
<tr>
<td>Chloroplasts</td>
<td>yes</td>
<td></td>
<td></td>
<td>some</td>
</tr>
<tr>
<td>Mode of nutrition</td>
<td>Autotrophic</td>
<td>Heterotrophic</td>
<td>Heterotrophic</td>
<td>Some autotrophic/ Some heterotrophic</td>
</tr>
<tr>
<td># of cells</td>
<td>Multicellular</td>
<td>Multicellular</td>
<td>Some unicellular/ most multicellular</td>
<td>Some unicellular/ some Multicellular</td>
</tr>
</tbody>
</table>
Fungi

- Hyphae branch into a complicated network known as the **mycelium**, which is the feeding network of the fungus.
- Fungi reproduce asexually and sexually to produce spores.
• Beneficial mycorrhizal fungi expand into the surrounding soil and greatly increase the root’s ability to absorb water and nutrients.
• Fungi return nutrients to the soil, which otherwise would be unavailable to plants.
Cladogram: a diagram showing relationships.

What did T-Rex taste like - Interactive learning module (University of California Museum of Paleontology)
Classification, Heredity, and Evolution

Origin of Life 1-2 points SC.912.L.15.8

Level 2: Basic Application of Skills & Concepts

- Scientific explanations for life on Earth
- Conditions required for life
- Evaluating sources of info
  - Origins of life
- Evaluating scientific claims
  - Origin of life

Practice: Escambia County: L.15.8
Origin of life on Earth

- Miller-Urey Experiment (McGraw)
- Conditions required for life (learn.genetics.utah.edu)
Classification, Heredity, and Evolution

Natural Selection  2-4 points  SC.912.L.15.13

Level 2: Basic Application of Skills & Concepts

- Increasing genetic variation
- Nonrandom mating
- Inherited variations
- Genetic drift
- Overproduction of offspring
- Gene flow

Practice:  Escambia County: N.1.1
Natural Selection explains how adaptations arise.

- More offspring will be produced than can survive.
- Individuals that have certain heritable characteristics survive and reproduce at a higher rate than other individuals.
- Over time, natural selection can increase the match between organisms and their environment. [Evolution (sumanas)]
- If an environment changes, or if individuals move to a new environment, natural selection may result in adaptations to these new conditions, sometimes giving rise to new species in the process.
- [Mechanisms of evolution (McGraw)]
Genetic drift

In each generation, some individuals may, just by chance, leave behind a few more descendants (and genes, of course!) than other individuals. The genes of the next generation will be the genes of the “lucky” individuals, not necessarily the healthier or “better” individuals.
Genetic drift can cause big losses of genetic variation for small populations.

- **Founder effect**
  - A few individuals become isolated from a larger population and establish a new population whose gene pool is not reflective of the source population.

- **Bottleneck effect**
  - A sudden change in the environment (for example, an earthquake, flood, or fire) drastically reduces the size of a population. [Stone Age Apocalypse (National Geographic)]
  - The few survivors that pass through the restrictive bottleneck may have a gene pool that no longer reflects the original population’s gene pool.

The population of California condors was reduced to nine individuals. [California Condors (The Peregrine Fund)]
Gene Flow

The transfer of alleles or genes from one population to another.
The environment selects who lives and reproduces

- Selection can only edit existing variations.
- Adaptations are often compromises.
- Chance, natural selection, and the environment interact.

- Individuals do not evolve!!!
- Populations evolve!!!

- Speciation in evolution (Berkeley)
Inheritance patterns 2-3 points SC.912.L.16.1

Level 3: Strategic Thinking & Complex Reasoning

- Analyzing patterns of inheritance
- Predicting inherited patterns
- Codominance
- Incomplete Dominance
- Sex-linked inheritance
- Polygenic inheritance
- Multiple Alleles

Practice: Escambia County: L.16.1
Mendel's law of segregation

The two alleles in a diploid organism separate during gamete formation (meiosis).
Mendel's law of independent assortment

Alleles are distributed to gametes independently.
**Codominance**

**equally dominant**

<table>
<thead>
<tr>
<th>Genotype</th>
<th>Red blood cell appearance</th>
<th>Phenotype (blood group)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I^A I^A$ or $I^A i$</td>
<td><img src="image" alt="Red blood cell A" /></td>
<td>A</td>
</tr>
<tr>
<td>$I^B I^B$ or $I^B i$</td>
<td><img src="image" alt="Red blood cell B" /></td>
<td>B</td>
</tr>
<tr>
<td>$I^A I^B$</td>
<td><img src="image" alt="Red blood cell AB" /></td>
<td>AB</td>
</tr>
<tr>
<td>$i i$</td>
<td><img src="image" alt="Red blood cell O" /></td>
<td>O</td>
</tr>
</tbody>
</table>

**Codominance**

Black chicken

<table>
<thead>
<tr>
<th>Genotype</th>
<th>Red blood cell appearance</th>
<th>Phenotype (blood group)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$B B$</td>
<td><img src="image" alt="Red blood cell B" /></td>
<td>Checkered</td>
</tr>
</tbody>
</table>

White chicken

<table>
<thead>
<tr>
<th>Genotype</th>
<th>Red blood cell appearance</th>
<th>Phenotype (blood group)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$W W$</td>
<td><img src="image" alt="Red blood cell BW" /></td>
<td>Checkered</td>
</tr>
<tr>
<td>$W W$</td>
<td><img src="image" alt="Red blood cell BW" /></td>
<td>Checkered</td>
</tr>
</tbody>
</table>

**Codominance**

Black

White

Checkered
Incomplete Dominance

Neither allele is dominant - the traits are blended together.

![Diagram of incomplete dominance in the F1 generation](image)
Multiple alleles

More than two alleles are available for one trait

There are four colors for this breed of rabbit:

<table>
<thead>
<tr>
<th>Possible genotypes</th>
<th>CC, C_Cchl, Cchl, Cc</th>
<th>c_Cchl</th>
<th>c_Cchl, c_Cchl</th>
<th>c_Cchl, c_Cchl</th>
<th>cc</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phenotype</td>
<td>Dark gray</td>
<td>Chinchilla</td>
<td>Light gray</td>
<td>Himalayan</td>
<td>Albino</td>
</tr>
</tbody>
</table>

![Bunny images]
Sex-Linked Recessive

- Always on X-chromosome

- If father has an affected gene (on his X-chromosome); he will ALWAYS pass that gene on to his female offspring - who will be carriers; male offspring will not be affected.

- If mom is a carrier, she has a 50% chance of passing it on to her male offspring.

- Mom can pass the gene to female offspring, but they will not express it as long as dad has a functioning gene on his X-chromosome.
Polygenic Inheritance

• Many genes affect skin color

• Color can also be affected by environmental issues - such as sunlight
Dihybrid crosses

• In a true dihybrid cross - each trait is a hybrid and two traits are evaluated;

9:3:3:1

9/16; 3/16; 3/16; 1/16

- Chances... or possibilities... of the different phenotypes
Dihybrid crosses

- You can use simple Punnett squares to determine more complex evaluations

- What is the possibility of getting a green, round seed from plants that are heterozygous YyRr for both traits?
  - Complete a Punnett square for yellow or green = 25% chance of green
  - A Punnett square for round or wrinkled = 75% chance of round
  - Multiple the two = ¼ x ¾ = 3/16 chance of getting green, round seeds

- What is the possibility of getting a plant with PPyyRr from plants with PpYyRr and Ppyyrr?
  - Punnett square for P = ¼ possibility
  - Punnett square for Y = ½ possibility
  - Punnett square for R = ½ possibility
  - ¼ x ½ x ½ = 1/16
Classification, Heredity, and Evolution

Nature of Science

Level 3: Strategic Thinking & Complex Reasoning

- Evaluating scientific investigations
- Defending conclusions
- Analyzing data

Practice: Escambia County: N.1.1
Plants

2-4 points

SC.912.L.14.7

Level 2: Basic Application of Skills & Concepts

- Flowers
- Plant roots
- Cones
- Dermal tissue
- Vascular tissue
- Plant leaves
- Plant stems
- Plant structures
  - Photosynthesis
  - Reproduction
  - Transpiration

Practice: Escambia County: L.14.7
Plant tissues

• You must know the function of plant tissues and organs in the context of physiological processes.

• Vocabulary:
  - meristematic, ground, dermal, and vascular tissues;
  - roots, stems, leaves, flowers, fruits, and cones;
  - cambium, guard cells, phloem, seed, stomata, and xylem.

• Functions: photosynthesis, cellular respiration, transpiration, and reproduction.
Roots, stems, leaves; flowers, fruits.

### Parts of a Plant

- **Flower**: Produces seeds.
- **Leaf**: Uses sunlight and chlorophyll to convert CO2 and water to sugar. Gives off water and oxygen.
- **Stem**: Supports leaves, transports water and nutrients.
- **Fruit**: Protects the seed and helps with seed dispersal.
- **Roots**: Supports plant and takes in water and nutrients.
- **Seed**: Produces new plant.
Dividing tissue is meristematic tissue.

There are two kinds of lateral meristems, the **vascular cambium** and the **cork cambium**.
These lateral meristems form as rings within the plant body as the stem increases in thickness.
The diagram above illustrate how the vascular cambium divides to produce new xylem cells toward the inside of the vascular cambium and new phloem cells toward the outside.
Plant structures

- Vocabulary: phloem, root hairs, root cap, stomata, xylem
- Xylem and Phloem (UIC)
Angiosperm reproduction

- Vocabulary: seed, stamen, pistil, ovary, petals, sperm, egg, sepal, filaments, anther, style, and stigma

- [Double fertilization (WHFreeman)](WHFreeman) choose “animated tutorial 27.1”
Gymnosperms and Angiosperms

- Vocabulary: seed, cone, pollen

- **Gymnosperms** (Biology 4 Kids)

- **Angiosperms** (Biology 4 Kids)
Organisms, Populations, and Ecosystems

Health

1-2 points

SC.912.L.14.52

Level 2: Basic Application of Skills & Concepts

• Significance of pathogenic agents
• Significance of genetic factors
• Vaccines
• Immune system
  – Specific response
  – Nonspecific response

Practice: Escambia County: L.14.52
Nonspecific immune responses

- Nonspecific Immune Response
  - Also called Innate Immunity or Natural Immunity
  - First two lines of defense (UIC)
  - Pathways of defense (Harvard)

- Causes localized redness, swelling, heat, and pain
  - An indication that the body is healing!
Specific immune response

- Cells of the Immune System - with embedded short videos (HHMI)
Specific immune response

- Activates Cytotoxic T-Cell
- Activates B-Cell
- Activates Memory T-Cell
- Activates Memory B-Cell
- Antibodies
- Kills Infected Cells
Vaccines

- Vaccines are effective against viruses
- How does a vaccine work? (dnatube)
- How vaccines work (The College of Physicians of Philadelphia)

**HOW DO VACCINES WORK?**
Vaccines reduce the risk of infection by working with the body’s natural defenses to safely develop immunity to disease.

A weakened or killed form of the disease is injected into the body.

The body creates antibodies to fight the germs.

If the actual disease germs ever attack the body, the antibodies return to destroy them.
Antibiotics

- Antibiotics kill bacteria - NOT VIRUSES

- If antibiotics are taken when not necessary or not taken long enough to kill all the bacteria
  - antibiotic-resistance bacteria will develop (through natural selection and mutations)
Significance of genetic factors, environmental factors, and pathogenic agents to health.
Brain  1 point  SC.912.L.14.26

Level 1: Recall

- Brain stem
- Pons
- Occipital lobe
- Parietal lobe
- Frontal lobe

Practice:  Escambia County:  L.14.26
Identify the major parts of the brain

- Vocabulary: cerebrum, cerebellum, pons, medulla oblongata, brain stem, frontal lobe, parietal lobe, occipital lobe, and temporal lobe
Blood Flow 1-2 points SC.912.L.14.36

Level 2: Basic Application of Skills & Concepts

- Blood viscosity
- Resistance
- Exercise

Practice: Escambia County L.14.36
Blood Flow

• Identify factors that affect blood flow
• Describe how these factors affect blood flow through the cardiovascular system
• Vocabulary: blood pressure, blood volume, resistance, disease, and exercise
Organisms, Populations, and Ecosystems

Biotechnology 1-3 points SC.912.L.16.10

Level 2: Basic Application of Skills & Concepts

- Impact of biotechnology
  - Environmental
  - Society
  - Individual

Practice: Escambia County L.16.10
## Biotechnology

- Evaluate examples
- Explain the possible impact of biotechnology on the individual, society, and/or the environment.

<table>
<thead>
<tr>
<th>EXAMPLE</th>
<th>OLD METHOD</th>
<th>NEW METHOD</th>
<th>AVOIDS PROBLEMS LIKE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Golden Rice</td>
<td>Take a supplement pill</td>
<td>Add a metabolic pathway for making Vitamin A to a rice plant</td>
<td>Blindness, expensive vitamin pills</td>
</tr>
<tr>
<td>Pesticide-Free Crops Potato</td>
<td>expensive - use poisons to kill pests</td>
<td>Add a gene encoding a &quot;safe&quot; insecticidal protein to crop plant</td>
<td>Crop losses / toxic residues &amp; wildlife loss / wasting money</td>
</tr>
<tr>
<td>Insulin</td>
<td>pig pancreas extract</td>
<td>Put human insulin gene into bacteria</td>
<td>Diabetes, allergic response, new diseases</td>
</tr>
<tr>
<td>Growth Factor</td>
<td>cadaver brain extract</td>
<td>Put human growth factor gene into bacteria</td>
<td>Dwarfism / spread of brain diseases</td>
</tr>
<tr>
<td>Diagnosis of Disease (e.g. Phenylketonuria)</td>
<td>Wait until disease occurs &amp; treat symptoms</td>
<td>Sensitive quick assays to avoid the disease</td>
<td>Progression of disease / unprepared parents</td>
</tr>
<tr>
<td>Super Laundry Soaps</td>
<td>Use bleach, hot water</td>
<td>Find &amp; clone designer enzymes</td>
<td>Dirty or shrunken clothes / polluting with chlorine</td>
</tr>
</tbody>
</table>
### A Basic Analogy

<table>
<thead>
<tr>
<th>Biological Systems</th>
<th>compare to</th>
<th>Computer Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>DNA in nucleus</td>
<td>software, programs on a hard drive</td>
<td></td>
</tr>
<tr>
<td>RNA</td>
<td>random access memory (RAM)</td>
<td></td>
</tr>
<tr>
<td>ribosomes</td>
<td>central processing unit (CPU)</td>
<td></td>
</tr>
<tr>
<td>Proteins</td>
<td>hardware like printers, screens, CD-burners, speakers</td>
<td></td>
</tr>
</tbody>
</table>

See the notes page for this slide for explanations
From: http://www.ouhsc.edu/biotechhighschool/examples.html
Organisms, Populations, and Ecosystems

Human Reproduction 1-2 points SC.912.L.16.13

Level 2: Basic Application of Skills & Concepts

- Female reproductive organs
- Human development fertilization to birth
  - 1st trimester
- Male reproductive organs

Practice: [Escambia County L.16.13](#)
Female reproductive organs

• Vocabulary: ovaries, oviduct (fallopian tube), uterus, cervix, and vagina.
Female reproductive organs

- **Ovaries**: The ovaries are small, oval-shaped glands that are located on either side of the uterus. The ovaries produce eggs and hormones.

- **Fallopian tubes**: These are narrow tubes that are attached to the upper part of the uterus and serve as tunnels for the ova (egg cells) to travel from the ovaries to the uterus. *Conception*, the fertilization of an egg by a sperm, normally occurs in the fallopian tubes. The fertilized egg then moves to the uterus, where it implants into the lining of the uterine wall.

- **Uterus (womb)**: The uterus is a hollow, pear-shaped organ that is the home to a **developing fetus**. The uterus is divided into two parts: the cervix, which is the lower part that opens into the vagina, and the main body of the uterus, called the corpus. The corpus can easily expand to hold a **developing baby**. A channel through the cervix allows sperm to enter and **menstrual blood** to exit.

- The **vagina** is a canal that joins the cervix (the lower part of uterus) to the outside of the body. It also is known as the birth canal.

Male Reproductive Organs

- Vocabulary: seminal vesicle, prostate gland, vas deferens, urethra, epididymis, scrotum, penis, and testes.
Male Reproductive Organs

- The **penis** is the male organ used in sexual intercourse.
- The **scrotum** is the thick-skinned sac that surrounds and protects the testes.
- **Testes** have two primary functions:
  - Producing sperm (which carry the man's genes)
  - Producing testosterone (the primary male sex hormone)

- The **epididymis** is a collection of coiled microscopic tubes that together are almost 20 feet (6 meters) long. The epididymis collects sperm from the testis and provides the environment for sperm to mature and acquire the ability to move through the female reproductive system and fertilize an ovum. One epididymis lies against each testis.
Male Reproductive Organs

- The **vas deferens** is a firm tube (the size of a strand of spaghetti) that transports sperm from the epididymis.
- The **urethra** serves a dual function in males. This channel is the part of the urinary tract that transports urine from the bladder and the part of the reproductive system through which semen is ejaculated.
- The **prostate** lies just under the bladder and surrounds the urethra. Walnut-sized in young men, the prostate enlarges with age. When the prostate enlarges too much, it can block urine flow through the urethra.
- The **seminal vesicles**, located above the prostate, join with the vas deferens to form the ejaculatory ducts, which travel through the prostate. The prostate and the seminal vesicles produce fluid that nourishes the sperm. This fluid provides most of the volume of semen, the fluid in which the sperm is expelled during ejaculation.
early stages of development

• Once a month, an egg is released from an ovary into a fallopian tube. The process of a sperm (haploid; 1N) joining an egg (haploid; 1N) is called fertilization.

• The fertilized egg aka zygote (diploid, 2n) divides repeatedly (mitosis) as it moves down the fallopian tube to the uterus.

• First, the zygote becomes a solid ball of cells called a morula. Then it becomes a hollow ball of cells called a blastocyst.

• Implantation: Inside the uterus, the blastocyst implants in the wall of the uterus, where it develops into an embryo attached to a placenta and surrounded by fluid-filled membranes.
early stages of development

• **Gastrulation** is the process where the inner cell mass of the blastocyst sorts itself into three cell layers
  - Ectoderm
  - Mesoderm
  - Endoderm
    - The 3 cell layers are referred to as primary germ layers because all organs and tissues are formed from them
  - Ectoderm develops into the skin and nervous system
  - Endoderm forms the lining of the digestive system and many digestive organs
  - Mesoderm form many of the body’s internal tissues and organs

• **Neurulation** is the development of the nervous system
  - First event to produce an organ
  - Produces the brain and spinal cord
Development of the fetus

- The **placenta** allows nutrients and oxygen from the mother’s blood to be transferred to the fetal blood, while waste products are transferred from the fetal blood to the maternal blood, without the two blood supplies mixing.
- The **umbilical cord** attaches the placenta to the fetus.
- The **amniotic sac** is filled with **amniotic fluid**. This sac is the baby’s home, gymnasium, and protection from outside knocks, bumps, and other external pressures. The amniotic sac allows the fetus room to swim and move around which helps build muscle tone.
Organisms, Populations, and Ecosystems

Ecosystems

5-7 points

SC.912.L.17.5

Level 3: Strategic Thinking & Complex Reasoning

- Changes in ecosystems
  - Seasonal variations
  - Succession
  - Climate change

- Consequences to biodiversity
  - Climate change
  - Nonnative species
  - Human activity

- Life in aquatic systems
  - Depth

- Temperature in aquatic systems

- Limiting factors

- Carrying capacity

Practice: Escambia County: L.17.5
Carrying capacity and its effect on population size in an ecosystem.

Population Dynamics

- Limiting factors can be **biotic**
  - food, predators
- or **abiotic**
  - water, shelter
- Increased food = increased population
- Increased predation = decreased population

- Carrying capacity is an average
  - The population will fluctuate with the available resources
Aquatic systems

- different types of organisms exist within aquatic systems due to chemistry, geography, light, depth, salinity, and/or temperature
- Water depth affects the amount of photosynthesis that can take place - which affects the number of organisms that can live
  - The deeper the water, the fewer organisms will be able to live
Aquatic systems

- different types of organisms exist within aquatic systems due to chemistry, geography, light, depth, salinity, and/or temperature
- Fresh water vs estuaries (brackish water) vs salt water
Potential changes to an ecosystem resulting from seasonal variations, climate changes, and/or succession.

different types of organisms exist within aquatic systems due to chemistry, geography, light, depth, salinity, and/or temperature

(chemistry) pH, oxygen, carbon dioxide, nitrogen, phosphorous, and salinity.

(geography) water depth, latitude, temperature, underwater topography, and proximity to land.
Potential changes to an ecosystem resulting from seasonal variations, climate changes, and/or succession.

- Climate change... biodiversity and population dynamics
Potential changes to an ecosystem resulting from seasonal variations, climate changes, and/or succession.

• Primary Succession is the establishment and development of an ecosystem of an area that is previously uninhabited.
  
  *Example: Bare rock because of a retreating glacier or cooled lava from a recent volcanic eruption.*

• The first organisms that live there are called pioneer species.

• Secondary Succession is the reestablishment of a damaged ecosystem in an area. There is still soil on the ground.
  
  *Example: Tsunami, earthquake, flood, fire*
Potential changes to an ecosystem resulting from seasonal variations, climate changes, and/or succession.

- Climate change... biodiversity and population dynamics

Click on the picture to access the video
positive and/or negative consequences that result from a reduction in biodiversity.

- Consequences of catastrophic events, climate changes, human activities, and the introduction of invasive and nonnative species
- **Invasive, Non-native plants (information from Florida Forest Service)**
- **CBS News Invasive Species**
Organisms, Populations, and Ecosystems

Energy pathways

Level 2: Basic Application of Skills & Concepts

- Carbon cycle
- Energy pyramid
- Food web
- Water cycle

Practice: [Escambia County L.17.9](#)
food web

- impact of changes in matter or energy in trophic levels.
food web

- application of the knowledge of roles of organisms in a food web to describe energy pathways rather than the identification of producers, consumers (primary, secondary, tertiary), and decomposers.

What happens to the other organisms in the ecosystem if one organism disappears?
Energy pyramid

• Energy decreases as energy moves through the food chain.
• About 10% of the energy is transferred from one level to the next.
Carbon cycle

• Carbon Cycle animation (MHHE)
water cycle aka hydrologic cycle

- one molecule of water in the water cycle (NASA)
  (Click on “download” to go full screen)

The hydrologic and carbon cycles (khanacademy - crash course)
Human Impact  
1-4 points 
SC.912.L.17.20

Level 3: Strategic Thinking & Complex Reasoning

- Human impact on environmental systems
- Using renewable resources
- Monitoring environmental parameters
- Costs and benefits
  - Renewable resources

Practice Questions:  Escambia County L.17.20
actions of humans may impact environmental systems and/or affect sustainability

• Human impact on environment (khanacademy - crash course)
possible environmental impacts resulting from the use of renewable and/or nonrenewable resources

- environmental costs and benefits
- [Interactive activity](childrensuniversity.manchester.ac.uk)
- Pros and cons of energy sources
Monitoring environmental parameters when making policy decisions

• **interactive simulation for carbon cycle**
  - Change the amount of carbon that is introduced into the atmosphere to simulate consequences
  - Taken from this [lab](#)

• **balance environmental needs of reefs with locals who need the reefs to survive (TED-ED talk)** (3 min)

• **Earth Observations help with making predictions that influence policy making** (5 min)
Organisms, Populations, and Ecosystems

Nature of Science

1-2 points

Level 3: Strategic Thinking & Complex Reasoning

- Designing scientific investigations
- Analyzing data
- Evaluating scientific investigations
- Defending conclusions
- Making inferences

Practice: Escambia County: N.1.1