

DNA and Genetics Scientific Principles

Section 1

SP #1 - DNA is found in the cells of all living things.

SP #2 - There is lots of DNA found inside cells. In one human cell there is about 2m of DNA (~ 6 feet) if the DNA is all straightened out end to end.

SP #3 - Usually DNA is all spread out in the nucleus like spaghetti. Before cell reproduction, it packages all the DNA into chromosomes.

SP # 4 - DNA is a long chain of nucleotides.

SP #5 - Each nucleotide has three parts - phosphate group, sugar (deoxyribose), and a base.

SP #6 - In DNA, there are four different bases - adenine (A), thymine (T), cytosine (C), and guanine (G).

SP #7 - Two bases pair to form the rungs of the ladder. Adenine always pairs with thymine. Guanine always pairs with cytosine.

SP #8 - The phosphate groups and sugar groups alternate to form the backbone of the DNA (the sides to the ladder).

SP #9 - Before a cell can reproduce, a copy must be made of the DNA.

SP #10 - To make a copy of the DNA, the DNA double helix must be unwound, the two strands must be separated (much like the two sides of a zipper). Each strand serves as the template for the new strand of DNA. A new chain of nucleotides is made that is complementary to the old strand. In the end you have two strands of identical DNA in which half is the old strand of DNA and the other half is a new matching chain of nucleotides.

Section 2

SP #11 - Traits are controlled by alleles on chromosomes. The order of the bases, determines what instructions the DNA provides and which traits are visible in the organism.

SP #12 - DNA can be divided up into different sections called genes. A gene is just a section of DNA that encodes for a specific characteristic.

SP #13 - Humans are diploid organisms, carrying two complete sets of chromosomes in their cells. Each parent gives one set of genes to their offspring. The two sets combined provide a full complement of chromosomes which means that the offspring have two copies of every gene.

SP #14 - When scientists look at the genes of an organism, they can read the DNA and determine which genes are present in their DNA. This is called the genotype of an organism.

SP #15 - When scientists look at an organism, they can make observations about the traits they have. This is called the phenotype of an organism. Scientists use adjectives (describing words) to represent the phenotype of an organism.

SP #16 - If you know the genotype of an organism, you can always determine what the organism should look like. But the reverse is not always true as most of the time you can't determine the genotype of the organism just by looking at it.

SP #17 - The different traits for one characteristic are encoded by different flavors of the gene. The different forms are known as alleles.

SP #18 - Dominant alleles only have to have one copy in order for the trait to be present. If there is one present, this will be the organism's phenotype. These are usually shown with a capital letter.

SP #19 - Recessive alleles have to have two copies in order for the trait to be present. Only when both copies are the recessive allele will this be the organism's phenotype. These are usually shown with a lowercase letter

SP #20 - Some characteristics are rule followers which means that one copy of the dominant allele means that the dominant phenotype will be expressed. This is called Mendelian genetics.

SP #21 - Some characteristics are because of one gene while other characteristics happen because of the interaction of several different genes. For example, eye color in humans is

controlled by two major genes and several minor genes that help make all of the variations seen in humans.

Section 3

SP#22 - In order for the cell to make proteins, the DNA is transcribed into RNA. The cell then reads the RNA to determine the order of the amino acids to create the proteins (this is called translation).

SP #23 - Random changes in the number, type, or order of bases on a piece of DNA are known as mutations. There are three main types of mutations - deletion (a base is left out), insertion (an extra base might be added), and the most common change a substitution (when one base replaces another).

SP #24 - Mutations to the DNA may be beneficial, neutral, or harmful. Beneficial mutations lead to new versions of proteins that help organisms adapt to changes in their environment. Harmful mutations may cause the proteins to change how they function so they don't work as well or make the organism not fit well in their environment. Neutral mutations lead to no real change in the protein or how the protein works which means that it doesn't affect the survival of the organism in any way.

SP #25 - Some characteristics are rule breakers which means that they do not follow the rule if there is one copy of the dominant allele the dominant phenotype will show up. Examples of this include incomplete dominance, codominance, polygenic traits, and epistasis. These are called non-Mendelian genetics.

SP not used in 2021-2022

SP #26 - Selective breeding involves choosing parents with particular characteristics to breed together and produce offspring with more desirable characteristics. Humans have selectively bred plants and animals for thousands of years to create crops with better yields.

SP #33 - A species is a group of related organisms that share common characteristics and are capable of interbreeding to produce fertile offspring.

SP moved to the Cells Unit

SP #25 - Asexual reproduction has advantages and disadvantages. Advantages include it is quick, does not need a partner, and requires less energy. The disadvantage is that all of the offspring are identical so in a changing environment they might not survive.

SP #26 - Sexual reproduction has advantages and disadvantages. Advantages include producing genetic variation so the offspring have an increased chance of survival in a changing environment. The disadvantages include it is slower, needs a partner, requires complex structures, and requires more energy.

SP #27 - Cells have a life cycle called the cell cycle and includes three major stages:

- Interphase - the cell is growing and carrying out life process;
- Mitosis - the cell is creating two identical nuclei
- Cytokinesis - the cell splits into two identical cells

Most of a cell's life is spent in interphase.

SP #28 - Mitosis is part of cell reproduction and results in two identical nuclei that can be used to create two new cells. Mitosis has four steps:

Prophase - the DNA is folded into chromosomes

Metaphase - the chromosomes line up along the MIDDLE

Anaphase - the chromosomes separate and pull AWAY from each other

Telophase - the chromosomes have moved to opposite sides of the cells to create TWO separate nuclei

SP #29 - Mitosis (cell division) happens in all organisms for a variety of reasons. Most growth in multicellular organisms happens because mitosis produces new cells. Mitosis also produces cells when an organism is injured and the damaged cells are replaced by new cells. Asexual reproduction occurs by mitosis.

SP #30 - In order for organisms to reproduce with sexual reproduction, they need to create sex cells (gametes or eggs and sperm) with half of the number of chromosomes in each. They create these sex cells with the process of meiosis.

SP #31 - Meiosis creates sex cells (gametes or eggs and sperm) for organisms who reproduce sexually. Meiosis has eight steps:

Prophase I - the DNA is folded into chromosomes

Metaphase I - the homologous (identical) chromosomes line up along the MIDDLE

Anaphase I - the pairs of chromosomes separate from their partners and pull AWAY from each other

Telophase I - the chromosomes have moved to opposite sides of the cells to create TWO separate nuclei

Prophase II - The chromosomes are NOT copied again. The nuclear membrane breaks down

Metaphase II - the chromosomes line up along the MIDDLE

Anaphase II - the chromosomes separate at the centromere and pull AWAY from each other

Telophase II - the chromosomes have moved to opposite sides of the cells to create four gametes (egg or sperm cells) with half of the DNA inside each gamete