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| **Reporting Category 3: Biological Evolution and Classification** | |
| **\*10 Questions on STAAR; 8 questions on STAAR M** | |
| **\*3 readiness standards; 7 supporting standards** | |
| **TEK**  **(RS)- will be tested (65%)**  **(SS)- may be tested (35%)** | **Key Ideas** |
| **7A**  **analyze and evaluate how evidence of common ancestry among groups is provided by the fossil record, biogeography, and homologies, including anatomical, molecular, and developmental** | **Evidence of Common Ancestry Among Groups**  **(Theory that all organisms are descended from the same ancestor)**   1. **Fossil record**   **A variety of organisms that have existed at different times, including very simple, ancient species and the eventual arrival of more varied and complex species**   1. **Biogeography**   **Geographic distribution of organisms (species that live in the same area are more closely related, but related species can also be found living far apart)**   1. **Homologies** 2. **Anatomical Homologies**   **Structural similarities (like bones in a bird’s wing and the human arm) that serve a different purpose for each species.**   1. **Molecular Homologies**   **Molecular similarities among organisms (the genomes for humans and chimpanzees are about 99% identical)**   1. **Developmental Homologies**   **Embryonic similarities among certain organisms show how some organisms develop in common ways (vertebrate embryos have gill pouches that later develop into gills or Eustachian tubes)** |
| **B.7.E analyze and evaluate the relationship of natural selection to adaptation and to the development of diversity in and among species** | **Evolution is the process through which species change over time.**   * **Natural Selection is a theory proposed by Charles Darwin that explains how evolution occurs. It proposes that those individuals in a population that are better adapted to their environment are more likely to survive and reproduce.** * **Inherited variations are differences in traits of individuals of the same species.** * **Adaptation is a trait that increases an organism’s chances of survival in its environment, such as white fur increasing an organism’s chances of survival in a snow- covered environment.** |
| **B.8.B categorize organisms using a hierarchical classification system based on similarities and differences shared among groups** | **How do scientists categorize organisms?**  **Scientists may use several ways to categorize organisms. It depends if they are looking at a group of organisms or an individual organism. They may use the following:**   * **Cladogram- a diagram that shows relationships among groups of organisms** * **Dichotomous key- determine the identity of a single organism**   **What is a cladogram?**   * **A cladogram is used to show the evolutionary relationships among species. They show how members of a group change over time, giving rise to new groups.** * **In a cladogram, more closely related groups are appear closer together while more distantly related groups are farther away.**   **Cladogram**  **What is a dichotomous key?**  **Dichotomous Key - a tool that allows the user to determine the identity of items by their characteristics, such as insects, leaves, trees, mammals, reptiles and others.**   |  |  | | --- | --- | | **Follow the clues in a dichotomous key to identify**  **the organism!** | **MM900356797[1]** |   **Dichotomous Key for Leaves** |
| **7B**  **analyze and evaluate scientific explanations concerning any data of sudden appearance, stasis, and sequential nature of groups in the fossil record** | **Scientists established a fossil record that reveals that evolution can proceed slowly with gradual changes in spurts with sudden changes. Organisms represent living fossils because they look very much like their ancestors that lived long ago.**   * **The fossil record is a timeline that shows how life has evolved in Earth. It is organized according to the age of the fossil and their similarities.** * **Gradualism is the process of evolution in which a species changes very slowly over a very long period** * **Punctuated equilibrium is the process of evolution where a species experiences little or no change for long periods, followed by sudden change**   **A living fossil is a species that shows little or no change since its ancestor first appeared on Earth** |
| **7C**  **analyze and evaluate how natural selection produces change in populations, not individuals** | **What is Natural Selection?**  **A population is a group of individuals of the same species who interbreed. Individuals in a population have varying traits. For ex: some dogs may have a sharper sense of smell than other dogs and can hunt better than other dogs (ex: blood hounds vs. poodles)**  **A variation that makes an organism more successful in its environment is called adaptation. Meiosis creates variation among individuals which causes consequences at the population level**  **Individuals with adaptations that help them survive and reproduce in their environment have high fitness.**  **Fitness refers to an organism’s ability to survive and reproduce in its environment.**  **Although individual variation is the root of natural selection, populations evolve by natural selection.**  **Natural selection is a process in which organisms with adaptations best suited to their environment leave more offspring than other organisms. Because these organisms produce more offspring, their genetic variations become more prevalent in a population and the population changes or evolves.**  **How does natural selection produce changes in populations and not individuals?**  **Natural selection can occur in a variety of ways. Natural selection on trait controlled by a single gene with two alleles can cause one allele to increase and the other to decrease. Polygenic traits are more complicated. Natural selection on polygenic traits that can occur as directional selection, stabilizing selection, or disruptive selection. Each of these ways causes a distinct change to a population.**  **Natural Selection on Polygenic traits**   |  |  | | --- | --- | | **Directional selection** | **Occurs when individuals with a particular phenotype (physical feature you see) have an advantage in their environment.**  **Often a single gene controls the trait.**  **Ex: A birds with larger beak sizes are more successful at surviving ihan birds with small or medium sized beaks.** | | **Stabilizing selection** | **Occurs when extremes in phenotypes gives individuals in the population a disadvantage. Often these traits are polygenic- controlled by multiple genes.**  **Ex: Body size of an organism. For most organisms, extremely large or extremely small body types are not favorable for survival.** | | **Disruptive selection** | **Occurs when extreme phenotypes for a trait are adaptive.**  **Ex: If bird beaks of an intermediate size are a disadvantage for survival, birds with small or large beaks are more likely to survive.**  **If the pressure in natural selection lasts long enough, birds will have beaks that are large or small.** | |
| **B.7.D analyze and evaluate how the elements of natural selection, including inherited variation, the potential of a population to produce more offspring than can survive, and a finite supply of environmental resources, result in differential reproductive success** | **What causes inherited variation among individuals in a population?**   * **Inherited variation refers to the genetic differences among individuals in a population, such as a body size or fur color. Can be caused by mutations in DNA that affect the way genes are expressed. Other causes include crossing- over and the independent assortment of chromosomes that occur during meiosis. Variations can be introduced when individuals migrate from one population to another and mate.** * **2 components of inherited variation are genotype and phenotype.** * **Knowing the frequency of alleles and phenotypes in a population is important for understanding how natural selection could affect the evolution of a population.**   **What contributions to differential reproductive success?**  **Natural selection is caused by an environmental stressor for which specific phenotypes have a fitness advantage. Over time, the individuals with those adaptive phenotypes survive and reproduce, which makes the allele responsible for the phenotype more common in the population.**   |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | **Environmental resources**  **The environment may pose many challenges. Resources are scarce and predators and competitors are numerous. Many organisms will die before they reproduce.**  **However, certain phenotypes can give some individuals a fitness advantage. Fitness refers to an organism’s ability to survive, attract a mate, and reproduce within a particular environment.**  **The difference in the number of offspring produced by 2 phenotypes is called differential reproductive success. Natural selection is the process by which traits become more or less common in a population due to differential reproductive success. There are several elements of natural selection.**   |  |  | | --- | --- | | **Inherited variation** | **Inherited traits that are favored – ie. Black mice that survive in an environment because they can camouflage better than brown mice- continues while the least favored trait declines. Mice with the black fur will have a better chance of surviving and passing on their alleles. If the environment changes, the relative fitness of individuals can change.** | | **Producing more offspring than can survive** | **Most populations produce far more offspring than can survive in any given environment due to resource constraints.**  **When populations produce many more offspring than can survive, the likelihood increases that some offspring will reach reproductive age. The ones that do reproduce likely have phenotypes gave them an advantage within that environment over those that did not survive or reproduce.** | | **Limited supply of environmental resources** | **In any environment, organisms compete for limited resources- space, food, and shelter.**  **When resources become scarce, such as a drought, then competition increases.**  **Populations often decline, and the individuals with advantageous traits for survival are most likely to live and reproduce.** | | |
| **7.F analyze and evaluate the effects of other evolutionary mechanisms, including genetic drift, gene flow, mutation, and recombination** | **Other Evolutionary Mechanisms**   |  |  | | --- | --- | | **Genetic drift** | **Change in the gene pool caused by chance; tends to decrease a species’ genetic variation**  **Example: Flood kills 95% of a worm population** | | **Gene flow** | **Change in gene pool caused by movement of organisms into (increase genetic variation) or out of (decrease genetic variation) the population** | | **Mutation** | **Change in the genetic pool caused by insertion, deletion, or substitution in DNA sequence of gamete cell; tends to increase genetic variation** | | **Recombination** | **Sexually reproducing species have increased genetic variation because of gene crossover events during meiosis** | |
| **B.7.G analyze and evaluate scientific explanations concerning the complexity of the cell** | **Complexity of the Cell**  **What do scientists think ancient cells were like?**   * **No one knows when the first cells lived on Earth. Microscopic fossils that look like bacteria may have been on rock for 3.5 billion year. These ancient fossils may have been ancestors of prokaryotes.** * **The first cells lived on Earth when its atmosphere lacked oxygen. They were similar to prokaryotes who live in extreme environments.** * **Over time, cellular processes such as photosynthesis and cellular respiration developed. Photosynthetic bacteria were the first organisms to perform photosynthesis about 2.2 billion years ago.**   **What are some scientific explanations for how the complexity of cells changed over time?**  **The oldest known fossils of eukaryotes are 2.1 billion years old and resemble green algae. Theories were proposed to explain this phenomenon.**  **Endosymbiotic theory- some organelles in eukaryotic cells formed from symbiotic relationships between early prokaryotes and eukaryotes.**  **Endosymbiosis- is a process in which one organism lives inside another organism to the benefit of both. According to the endosymbiotic theory, free- living aerobic bacteria became endosymbionts inside larger, anaerobic cells. Over time, they evolved into the organelles that are now observed as mitochondria. In another endosymbiotic process, free- living photosynthetic bacteria become chloroplasts. Lynn Margolis proposed this theory.** |
| **B.8.A define taxonomy and recognize the importance of a standardized taxonomic system to the scientific community** | **Taxonomy**  **Taxonomy is the study of the classification of organisms, enables the international scientific community to use a common system to identify, organize, and classify new and existing organisms or groups of organisms. Carolus Linneaus developed this system.**  **Binomial nomenclature- “two word naming system”; The first word is the organism’s genus or the group at which it and other species belong. The second word is a species’ name. A species is a group of organisms that can breed or reproduce with one another and produce fertile offspring. Ex: Humans are called *Homo sapiens;* Binomial nomenclature: system of naming an organism using its genus and species; write in italics and capitalize only the genus**  **LEVELS OF CLASSIFICATION:**  **Kingdom Phylum Class Order Family Genus Species**  **(Largest) (Smallest)**  **To help you remember: Think of the following: (King Philip came Over For Grape Soda)**  **CLASSIFICATION OF HUMANS:**   * **Kingdom *Animalia* (multicellular organisms that eat food)** * **Phylum *Chordata* (dorsal hollow nerve cord, notochord, pharyngeal slits)** * **Class *Mammalia* (hair, mammary glands, endothermy, four-chambered heart)** * **Order *Primates* (nails, clavicle, orbits encircled with bone, enlarged cerebrum, opposable digits)** * **Family *Homidae* (bipedal – walk erect on two feet, advanced tool use)** * **Genus *Homo* (“human” like)** * **Species *Homo sapiens***   **Why is a standardized taxonomic system important to the scientific community?**  **It allows scientists to communicate precisely about a species they are studying. The use of common names causes far too much confusion. 2 names are much more precise by using only the genus and species. We immediately know the group and their characteristics.**  **Ex: camel - there are many species of camels.**  **A scientific name such as *Camelus bactrianus* is recognized all around the world as only one type of camel.**  **Before Linneau’s taxonomic naming system, scientists would use scientific names in as many as seven words and a species had more than one scientific name. Ex: a wild rose would be labeled as *Rosa sylvestris inodora seu canina*** |
| **B.8.C compare characteristics of taxonomic groups, including archaea, bacteria, protists, fungi, plants, and animals** | **6 Kingdoms of Classification**  **Taxonomy is the study of the classification of organisms, enables the international scientific community to use a common system to identify, organize, and classify new and existing organisms or groups of organisms**  **Autotroph: organism that makes its own food Ex: plants**  **Heterotroph: organisms that depends on other organisms for food**  **3 Domains are used to classify or group all organisms**   |  |  | | --- | --- | | **Domain** | **Description** | | **Archae** | **Primitive unicellular eukaryotes; some autotrophs and some heterotrophs ; some live in harsh or extreme conditions**   |  |  | | --- | --- | | **Kingdom** | **Archaebacteria** | | **Cell type** | **Prokaryote** | | **Cell structures** | **Cell walls without peptidoglycan** | | **# of cells** | **Unicellular** | | **Nutrition** | **Autotroph or heterotrophy** | | **Reproduction** | **Asexual by binary fission** | | **Metabolism** | **Asexual** | | **Examples** | **Methanogens (gas loving bacteria), halophiles (salt loving bacteria- Ex: Dead Sea)** | | | **Bacteria** | **Unicellular prokaryotes; some autotrophs, but most are heterotrophs; typically bacteria**   |  |  | | --- | --- | | **Kingdom** | **Eubacteria** | | **Cell type** | **Prokaryote** | | **Cell structures** | **Cell walls with peptidoglycan** | | **# of cells** | **Unicellular** | | **Nutrition** | **Autotroph or heterotrophy** | | **Reproduction** | **Animal** | | **Metabolism** | **Aerobic or anaerobic** | | **Examples** | **Streptococcus, Escherichia coli (E. coli)** | | | **Eukarya** | **Eukaryotes; wide variety**   |  |  |  |  |  | | --- | --- | --- | --- | --- | | **Kingdom** | **Protista** | **Fungi** | **Plantae** | **Animalia** | | **Cell type** | **EUKARYOTE** | **EUKARYOTE** | **EUKARYOTE** | **EUKARYOTE** | | **Cell structures** | **Some: cell walls of cellulose; Some: cilia** | **Cell walls of chitin** | **Cell walls of cellulose; chloroplasts** | **No cell walls or chloroplasts** | | **# of cells** | **Most unicellular; some colonial; some multicellular** | **Most multicellular; some unicellular** | **Most multicellular; some green algae unicellular** | **multicellular** | | **Nutrition** | **Autotroph or heterotroph** | **heterotroph** | **Autotroph** | **Heterotroph** | | **Reproduction** | **Asexual or sexual** | **Asexual or sexual** | **Asexual or sexual** | **Usually sexual** | | **Metabolism** | **Most are aerobic** | **Anaerobic or aerobic** | **Aerobic** | **Aerobic** | | **Examples** | **Amoeba, paramecium, slime, molds, giant kelp** | **Mushrooms, yeast - *Candida albicans* (yeast infection); *Tinea pedis* (athlete’s foot)** | **Mosses, ferns, flowering plants** | **Sponges, worms, insects, fishes, mammals** | |  | |