

BIO GSE Portfolio Questions

Cells Domain

SB1. Obtain, evaluate, and communicate information to analyze the nature of the relationships between structures and functions in living cells.

- a. Construct an explanation of how cell structures and organelles (including nucleus, cytoplasm, cell membrane, cell wall, chloroplasts, lysosome, Golgi, endoplasmic reticulum, vacuoles, ribosomes, and mitochondria) interact as a system to maintain homeostasis.
- b. Develop and use models to explain the role of cellular reproduction (including binary fission, mitosis, and meiosis) in maintaining genetic continuity.
- c. Construct arguments supported by evidence to relate the structure of macromolecules (carbohydrates, proteins, lipids, and nucleic acids) to their interactions in carrying out cellular processes.
- d. Plan and carry out investigations to determine the role of cellular transport (e.g., active, passive, and osmosis) in maintaining homeostasis.
- e. Ask questions to investigate and provide explanations about the roles of photosynthesis and respiration in the cycling of matter and energy within the cell (e.g., single celled alga).

1. Differentiate between a prokaryote and eukaryote cell. List four items in each column.

Prokaryote	Both	Eukaryote
NONucleus NO organelles Unicellular	Ribosomes DNA Cytoplasm	Nucleus Organelles Both uni & multi cellular
Cell Walls Peptidoglycan	cell Membrane vacuoles	Cytoskeleton Cilia Phospholipids

2. Connect the following organelles together based on function.

a. Golgi apparatus, Endoplasmic reticulum, and bound ribosome:

Bound Ribosomes make proteins for export → Modified & transported by RER → Sort & package for delivery outside of cell

b. Food vacuole, cell membrane, and lysosome:

Cell membrane engulfs food, membrane surrounds "food" → lysosome merges w/ food vacuole & breaks it down

c. Chloroplast, mitochondria, and flagellum:

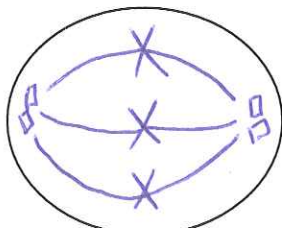
chloroplast makes glucose via photosynthesis → Mitochondria use glucose for E via Cellular Respiration → Helps cell move

3. Complete the chart on methods of cell division.

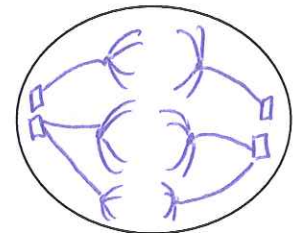
	Binary fission	Mitosis	Meiosis
Prokaryote or Eukaryote?	Prokaryote	Eukaryote	Eukaryote
Why use this cell division?	Reproduction	Growth & Repair	Make gametes (for reproduction)
Method(s) of variation	Mutations	Mutations	Synapse, Crossing over, Independent Assortment, Segregation
Results	2 identical	2 identical	4 different

4. Draw models of the following phases of mitosis and meiosis:

Metaphase of Mitosis



Anaphase I of Meiosis I



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5. Complete the chart on macromolecules.

	Monomer	Polymer	Function
Carbohydrates CHO	Monosaccharides [Glucose, Ribose, Fructose]	Disaccharides [sucrose, lactose] Polysaccharides [starch, glycogen, cellulose]	Provide E (short term & quick rel.)
Lipids CHO(P)	Fatty Acids & Glycerol	Triglyceride [Saturated/Unsaturated]	hormones, Fuel for cell, Protection, Insulation
Proteins CHON	Amino Acids [joined by peptide bonds]	Polypeptide Chain	Functional enzymes - Regulate cell process - Body structure
Nucleic acids CHONPS	Nucleotides [Nitrogenous Base, Sugar, Phosphate]	Nucleic Acid (DNA & RNA)	Make-up cells, Store & transmit genetic info.

6. Differentiate between passive and active transport.

	Passive Transport	Active transport
Energy requirement?	No energy required	Energy Required
Molecule movement with respect to a concentration gradient	Moves with concentration gradient (High to Low)	Moves against concentration gradient (Low to High)
Use of transport proteins	Channel proteins in FD allow molecules through cell membrane (passively) Carriers or	Protein pumps that require energy to move
Examples (Name 2)	Simple Diffusion, Osmosis, Facilitated Diffusion	Endo & Exocytosis, Na/K Pump, Proton Pump

7. Consider the following lab scenarios.

Hypotonic (↓ solute) = water out (Hyper. environ.) / Hypertonic (↑ solute) = water in (Hypo. environ.)
 A dialysis bag was placed in a solution of distilled water (0% solute). After a 24 hour time period, the mass of the bag changed from 10.0 g to 20.5 g. Using osmotic concentration terms, describe the bag's change in mass.



Environment = Hypotonic (↓ solute)
 Bag = Hypertonic (↑ solute concentration)

Water entered bag = ↑ mass

A zucchini core with an initial mass of 2.5 g was placed in an unknown solution. After a 24 hour time period, the mass of the core changed to 0.7 g. Using osmotic concentration terms, describe the core's change in mass.



Environment = Hypertonic (↑ solute)
 Zucchini = Hypotonic (↓ solute)

Water exited zucchini = ↓ mass (shrivel)

8. Euglena, unicellular autotrophic algae, are able to undergo two metabolic processes to sustain themselves. These organisms are able to use sunlight energy along with carbon dioxide and water to create glucose (sugar). This process creates "food" for euglena. They are then able to metabolize the sugar to create ATP (cellular energy molecules) to run processes such as mechanical work, transport work, activation of proteins, etc.

9. There is metabolic process that is common to all living organisms. It allows every organism no matter the oxygen requirement to synthesize 2 ATP. This process is known as glycolysis.

If this a common process, then what do we all have in common to allow it to occur?

Common genes/proteins/enzymes for the process

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Genetics Domain

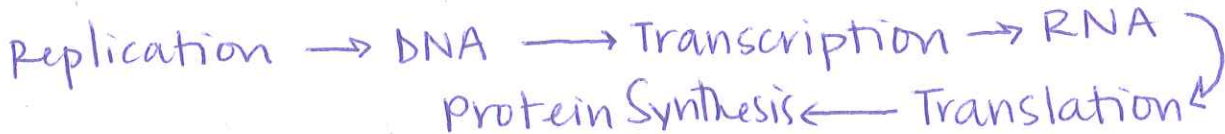
SB2. Obtain, evaluate, and communicate information to analyze how genetic information is expressed in cells.

- Construct an explanation of how the structures of DNA and RNA lead to the expression of information within the cell.
- Construct an argument based on evidence that inheritable genetic variations may result from:
 - new genetic combinations through meiosis (crossing over, nondisjunction);
 - non-lethal errors occurring during replication (insertions, deletions, substitutions); and/or
 - heritable mutations caused by environmental factors (radiation, chemicals, and viruses).
- Ask questions to gather and communicate information about the use and ethical considerations of biotechnology in forensics, medicine, and agriculture.

SB3. Obtain, evaluate, and communicate information to analyze how biological traits are passed on to successive generations.

- Use Mendel's laws (segregation and independent assortment) to ask questions and define problems that explain the role of meiosis in reproductive variability.
- Use mathematical models to predict and explain patterns of inheritance.
- Construct an argument to support a claim about the relative advantages and disadvantages of sexual and asexual reproduction for a population.

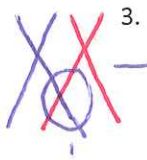
1. Outline the pathway of DNA to RNA to protein synthesis. *Central Dogma [DNA → RNA → Protein]*



2. Differentiate between the three major types of RNA involved in protein synthesis.

- mRNA: *Messenger - blueprint from DNA to make proteins*
- tRNA: *Transfer - brings AA to ribosomes during translation*
- rRNA: *Ribosomal - made in nucleolus; part of ribosome*

3. During meiosis, three unique events may occur to allow variety within gametes. Summarize the following events and how variations are possible from them: *→ X X*



a. Crossing over during Prophase I of Meiosis I:

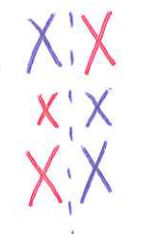
Tetrads cross chromatids & exchange information

b. Independent assortment during Meiosis I:

Involves 2 or more (non-linked) traits; genes on separate chromosomes assort into gametes independently

c. Nondisjunction during Anaphase I of Meiosis I or Anaphase II of Meiosis II:

1 pair of homologous chromosomes did not separate *1 pair of sister chromatids did not separate*



4. During replication of DNA, it is possible for DNA polymerase to make a mistake with base pairing. Provide a brief summary of the following gene mutations within DNA:

(DNA) TTC = AAG (RNA) = Lysine

a. Point mutation (substitution of a T for a C at the second letter of a triplet code):

TCC = A G G = Arginine **Not always an issue; only affects codon that contains the sequence*

b. Frameshift mutation (insertion of an A prior to the third letter of a triplet code):

TTAC = A A U C = Asparagine

** Usually insertions or deletions; tend to be a bigger issue*

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5. Describe the worst type of mutation for a cell. (Give details about the type of cell, the type of mutation, and resulting effects.)

Type of Cell = Gamete

Type of Mutation = Frameshift / Nondisjunction

Effects = Missence (wrong AA), Nonsense (premature stop), or abnormal chromosome #

6. Describe the advantages and disadvantages with the use of recombinant DNA in various fields (e.g. genetically modified foods, artificial selection, cloning, pharmaceutical products)

EMOs
Ad: More food on less land; Better yields
Dis: Don't know long term effects

AS
Ad: Choosing for specific traits; Better yields
Dis: ↓ gene pool = "inbreeding" or other genetic issues

Pharma
Ad: New vaccines, drugs, detectors, biopharmaceuticals
Dis: Ethics

7. Gregor Mendel postulated three scientific principles based on his experiments using garden pea plants. He first concluded that "discrete units" were inherited separately from each parent in to individual gametes. This first principle is known as Mendel's law of Segregation. He then concluded that the "discrete units" existed as alternate versions (which we now call alleles) and one version is known as dominant and the other as recessive. In order to inherit a dominant trait, one must inherit a dominant allele. This is known as Mendel's law of dominance. The final principle was one that Mendel discovered as he crossed plants with multiple characteristics (tall, purple flowered plant crossed with a short, white flowered plant). He found it was possible to have offspring as tall, white-flowered plants as the "discrete units" are inherited independently of each other.

8. Create Punnett squares and provide ratios or percentages for the following:

R = round r = wrinkled

Heterozygous round seed plant with a wrinkled seed plant. Provide the phenotype ratio.

$Rr \times rr$ Pheno = 1:1 50% or $\frac{1}{2}$ Round & 50% or $\frac{1}{2}$ Wrinkled

	R	r
r	Rr	rr

Pink snapdragon flowered plant with a white snapdragon flowered plant. Assume pink color is incomplete dominance. Give the percentage of pink flowering plant offspring.

$Rr \times rr$

	R	r
r	Rr	rr

50% or $\frac{1}{2}$ Pink

R = Red r = White Rr = Pink

Hemophilia is an X-linked recessive trait. A carrier female and a normal male. What is the likelihood of male offspring with hemophilia? H = Normal h = hemophilia

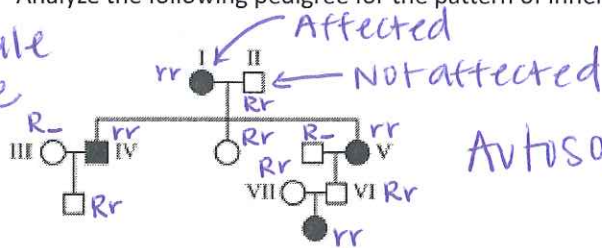
$X^H X^h \times X^H Y$

$\frac{1}{2}$ Males = 50%

	X^H	X^h
X^H	$X^H X^H$	$X^H X^h$
Y	$X^H Y$	$X^h Y$

9. Analyze the following pedigree for the pattern of inheritance in the family.

○ Female
□ Male



Autosomal Recessive

10. Within the life cycle of a eukaryote, the organism performs both asexual and sexual reproduction for different reasons.

- a. Which cell division of a eukaryote is associated with asexual reproduction? Why must a eukaryote use this division?

Mitosis - growth, repair, DNA overload

- b. To prepare for sexual reproduction, the eukaryote must undergo a different cell division. Which cell division is used and why?

Meiosis - to make gametes and vary offspring & genetics

- c. Describe the process of random fertilization.

Any sperm can fuse with any egg (represented by chance)

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Organisms Domain

SB4. Obtain, evaluate, and communicate information to illustrate the organization of interacting systems within single-celled and multi-celled organisms.

a. Construct an argument supported by scientific information to explain patterns in structures and function among clades of organisms, including the origin of eukaryotes by endosymbiosis. Clades should include:

- archaea
- bacteria
- eukaryotes
 - ☑☑fungi
 - ☑☑plants
 - ☑☑animals

b. Analyze and interpret data to develop models (i.e., cladograms and phylogenetic trees) based on patterns of common ancestry and evolution to determine relationships among major groups of organisms.

c. Construct an argument supported by empirical evidence to compare and contrast the characteristics of viruses and organisms.

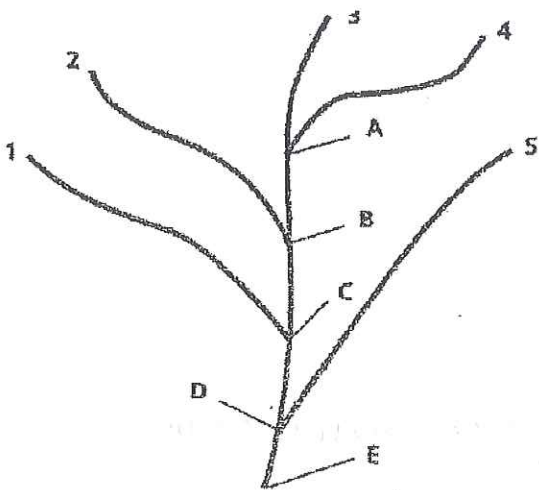
1. One definition of a virus says it is a non-living particle. Provide two pieces of evidence to support this claim.

DO NOT REPRODUCE ON OWN
NEED A HOST TO SURVIVE
NO NUCLEUS
DO NOT GROW
DO NOT MAKE ENERGY

2. Some scientists believe that viruses are actually obligate intracellular parasites. Provide two pieces of evidence to support this claim.

MUST HAVE HOST CELL FOR REPRODUCTION
HARM HOST CELL (LYTIC)

3. Phylogenetic tree -



a. Name the organisms that have ancestor B in common.

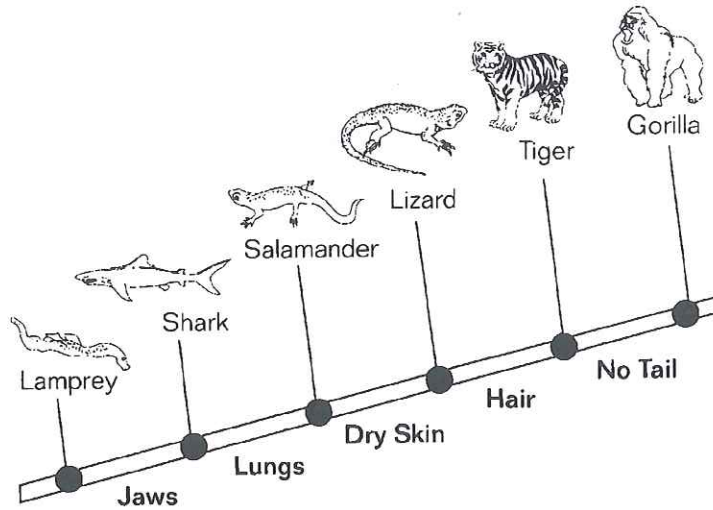
2, 3, 4

b. Identify the common ancestor to all organisms within the tree.

E

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4. Cladogram -



a. Identify the characteristic that a tiger possesses but a gorilla does not.

Tail

b. Describe the type of skin that a salamander would have.

Wet skin

5. In the 1990s, a kingdom known as Monera existed that encompassed all of the prokaryotic organisms into one kingdom. Upon further analysis, the Monera kingdom was differentiated into two kingdoms. Describe the differences that exist between Archaeobacteria and Eubacteria kingdoms that would lead scientists to make this change.

Extreme environments
cell walls don't have peptidoglycan
Found everywhere (most common)
Rigid cell wall of peptidoglycan

6. Within the Domain Eukarya, there is one kingdom that does not have one true ancestor. Scientists have found this kingdom to be greatly varied in structures, niche, and mode of nutrition. Identify the kingdom and the three main groups of organisms within it based on their niches.

Protista - includes organisms that resemble animal (protozoans), plant (protists), & fungi (slime molds)

7. As scientists began their classification schemes of eukaryotes, fungi were placed with plants.

a. Identify one similarity between the two (besides that they are both eukaryotes and multicellular)

cell wall (p-cellulose, F-chitin)

b. Identify two differences between the two.

Plants = autotrophic, chlorophyll
Fungi = heterotrophic, chloro.
Non-parasitic, mostly parasitic, no

8. In the 1970s, a scientist hypothesized that smaller free-living prokaryotes were once engulfed by larger prokaryotes, but instead of being digested, the smaller prokaryotes performed a function for the larger cell.

a. Name this theory.

Endosymbiotic Theory

b. Provide two pieces of evidence to support this theory.

have their own cell membrane, DNA, & capability of reproduction

c. Name two organelles that support this theory. Ecology Domain

Mitochondria & Chloroplasts

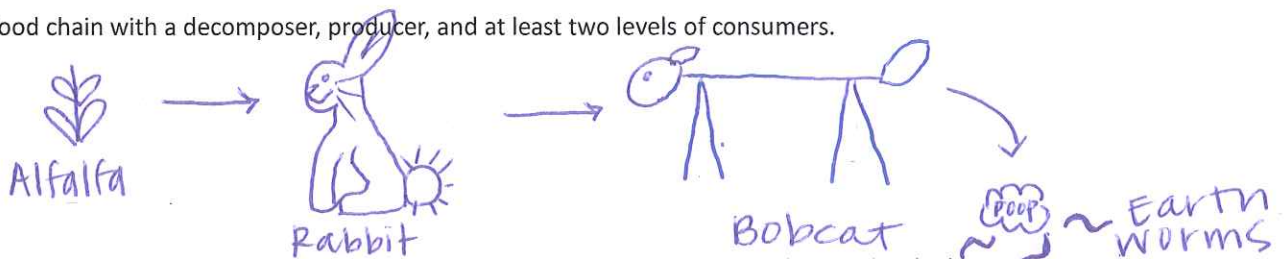
Ecology Domain-

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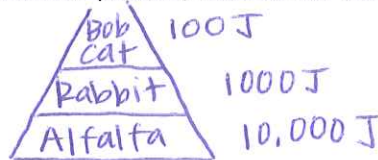
SB5. Obtain, evaluate, and communicate information to assess the interdependence of all organisms on one another and their environment.

- Plan and carry out investigations and analyze data to support explanations about factors affecting biodiversity and populations in ecosystems.
- Develop and use models to analyze the flow of matter and energy within ecosystems through the processes of photosynthesis and respiration by
 - Arranging components of a food web according to energy flow.
 - Comparing the quantity of energy in the steps of an energy pyramid.
 - Explaining the need for cycling of major biochemical elements (C, O, and H).
- Construct an argument to predict the impact of environmental change on the stability of an ecosystem.
- Design a solution to reduce the negative impact of a human activity on the environment.
- Construct explanations that predict an organism's ability to survive within changing environmental limits (e.g., temperature, pH, drought, fire).

1. Create a food chain with a decomposer, producer, and at least two levels of consumers.



2. Based on your food chain from the previous question, construct an energy pyramid. Consider the base energy amount at 10,000 Joules.



3. Describe the two major metabolic processes involved in the Carbon cycle. Describe the human activity that disrupts this cycle.

Two processes:

Cellular Respiration & Photosynthesis

Human activity:

Burning of fossil fuels (Land-use change)

4. Describe the nitrogen cycle (nitrogen fixation, nitrification, critical organisms, and denitrifying). Describe the human activity that disrupts this cycle.

Nitrogen fixation: Process by which earth's atmospheric nitrogen is converted into ammonia for living organisms

Nitrification: Oxidation of ammonia or ammonium to nitrite (Limiting step in N cycle)

Critical organism for nitrogen fixation:

Nitrogen-fixing Bacteria (found in ground/root nodules)

Denitrification:

Nitrate is reduced to form N_2 process

Human activity:

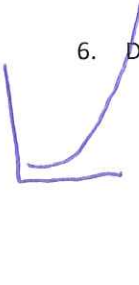
Fertilizer Run-off / Combustion (adds too much N in atmosphere = wrong form)

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5. Describe the water cycle (precipitation, evaporation, runoff, transpiration). Describe the human activity that disrupts this cycle.

- Precipitation: Atmospheric water that falls to ground (rain, sleet, hail, snow)
- Evaporation: Vaporization of liquid water to air
- Runoff: Precipitation that did not get absorbed by ground
- Transpiration: Vaporization of water from plants to air
- Human activity: Reservoirs, Urbanization, Deforestation

6. Differentiate between exponential and logistic growth models for a population. Draw the graphs for each model.



- Exponential: Rapid growth due to unlimited resources
- Logistic: Growth rate decreases as population reaches carrying capacity due to limited resources

7. Differentiate between density-dependent and density-independent factors that affect a population's size.

- Density – dependent: Disease, Predation, Starvation / competition
- Density – independent: Natural Disasters, Weather

8. Differentiate between primary and secondary succession of an ecosystem. Provide examples of each.

- Primary succession: Life grows on an area that never had life
- Rock, volcanic island
- Secondary succession: Life regrows on an area that once had life
- Volcanic eruption, deforestation, natural disaster

9. Describe the recovery of an ecosystem after a secondary succession event. Consider the progression of vegetation.

Soil → Grasses/weeds → Small Shrubs & Bushes → Evergreens → Deciduous/Conifers

10. Consider each of the following with the effect it has on an ecosystem and a method to help reduce the negative impact on the ecosystem.

	Effect on ecosystem	Reduce the negative impact
Trash/plastics on beach	Gets in ocean - kills animals that eat or get caught	
Runoff of chemicals in freshwater	Decreases amount of clean water, kills organisms	
Wildfires	Natural - helps some grow unnatural - kills off organisms	
Introduction of new species	No natural predators, affects organisms (kills off, etc)	

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Evolution Domain

SB6. Obtain, evaluate, and communicate information related to the theory of evolution.

- Construct an explanation of how new understandings of the age of Earth, the emergence of new species from pre-existing species, and our understanding of genetics have influenced our understanding of biology.
- Analyze and interpret data to explain patterns in biodiversity that result from speciation (macroevolution).
- Construct an argument to support the claim that evidence from comparative morphology (analogous vs. homologous structures), embryology, biochemistry (protein sequence) and genetics support the theory that all living organisms are related by way of common descent.
- Develop and use mathematical models to support explanations of how undirected genetic changes in natural selection and genetic drift have led to changes in populations of organisms (microevolution).
- Develop a model to explain the role evolution plays in causing biological resistance (e.g., pesticides, antibiotic resistance, and influenza vaccines).

1. How old is the Earth?

4.5 billion years old

2. Describe the use of the age of sedimentary rock layers and half-life of isotopes to predict the age of fossils.

Layers of rock tell the history of Earth, while fossils found in the rock tell the history of life. Age of rock & fossils are thought to be same age. Half-life of radioactive elements are used to determine age.

3. Describe the current understanding of genetics/chromosomal theory of inheritance.

Genes which contain an organism's genetic sequence of DNA are located on chromosomes, which are replicated & transferred to offspring via gametes

4. Both Lamarck and Darwin hypothesized an idea of descent with modification; however, their ideas of the inheritance of traits was different. Describe the current accepted hypothesis and how it aligns with our understanding of genetics.

Lamarck - acquired traits are passed to offspring
Darwin - organisms have more favorable traits which keep them alive to pass on to their offspring

Current = species change over time due to natural selection & give rise to new species.

5. Describe four key pieces of evidence to align with natural selection and/or descent with modification. These organisms

- Fossil Record** - transitional fossils have been found; we can look at the FR to see change over time. share a common ancestor
- Homologous Structures & Embryology** - structures look different, but are made from same bones that come from same undifferentiated cells in embryo; can be vestigial & have no use;
- DNA** - similarities in DNA & protein sequences; similarities in karyotypes suggest an evolutionary relationship
- Geographic Distribution** - closely related, but different species living in same geographic area [divergent] & different species that live far apart, but in similar habitats adapt to be more alike due to similar ecosystems [convergent]

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6. Draw and provide an example for each of the varied selection curves (directional, disruptive, and stabilizing).

	Graph	Example
<p>Directional Individuals at one end of the curve have a higher fitness than middle or end</p>		<p>Beak size - birds with bigger beaks can feed more easily on large seeds than small beaks when there's a food shortage</p>
<p>Disruptive Individuals @ extremes of the curve have a higher fitness than those in middle</p>		<p>Medium seeds become scarce, only small & large beak birds survive due to food choices</p>
<p>Stabilizing Individuals in center of curve have higher fitness than individuals at either end</p>		<p>Babies born with low or high birth weights have a higher mortality rate, so those in the center have a higher fitness</p>

7. Suppose a pathogen is introduced in a population.

a. What is a possible outcome from this pathogen on a small population with little variations?

Little variation = traumatic effect [Genetic Drift]

b. What is a possible outcome from this pathogen on a large population with variation?

Little to no change

c. What is a possible outcome from this pathogen if it only targets individuals that express recessive alleles?

Decrease recessive allele freq & increase in dominant allele

8. The key evolutionary factor that all organisms (including viruses) are capable of is to have a variation/mutation within DNA. This contributes to antibiotic resistance in bacteria and the use of different vaccines each year for viruses.

9. Differentiate between geographic and reproductive isolation. Provide one example of each.

Geo - caused by populations being separated by a physical barrier; form of reproductive isolation; ex - Darwin's finches

Pre & post-zygotic Iso - caused by populations being separated by behavioral, temporal, & geographic barriers; cause of speciation; ex - Hybrid viability & fertility [think mules]

10. Differentiate between the types of evolution. Provide an example of each.

	Summary	Example
Coevolution	2 or more species that adapt together as they interact	Flowering plants & insects [symbiotic relationships]
Convergent evolution	2 unrelated species share many characteristics due to living in same habitat	Arrow-dynamic nature of marine organisms [shark, whale, penguin]
Divergent evolution	2 or more species originate from same ancestral species & produce homologous structures	Limb structure of mammals - same bones, different forms