Keystone Biology Module B Fact Sheet

Cell Growth and Reproduction

Module B, Anchor 1

**Key Concepts:**

- The larger a cell becomes, the more demands the cell places on its DNA. In addition, a larger cell is less efficient in moving nutrients and waste materials across the cell membrane.

- Asexual reproduction is the production of genetically identical offspring from a single parent.

- Offspring produced by sexual reproduction inherit some of their genetic information from each parent.

- Chromosomes make it possible to separate DNA precisely during cell division.

- During the cell cycle, a cell grows, prepares for division, and divides to form two daughter cells.

- During prophase, the genetic material inside the nucleus condenses. During metaphase, the chromosomes line up across the center of the cell. During anaphase, the chromosomes separate and move along spindle fibers to opposite ends of the cell. During telophase, the chromosomes, which were distinct and condensed, begin to spread out into tangle of chromatin.

- The cell cycle is controlled by regulatory proteins both inside and outside the cell.

- Cancer cells do not respond to the signals that regulate the growth of most cells. As a result, the cells divide uncontrollably.

- The diploid cells of most adult organisms contain two complete sets of inherited chromosomes and two complete sets of genes.

- In prophase I, replicated chromosomes pair with corresponding homologous chromosomes. At metaphase I, paired chromosomes line up across the center of the cell. In anaphase I, chromosome pairs move toward opposite ends of the cell. In telophase I, a nuclear membrane forms around each cluster of chromosomes. Cytokinesis forms two new cells. As the cells enter prophase II, their chromosomes become visible. The final four phases of meiosis II result in four haploid daughter cells.

- In mitosis, when the two sets of genetic material separate, each daughter cell receives one complete set of chromosomes. In meiosis, homologous chromosomes line up and then move to separate daughter cells. Mitosis does not normally change the chromosome number of the original cell. Meiosis reduces the chromosome number by half. Mitosis results in the production of two genetically identical diploid cells, whereas meiosis produces four genetically different haploid cells.

- Alleles of different genes tend to be inherited together from one generation to the next when those genes are located on the same chromosome.

Genetics

Module B, Anchor 3

**Key Concepts:**

- An individual’s characteristics are determines by factors that are passed from one parental generation to the next.

- During gamete formation, the alleles for each gene segregate from each other so that each gamete carries only one allele for each gene.

- Punnett squares use mathematical probability to help predict the genotype and phenotype combinations in genetic crosses.

- The principle of independent assortment states that genes for different traits can segregate independently during the formation of gametes.

- Mendel’s principles of heredity, observed through patterns of inheritance, form the basis of modern genetics.

- Some alleles are neither dominant nor recessive. Many genes exist in several different forms and are therefore said to have multiple alleles. Many traits are produced by the interaction of several genes.

- Environmental conditions can affect gene expression and influence genetically determined traits.

- The DNA that makes up genes must be capable of storing, copying, and transmitting the genetic information in a cell.

- DNA is a nucleic acid made up of nucleotides joined into long strands or chains by covalent bonds.

- DNA polymerase is an enzyme that joins individual nucleotides to produce a new strand of DNA.

- Replication in most prokaryotic cells starts from a single point and proceeds in both directions until the entire chromosome is copied.

- In eukaryotic cells, replication may begin at dozens or even hundreds of places on the DNA molecule, proceeding in both directions until each chromosome is completely copied.

- The main differences between DNA and RNA are that (1) the sugar in RNA is ribose instead of deoxyribose; (2) RNA is generally single-stranded, not double-stranded; and (3) RNA contains uracil in place of thymine.

- In transcription, segments of DNA serve as templates to produce complementary RNA molecules.

- The genetic code is read three “letters” at a time, so that each “word” is three bases long and corresponds to a single amino acid.

- Ribosomes use the sequences of RNA codons to assemble amino acids into polypeptide chains.

- The central dogma of molecular biology is that information is transferred from DNA to RNA to protein.

- Mutations are heritable changes in genetic information.

- The effects of mutations on genes vary widely. Some have little or no effect; some produce beneficial variations. Some negatively disrupt gene function.

- Mutations often produce proteins with new or altered functions that can be useful to organisms in different or changing environments.

- Human genes follow the same Mendelian patterns of inheritance as the genes of other organisms. Many human traits follow a pattern of simple dominance. The alleles of other human genes display codominant inheritance. Because the X and Y chromosomes determine sex, the genes located on them show a pattern of inheritance called sex-linkage.

- Changes in a gene’s DNA sequence can change proteins by altering their amino acid sequences, which may directly affect one’s phenotype.

- If nondisjunction occurs during meiosis, gametes with an abnormal number of chromosomes may result, leading to a disorder of chromosome numbers.

- Recombinant DNA technology – joining together DNA from 2 or more sources – makes it possible to change the genetic composition of living organisms.

- Transgenic organisms can be produced by the insertion of recombinant DNA into the genome of a host organism.

- Ideally, genetic modification could lead to better, less expensive, and more nutrition food as well as less harmful manufacturing processes.

- Recombinant DNA technology is advancing the prevention and treatment of disease.

- DNA fingerprinting analyzes sections of DNA that vary widely from one individual to another.

Evolution

Module B, Anchor 3

**Key Concepts:**

- Alleles that give an organism a better chance of survival in their environment, better chance of reproduction, will become more frequent in a population.

- Isolating mechanisms contribute to the development of new species by preventing groups of organisms from mating. Difference accumulate over time that result in new species. Two main types of isolating mechanisms are geographic (barriers separate groups of organisms) and reproductive (including behavioral and temporal)

- Genetic drift is the random chance events that occur to result in changes in a population. Two examples of this are founder effect (part of a population colonizes a new area and starts a new population where differences can accumulate to form new species) and bottlenecking (great disturbance – such as a volcanic eruption wipes out part of a population).

- Genetic mutations lead to genetic variation within a population. Genetic mutations can alter the genotype of an individual which can alter the phenotype of an individual.

- Fossils show a pattern of development from early ancestors to modern descendants. Fossils provide

an actual record of Earth’s past life-forms and demonstrate a change over time

- Anatomical comparisons of the different types of organisms often reveal basic similarities in body structures even though the structure’s function may differ between organisms.

Different anatomical structures:

1. Vestigial structures: structures present in organisms, but are reduced in size and either have no or little function than in other related species.

Ex: Human appendix, whale hip bone

2. Homologous structures: structures derived from a common ancestor or same evolutionary or developmental origin.

Ex: The forearm of the crocodile, cat, bat and bird

3. Analagous Structures: Structures of different species having similar or corresponding function but not from the same evolutionary origin.

Ex: The wings of a bat and a butterfly

- At some time in development, all vertebrates have a tail, buds that become limbs, and pharyngeal pouches.

- With the increase of anatomical differences, protein and DNA differences also increase.

- Hypothesis is a proposed explanation for a phenomenon, it is an idea about the solution to a problem utilizing knowledge & research. It is also used to help guide scientists through the experimental process.

- Inference is a conclusion drawn from specific observations.

- Law is the summarizing statement of observed experimental facts that have been tested many times and is generally accepted to be true.

- Theory represents a hypothesis or group of related hypotheses, which has been confirmed through repeated experimental tests.

- Principle is a basic truth, law, or assumption.

- Fact is something demonstrated to exist or known to have existed.

- Observation is an inference or a judgment that is acquired from or based on observing.

Ecology

Module B, Anchor 4

**Key Concepts:**

- The biological influences on organisms are called biotic factors. The physical components of an ecosystem are called abiotic factors.

- Primary producers are the first producers of energy-rich compounds that are later used by other organisms. Organisms that rely on other organisms for energy and nutrients are called consumers.

- Energy flows through an ecosystem in a one-way stream, from primary producers to various consumers. Pyramids of energy show the relative amount of energy available at each trophic level of a food chain or food web. A pyramid of biomass illustrates the relative amount of living organic matter available at each trophic level of an ecosystem. A pyramid of numbers shows the relative number of organisms at each tropic level in an ecosystem.

- Unlike the one-way flow of energy, matter is recycled within and between ecosystems.

Water continuously flows between the oceans, the atmosphere, and land – sometimes outside organisms and sometimes inside organisms. Every organism needs nutrients to build tissues and carry out life functions. Like water, nutrients pass through organisms and the environment through biogeochemical cycles. The carbon, nitrogen, and phosphorus cycles are particularly important for life.

- A region’s climate is defined by year-after-year patterns of temperature and precipitation. Global climate is shaped by many factors, including solar energy trapped in the biosphere, latitude, and the transport of heat by winds and ocean currents.

- A niche is the range of physical and biological conditions in which a species lives and the way the species obtains what it needs to survive and reproduce.

- By causing species to divide resources, competition helps determine the number and kinds of species in a community and determine the number and kinds of species in a community and the niche each species occupies.

- Predators can affect the size of prey populations in a community and determine the places prey can live and feed. Herbivores can affect both the size and distribution of plant populations in a community and can determine the places certain plants can survive and grow.

- Biologists recognize three main classes of symbiotic relationships in nature: mutualism, parasitism, and commensalism.

- Ecosystems change over time, especially after disturbances, as some species die out and new species move in. Secondary succession in healthy ecosystems following natural disturbances often reproduces the original climax community. Ecosystems may or may not recover from human disturbances.

- Biomes are described in terms of abiotic factors like climate and soil type, and biotic factors like plant and animal life.

- Ecologists typically divide the ocean into zones based on depth and distance from shore.

- The factors that can affect population size are the birthrate, the death rate, and the rate at which individuals enter or leave the population.

- Under ideal conditions with unlimited resources, a population will grow exponentially. Logistic growth occurs when a population’s growth slows and then stops, following a period of exponential growth.

- Acting separately or together, limiting factors determine the carrying capacity of an environment for a species.

- Birthrates, death rates, and the age structure of a population help predict why some countries have high growth rates while other countries grow more slowly.

- Humans affect regional and global environments through agriculture, development, and industry in ways that have an impact on the quality of Earth’s natural resources, including soil, water, and the atmosphere. Sustainable development provides for human needs while preserving the ecosystems that produce natural resources.

- Biodiversity’s benefits to society include contributions to medicine and agriculture, and the provision of ecosystem goods and services. Humans reduce biodiversity by altering habitats, hunting, introducing invasive species, releasing pollution into food webs, and contribution to climate change.