

The Big Picture: A Review of Biology

Cells and Their Processes

Organic Compounds

- A compound is a combination of 2 or more atoms
- An organic compound is a compound that contains carbon atoms that have combined with each other
- An inorganic compound is a compound with no combination of carbon atoms

The Four Types of Organic Compounds (The Molecules of Life)

- Carbohydrates: Sugars used for short term energy
- Lipids: Fats and oils used for long term energy
- Proteins: Made up of amino acids; used for construction materials and chemical reactions in the body
 - Enzymes: Special types of proteins that speed up chemical reactions in the body but are not changed by the reactions
- Nucleic acids: DNA and RNA; contains genetic information

Cells

- A cell is the smallest unit that is alive and can carry on all the processes of life
- Cells make up organisms (living things)
 - Unicellular organisms are made up of 1 cell
 - Multicellular organisms are made up of many cells
- Cells contain organelles, which are specialized compartments that carry out a specific function
- Types of cells
 - Eukaryotic cells contain a nucleus, such as animal and plant cells
 - Prokaryotic cells contain no nucleus, such as bacteria

Animal Cells

- Usually round
- Organelles include
 - nucleus: controls cell activities
 - cell membrane: controls what enters and leaves the cell and also protects the cell
 - endoplasmic reticulum (ER): tunnels for compounds to move through the cell
 - Golgi body: processes and stores protein
 - Ribosomes: make proteins
 - Mitochondria: Makes energy for the cell
 - Lysosome: Has enzymes that digest waste and old organelles
 - Cytoplasm: Fills the empty space of the cell
 - Vacuole: Stores food, water, and waste
 - Centrioles: Help in cell division and is only found in animal, not plant, cells

Plant Cells

- Usually square
- Organelles include
 - Everything that an animal cell has plus more
 - Chloroplast: Traps sunlight to make food for the plant
 - Cell wall: Protects the cell

Bacterial cells

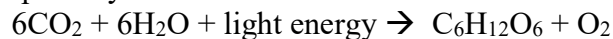
- Smaller and simpler than plant or animal cells
- Bacteria are unicellular
- No nucleus
- Have a single closed loop of DNA, cell wall, cell membrane, cytoplasm and ribosomes
- Some have a capsule (shell for protection), pili (short hair like structures to hold onto host cells), and flagella (whip like structure for movement)

Cell membrane

- Made up of molecules called phospholipids
- Phospholipid bilayer is the 2 layers of phospholipids that make up the cell membrane
- Cell membrane is fluid, which means that it is constantly flowing and moving over the cell
- Cell membrane is selectively permeable, which means that it allows small compounds, but not large ones, to pass right through
- There are different ways that materials are transported across the cell membrane
 - Passive transport: requires no energy
 - Diffusion: compounds move from high to low concentration
 - Osmosis: diffusion of water
 - Active transport: requires energy
 - Endocytosis: large compound are brought into the cell
 - Exocytosis: large compounds are exported out of the cell
- Types of solutions
 - Hypotonic solutions cause water to move into the cell so the cell swells up
 - Hypertonic solutions cause water to move out of the cell so the cell shrivels up
 - Isotonic solutions cause no net movement of water into or out of the cell

Photosynthesis

- Process by which organisms use energy from sunlight to make their own food (glucose)
- Glucose is a simple sugar
- Photosynthesis occurs in the chloroplasts of plant cells and some bacteria
- Chloroplasts have a green pigment called chlorophyll
- Steps of photosynthesis
 - 1. Light reaction: chlorophyll in the chloroplasts absorbs sunlight
 - 2. Dark reaction: The energy from the sunlight is used to make glucose
- Light energy is completely changed into chemical energy (glucose)
- Chemical equation for photosynthesis



Cellular Respiration

- Process that breaks down glucose in order to make energy for an organism
- ATP: compound that stores energy in an organism
- Occurs in the mitochondria of the cell
- Two types of cellular respiration
 - Aerobic respiration: requires oxygen to occur
 - Mostly happens in animals and plants

- There are 3 steps in aerobic respiration
 - Step 1 is glycolysis: glucose is cut in half
 - Step 2 is the citric acid cycle: glucose halves get electrons chopped off of them
 - Step 3 is the electron transport chain: electrons combine with oxygen and are used to make a lot of ATP
- Chemical equation for respiration

$$\text{C}_6\text{H}_{12}\text{O}_6 + \text{O}_2 \rightarrow 6\text{CO}_2 + 6\text{H}_2\text{O} + \text{ATP energy}$$
- Aerobic respiration is the opposite of photosynthesis
- Anaerobic respiration: does not require oxygen to occur
 - Mostly happens in bacteria and yeast
 - Also called fermentation
 - Makes less ATP than aerobic respiration

Chromosomes

- DNA strands in the nucleus that contain the directions on how to make and keep an organism alive
- Made up of genes, which are traits of an organism
- Cells will die if their DNA is damaged or removed
- Humans have mostly diploid cells, which means that we have 2 of each type of chromosome
 - Homologous chromosomes are 2 of the same type of chromosome
 - We have 23 types of chromosomes but...
 - We have 46 chromosomes in all,
23 chromosomes from mom + 23 chromosomes from dad
- Human gametes (sperm and egg cells) are haploid cells, which means that they have 1 of each type of chromosome
 - Sperm and egg cells have 23 chromosomes in all
- Autosomes: Chromosomes that do not determine gender
- Sex chromosomes: Chromosomes that determine gender
 - Girls are XX, Boys are XY
- Karyotype: ordered picture of an organism's chromosomes
 - Healthy individuals have 2 of each type of chromosome
 - Individuals with Down Syndrome have three #21 chromosomes

Cell Cycle

- The cell cycle is the phases in the life of a cell
 - 1. M phase: Mitosis (cell division) occurs
 - 2. G1 phase: Cell grows
 - 3. S phase: DNA synthesis (chromosomes are copied)
 - 4. G2 phase: Cell grows
 - 5. M phase begins again
- Chromosomes must be copied before mitosis so that new cells receive the same chromosomes found in the old cells

Mitosis

- Division of a cell into 2 identical cells
- Before mitosis: Chromosomes have copied themselves
 - Sister chromatids: original chromosome and its exact copy are attached to each other
- Phases of mitosis
 - o 1. Prophase: Nuclear membrane falls apart and spindle fibers start to form
 - o 2. Metaphase: Sister chromatids line up along the middle of the spindle fibers
 - o 3. Anaphase: Sister chromatids separate and move to opposite ends of the cell
 - o 4. Telophase: Spindle fibers break down and new nuclear membrane forms around each set of chromosomes
 - Cytokinesis occurs when the cytoplasm actually divides, forming two new cells

Genetics

Meiosis

- Cell division that produces gametes (sex cells), such as sperm and egg cells
- Fertilization: Process of an egg and a sperm cell combining to produce a zygote
 - o Zygote: Baby that is only 1 cell big
 - o Egg cell (23 chromosomes) + sperm cell (23 chromosomes) = baby (46 chromosomes)
- Steps in meiosis
 - o 1. Before meiosis:
 - 2 chromosomes of the same type come together to make a chromosome pair
 - Each chromosome doubles
 - This gives 4 chromosomes stuck together
 - o 2. Meiosis I: Chromosome pairs separate into two new cells
 - o 3. Meiosis II: Each chromosome separates from its copy into 4 new cells
- In meiosis, one cell becomes four cells but in mitosis, one cell becomes two cells

DNA

- Deoxyribonucleic acid
- Makes up the chromosomes in the nucleus and never leaves the nucleus
- A chromosome is a chain of different genes
- DNA has a double helix shape
- Has four types of bases: adenine (A), guanine (G), thymine (T), cytosine (C)
- A binds T and G binds C
- DNA is complementary, which means that the bases on one strand match up to the bases on the other strand
 - o For example: Strand 1: ATG CCT GAC
Strand 2: TAC GGA CTG
- Semi conservative replication is the process by which DNA copies itself and each new piece of DNA is made up of 1 old strand and 1 new strand

RNA

- Ribonucleic acid
- RNA is a copy of DNA that goes out into the cytoplasm to tell the cell what to do in order to stay alive
- RNA is single stranded and has uracil (U) rather than thymine (T)
 - o U binds A and G binds C
 - o If the DNA is ATG CCA AAG
Then the RNA will be UAC GGU UUC

Using DNA to make protein

- 1. Transcription: DNA in the nucleus is used to make messenger RNA (mRNA)
 - DNA has all the directions the cell needs to live
- 2. RNA moves out into the cytoplasm
 - RNA carries the directions to other parts of the cell
- 3. Translation: The RNA attaches to a ribosome and directs the production of a protein
 - Proteins do all the work in the cell
 - Every 3 bases in RNA is called a codon and codes for 1 amino acid

Mutations

- A mutation is a change in a gene or chromosome
- If the mutation happens in a body cell, it only affects the organism that carries it
- If the mutation happens in a sex cell, it can be passed on to offspring
- Mutations can be
 - harmful if they reduce an organism's chances for reproduction or survival
 - helpful if they improve an organism's chances for survival
 - neutral if they do not produce an obvious changes in an organism
 - lethal if they result in the immediate death of an organism
- Mutations can occur spontaneously or be caused by a mutagen, which is a factor in the environment like UV and chemicals

Mendelian Genetics

- Gregor Mendel is an Austrian monk credited with beginning the study of genetics
- Genetics is the study of heredity
- Humans have 2 genes for every trait
 - Alleles: Different forms of a single trait, like blue and brown are two eye color alleles
- Dominant gene: "Stronger" of 2 genes and shows up in the organism
 - Represented by a capital letter
 - B is the dominant gene for brown eyes
- Recessive gene: "Weaker" of 2 genes and only shows up when there is no dominant gene present
 - Represented by a lowercase letter
 - b is the recessive gene for blue eyes
- Homozygous (purebred): When 2 genes are alike for a trait
 - BB is homozygous for brown eyes, bb is homozygous for blue eyes
- Heterozygous (hybrid): When 2 genes are different for a trait
 - Bb is heterozygous
- Mendel's law of segregation states that the 2 genes we have for each trait get separated from one another when we make egg and sperm cells
- Mendel's law of independent assortment states that the gene for one trait is inherited independently of the genes for other traits
 - Only true when the genes are on different chromosomes

Punnett Squares

- Punnett squares are charts that are used to show the possible gene combinations in a cross between 2 organisms
 - * Let's say that B is the dominant gene for brown eyes and b is the recessive gene for blue eyes*
- Genotype: The genes of an organism (Bb)
- Phenotype: The physical appearance of an organism (Brown eyes)

<u>Parents</u> Bb x bb		<u>Offspring genotype</u> 50% Bb 50% bb <u>Offspring phenotype</u> 50% Brown eyes 50% blue eyes			
B	b				
b	<table border="1" style="display: inline-table;"> <tr> <td>Bb</td> <td>bb</td> </tr> <tr> <td>Bb</td> <td>bb</td> </tr> </table>	Bb	bb	Bb	bb
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Bb	bb				
Bb	bb				

<u>Parents</u> Bb x Bb		<u>Offspring genotype</u> 25% BB 50% Bb 25% bb <u>Offspring phenotype</u> 75% Brown eyes 25% blue eyes			
B	b				
B	<table border="1" style="display: inline-table;"> <tr> <td>BB</td> <td>Bb</td> </tr> <tr> <td>Bb</td> <td>bb</td> </tr> </table>	BB	Bb	Bb	bb
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Human Genetics

- Multiple alleles are three or more alleles that exist for a single gene
 - o For example, A, B, and O are the multiple alleles for blood type
 - o The possible blood types are A, B, AB, and O
 - You can be A+ or A-, B+ or B-, AB+ or AB-, O+ or O- depending on whether your blood cells have a special Rh protein
- Codominance occurs when 2 dominant genes are expressed and both genes are seen in the organism
 - o AB blood is codominant, a cat with black and white spots is codominant
- Incomplete dominance occurs when 2 dominant genes are expressed and blended together in the organism
 - o If the red flower color gene (R) is mixed with the white flower color gene (W) then the offspring will be pink (RW)
- A polygenic trait is a trait that is controlled by more than one pair of genes, like skin color
- A sex-linked trait is a trait that is found on the X chromosome, such as colorblindness
 - o Females are XX so have 2 copies of sex-linked traits
 - o Males are XY so have 1 copy of sex-linked traits

Ecology

Ecology

- Ecology is the study of how organisms fit into their environment
- A community is the organisms that live in a particular environment
- A habitat is the physical location of a community
- An ecosystem is a collection of organisms and their physical environment
- The diversity of an ecosystem is a measure of the number of species living there
- There are different feeding groups of organisms
 - o Autotrophs: Organisms that make their own food, like plants and some bacteria
 - o Heterotrophs: Organisms that cannot make their own food, like
 - Herbivores: Eat plants
 - Carnivores: Eat meat
 - Omnivores: Eat plants and meat

- There are different factors in an ecosystem
 - Abiotic factors are nonliving things
 - Biotic factors are living things, such as
 - Producers: Organisms that take in energy from their surroundings to make their own food
 - Consumers: Organisms that eat other organisms for energy
 - Decomposers: Special type of consumer that eats waste products and dead organisms for energy
- There are different trophic levels in a food chain
 - A trophic level is a feeding level in an ecosystem
 - A food chain is a lineup of organisms that shows the direction of energy flow (you can also determine what eats what)
 - 1st trophic level is usually a producer
 - 2nd trophic level is a primary consumer
 - 3rd trophic level is a secondary consumer
 - 4th trophic level is a tertiary consumer
 - and so on
 - Last trophic level is a decomposer
- Every time an organism eats, it obtains energy from its food
 - So energy is transferred from the 1st to the 2nd to the 3rd trophic level and so on (but some of this energy does get lost along the way)
 - Energy pyramid: Picture showing how much energy is transferred to the different trophic levels in a food chain
- A food web is a network of connected food chains

Cycles of Matter

- Water, nitrogen, carbon, and oxygen are recycled in the environment through cycles
- The nitrogen cycle
 - Nitrogen in the atmosphere is taken in by bacteria that live in plant roots
 - The nitrogen is passed onto the plants and any animals that eat the plants
 - Once the plant or animal has died, decomposers (bacteria) again take up the nitrogen in the dead material and send it back to the atmosphere
- The water cycle
 - Precipitation, such as rain and snow, fall to the earth
 - The water either
 - seeps into the ground for plants to use and the plants give off excess water back to the atmosphere
 - or runs off the land to lower-lying bodies of water where it evaporates back into the atmosphere
- The oxygen-carbon cycle
 - Carbon dioxide from the atmosphere is taken in by plants who use it during photosynthesis and release oxygen back into the atmosphere
 - Oxygen in the atmosphere is taken in by animals and plants who use it during respiration and release carbon dioxide back into the atmosphere

Interaction in an environment

- Each organism has a niche, or role, to play in its environment
- Competition is a struggle between organisms for resources, such as food, water, shelter
- Predators are organisms that catch, kill, and eat other organisms called prey
- Symbiosis is a close relationship between 2 organisms in which one organism lives near, on, or even inside another organisms and in which at least one organism benefits

- o There are three types of symbiosis
- o 1. Commensalism is when one of the 2 organisms benefits from the symbiosis
- o 2. Mutualism is when both organisms benefit from the symbiosis
- o 3. Parasitism is when one organism benefits (parasite) and the other organism is harmed (host) from the symbiosis
 - The parasite feeds on the host while it is still alive, weakening but not killing it
- An adaptation is a change in the behavior or physical characteristics of a species that make it better suited to its environment
- Populations of organisms increase and decrease due to overpopulation of a competitor or predator, disease, lack of food or water or shelter, and extreme weather
- Ecosystems are constantly changing due to changing populations of organisms, changing weather, natural disasters, and human activity
- Every time a change occurs, the balance of the ecosystem has to be readjusted

The Theory of Evolution

Evolution

- Evolution is a change in a species over time
- The theory of evolution was stated by Charles Darwin and is based on natural selection
- Natural selection states that organisms with traits well suited to an environment are more likely to survive and produce more offspring than organisms without these favorable traits
- Biodiversity: Organisms become very different from each other as they evolve and become better suited to their environments
- The theory of evolution is supported by evidence that includes
 - o Adaptations: structures and behaviors that organisms have evolved in order to survive better in their environments
 - o The fossil record which is information about all known fossils
 - o Comparative anatomy which is when the bodies of different organisms are compared to see if they are related
 - Homologous structures are body structures on different organisms that are similar
 - Vestigial structures are body structures that may have served a purpose in ancient ancestors but no longer are functional in current organisms
 - o The fact that all vertebrate embryos look very similar as they develop before birth
 - o The fact that the DNA of closely related organisms looks very similar

Taxonomy

- Taxonomy is the science of classifying and naming living things
- Organisms are organized into 7 different levels of taxonomy (King Philip Came Over From Great Spain)

o 1. Kingdom – most broad	o 5. Family
o 2. Phylum	o 6. Genus
o 3. Class	o 7. Species – most specific
o 4. Order	
- Closely related organisms have more levels of taxonomy in common than unrelated organisms

- There are six kingdoms of living things (Archie eats pretty fantastic apple pies)
 - o 1. Archaeobacteria: bacteria that live in extreme environments
 - o 2. Eubacteria: common bacteria
 - o 3. Protista: Single-celled eukaryotes
 - o 4. Fungi: Mushrooms, yeasts, molds
 - o 5. Animalia: multicelled heterotrophs
 - o 6. Plantae: multicelled autotrophs
- Every organism has a unique two-word scientific name that is written in Latin
 - o The first word is the genus, the second word is the species (Humans are *Homo sapiens*)
- Some scientists prefer to organize organisms into domains rather than kingdoms
 - o There are three domains (Archie eats eels)
 - o 1. Archaea: Bacteria that live in extreme environments
 - o 2. Eubacteria: Common bacteria
 - o 3. Eukarya: Organisms whose DNA is in a nucleus

Biology EOCT Study Guide

1. What is a compound?
2. What is the difference b/w organic and inorganic compounds?
3. What are the 4 major organic compounds found in all living things?

<u>Compound</u>	<u>Example(s)</u>	<u>Made up of</u>	<u>Main Functions</u>
a.			
b.			
c.			
d.			

5. What type of organic compound are enzymes?
6. Why are enzymes important?
7. Define cell.
8. What is the difference b/w unicellular and multicellular?
9. Define organelle.
10. What is the diff. b/w prokaryotes and eukaryotes?
11. What are the major functions of the following organelles:

a. nucleus	e. lysosome	i. Golgi body
b. mitochondrion	f. ribosome	j. cell membrane
c. chloroplast	g. endoplasmic reticulum	k. cytoplasm
d. centriole	h. vacuole	l. cytoskeleton

12. List 3 major differences b/w an animal cell and a plant cell.
13. List 4 differences b/w bacteria and other organisms.
14. What is the cell membrane made of?
15. Define phospholipid bilayer.
16. What does it mean to say the cell membrane is selectively permeable?
17. What are the 2 general types of membrane transport?
18. What is the diff. b/w the 2 types of transport?
19. Define diffusion. What type of transport is it?
20. Define osmosis.
What type of transport?

21. Define endocytosis and exocytosis.
What type of transport?
22. What are the 3 types of osmotic solutions and what is the diff. b/w them?
23. Write the chemical equation for photosynthesis.

(Write/Color oxygen orange, light yellow, carbon dioxide green, water blue, glucose black, and ATP red)
24. Write the chem equation for cell respiration.
25. Where in the cell does photosynthesis occur?
26. Where in the cell does cell respiration occur?
27. What types of organisms carry out photosynthesis?
28. What is ATP?
29. What are the 2 types of cell respiration and how are they different?
30. What types of organisms carry out aerobic resp?
31. What types of organisms carry out anaerobic resp?
32. Explain the process of aerobic resp.
33. Another word for anaerobic resp is _____.
34. Which process makes more ATP....aerobic or anaerobic?
35. Define chromosome.
36. Chromosomes are made up of _____, which are made up of DNA.
37. Define diploid and haploid.
38. What are homologous chromosomes?
39. What are the human diploid and haploid numbers?
40. What are gametes?
41. What is the diff. b/w autosomes and sex chromosomes?
42. A male's sex chromosomes are _____ and a female's are _____.
43. What is a karyotype?
44. What are the phases of the cell cycle?

45. What happens in each phase of the cell cycle?
46. Why does the DNA need to be copied BEFORE mitosis occurs?
47. What is the end result of mitosis?
48. List the phases of mitosis and explain what the chromosomes are doing in each phase.
49. What is cytokinesis?
50. What is the main diff. b/w mitosis and meiosis?
51. Define fertilization.
52. Define zygote.
53. Explain what happens to the chromosomes before meiosis, during Meiosis I and during Meiosis II.

54. What is the end result of meiosis?
55. What is DNA?
56. Where do you find DNA in eukaryotic cells?
Where in prokaryotic cells?
57. What shape does DNA have?
58. What are the rules of base-pairing?
59. What does it mean to say that DNA replication is a semiconservative process?
60. What are 3 differences b/w DNA and RNA?
61. Describe how DNA and RNA are used to make a protein.
62. Why is it worse to have a mutation in a sex cell than in a somatic cell?
63. How can mutations be harmful?
64. How can mutations be helpful?
65. How can mutations not affect the organism?
66. How can mutations be deadly?
67. Define mutagen and give 2 examples.
68. Who is the father of genetics?

69. What are alleles?
70. What is the diff. b/w dominant and recessive alleles?
71. Give 2 examples of a homozygous genotype.
72. Give an example of a heterozygous genotype.
73. What's the diff. b/w Mendel's laws of segregation and independent assortment?
74. What's the diff. b/w genotype and phenotype?
Give an example of each.
75. _____ is when 2 dominant alleles are expressed and the phenotype is blended.
76. _____ is when there are 3 or more alleles for a gene.
77. _____ is when a trait is controlled by more than one gene.
78. _____ are found only on sex chromosomes.
79. _____ is when 3 dominant alleles are expressed and both variations of the trait can be seen.
80. Give an example of: a. multiple alleles b. polygenic traits c. sex-linked traits
81. What is the diff. b/w a population and a community?
82. How is a habitat diff. from a niche?
83. List the levels of ecology from simplest to most complex.
84. What is biodiversity and why is it important in an ecosystem?
85. What is the diff. b/w autotrophs and heterotrophs?
86. Give 3 examples of abiotic factors.
87. Give 3 examples of biotic factors.
88. Define trophic level.
89. What trophic level do producers usually fall into?
90. What level do tertiary consumers fall into?
91. What is always at the top of a food chain/web?
92. What does an energy pyramid show?
93. What happens to energy as it is transferred through a food chain/web?

94. What major elements are cycled throughout the ecosystem?
95. What are the major organisms involved in the nitrogen cycle?
96. What 2 kingdoms are most involved in the oxygen-carbon dioxide cycle?
97. What type of symbiosis does each of these represent....
- a. +/-
 - b. +/-0
 - c. +/+
98. What is the diff. b/w a parasite and a predator?
99. Define adaptation.
100. What 5 factors can cause populations to increase/decrease?
101. What is the main diff. b/w primary and secondary succession?
102. Define evolution.
103. Who developed the theory of evolution by natural selection?
104. What is natural selection?
105. What is another (more common) way to define natural selection?
106. Explain the 5 pieces of evidence that supports evolution.
107. Define taxonomy.
108. List the 7 taxa in order from most specific to most broad.
109. Circle the 2 that are most closely related:
- Quercus alba*
 - Tyto alba*
 - Quercus phellos*
 - Freesia alba*
110. What is the main diff. b/w the 2 Domains/Kingdoms of bacteria?
111. What are the 3 Domains and how are they distinguished?
112. What are the 3 rules of binomial nomenclature (naming organisms)?
113. List the steps of the scientific method.
114. What is the diff. b/w a dependent and an independent variable?
115. What is the diff. b/w a control and a constant in an experiment?