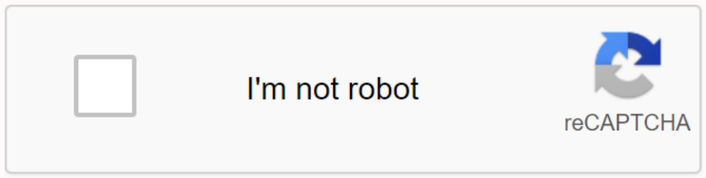

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Dna mutation worksheet middle school

After this lesson, students should be able to: List different types of mutations. Describe some possible effects of mutations. Explain the role of mutations in genetic syndromes. NgSS HS-LS3-2 performance expectations. Make and defend evidence-based claims that hereditary genetic variations may result from: (1) new genetic combinations through meiosis, (2) viable errors that occur during replication, and/or (3) mutations caused by environmental factors. (Grades 9 - 12) Do you agree with this alignment? Thank you for your feedback! Click to view additional curricula in line with this performance expectations This lesson focuses on the following three-dimensional learning aspects of NGSS: Science & Engineering Practices Disciplinary Core Ideas Crosscutting Concepts Make and Defend Claims Based On Evidence about the Natural World, Which Reflects Scientific Knowledge, and Student-Generated Evidence. Alignment Agreement: Thanks for your feedback! In sexual reproduction, chromosomes can sometimes exchange segments during the meiosis (cell division) process, creating new genetic combinations and thus more genetic variations. Although DNA replication is strictly regulated and remarkably accurate, errors occur and lead to mutations that are also a source of genetic variation. Environmental factors can also cause mutations in genes, and viable mutations are inherited. Alignment Agreement: Thanks for your feedback! Environmental factors also influence the expression of properties, thus influencing the likelihood of traits occurring in the population. Thus, the variation and distribution of observed traits depends on both genetic and environmental factors. Alignment Agreement: Thanks for your feedback! Empirical evidence is necessary to distinguish between cause and correlation and to claim specific causes and effects. Alignment Agreement: Thanks for your feedback! Biochemistry and molecular biology have made it possible to manipulate genetic information found in living creatures. (Grades 9 - 12) More Details Show Aligned Outlines Do you agree to this alignment? Thank you for your feedback! identify the components of DNA and describe how the information for the specification of the characteristics of the organism in the DNA is transmitted; (Grades 9 - 11) More Details Show Aligned Outlines Do you agree to this alignment? Thank you for your feedback! identify and illustrate changes in DNA and evaluate the significance of these changes; (Grades 9 - 11) More Details Show Aligned Outlines Do you agree to this alignment? Thank you for your feedback! Suggest alignment not mentioned above Students should have a good knowledge of how DNA is copied from one cell to another by either meiosis or mitosis. They should also know that changes in DNA or genes lead to changes in proteins that may or may not cause noticeable changes in the properties of organisms. (Be prepared to view the 22-slide mutation class presentation, PowerPoint file®.) (Slides 1-3) Who's going to tell me how the X-Men kyclops got their superpowers? (Answer: He's a mutant and born with his superpowers.) What about the Hulk? (Answer: Mutations due to exposure to gamma rays.) And Spiderman? (Answer: Mutated when bitten by a radioactive spider.) So we've identified three superheroes who have all acquired some special abilities from mutations. For the Kyclops and all X-Men, the abilities were caused by antenate DNA or genomic mutation. Hulk and Spiderman forces happened a little differently because mutations occurred later when they were exposed to radioactivity in some form or another. Today we will discuss some of the science behind the mutation. While the superpowers and abilities we have just discussed may be fictitious, it is true that mutations can have a significant impact on humans, and there is evidence that radiation exposure can lead to increased mutation rates. First we will discuss different types of mutations, then where and how they can appear. We will also talk about some environmental factors that can affect the rate of mutations, and

finish by looking at some possible effects of mutations. (Go ahead and present the content under Lesson Background.) (Slide 4) Mutation types: Mutations can be classified in several different ways. In this lesson, we will focus on sorting mutations by their effects on the structure of DNA or chromosome. For this categorization, mutations can be arranged in two main groups, each of which has multiple specific types. Two general categories are small and extensive mutations. As in children's play, phone mutational phone activity helps students illustrate how mutations occur in nature. Small mutations are those that affect DNA at the molecular level by changing the normal sequence of nucleotide base pairs. These types of mutations can occur during the DNA replication process during meiosis or mitosis. There may be three possible types of minor mutations: substitution, erasure and insertion. (Slide 5) Substitutions are also referred to as point mutations that occur when nucleotide is replaced by another nucleotide in the DNA sequence. The most common substitutions include switching adenine and guanine (A ↔ G) or cytosine and thymine (C ↔ T). Since the total number of nucleotides is preserved, this type of mutation affects only codon for one amino acid. (Slide 6) Deletion is the removal of nucleotide from the DNA sequence. Deletions are referred to as frameshift mutations because removing even one nucleotide from a gene subsequently alters each codon after mutation (it is said that the reading frame is shifted); this is shown in Figure 1 for both deletion and insertion. Changing the number of nucleotides changes those that are usually read together. Figure 1. An example of small mutations. Substitutions are point mutations and change only one acid in the protein. Insertion and deletion are mutations for shifting images and altering each amino acid encoded after mutation. (Slide 7) The insertion is the addition of a nucleotide to the DNA sequence. Similar to deletion, insertions are also considered frameshift mutations and change each codon that is read after the mutation. (Slide 8) Extensive mutations are those that affect entire parts of the chromosome. Some large mutations affect only individual chromosomes, others occur across non-homological pairs. Some large mutations in the chromosome are analogous to small mutations in DNA; the difference is that large mutations change whole genes or sets of genes, not just individual DNA nucleotides. Individual chromosome mutations are most likely to occur in the event of a certain error in the DNA replication phase of cell growth, and therefore may occur during meiosis or mitosis. Multi-chromosome mutations are more likely to occur during meiosis during crossbreeding, which occurs during prophylactic I. Most of these mutations are shown in Figure 2. Figure 2. Extensive mutations affect entire parts of the chromosome. (Slide 9) Large-scale deletion is the only chromosome mutation involving the loss of one or more genes from the parent chromosome. (Slide 10) Duplication is the addition of one or more genes that are already present in the chromosome. It is the only chromosome mutation. (Slide 11) An inverse mutation involves a complete reversal of one or more genes in the chromosome. Genes are present, but the order is backwards from the maternal chromosome. It is also a single chromosome mutation. (Slide 12) Large-scale insertion involves multiple chromosomes. For this type of insertion, one or more genes are removed from one chromosome and inserted into another non-homological chromosome. This can occur by mistake during prosis I meiosis, when chromosomes exchange genes to increase diversity. (Slide 13) Translocation also includes multiple nonhomological chromosomes. Here chromosomes exchange one or more genes with another chromosome. (Slide 14) Non-disjunctive mutation does not include any errors in DNA replication or crossing. Instead, these mutations occur during anaphylasis and telophase, when chromosomes are not properly separated into new cells. Frequent does not discuss missing or other chromosomes. When gametes with nondisjunctions are produced during meiosis, it can result in offspring with monosomy or trisomy (missing or extra homologous chromosome). (Slide 15) The effects of mutations can range from nothing to cell non-life. All mutations affect proteins that arise during protein synthesis, but not all mutations have a significant impact. Effects can also be viewed differently between small and large mutations. (Slide 16) Effects of small mutations: Frame shift mutation, and deletion of genes have similar effects. When the nucleotide is added or removed from the DNA sequence, the sequence shifts and each codon after the mutation changes, as shown in Figure 1. This results in serious changes in the proteins that are encoded by DNA, which can lead to loss of functionality of these proteins. Substitutions, or point mutations, are much finer and have three possible effects. The table in Figure 3 shows how some point mutations can lead to common disorders. Silent: Nucleotide is replaced, but the codon still produces the same amino acid. Missense: Kodon now leads to other amino acids that may or may not significantly alter the function of the protein. Nonsense: Kodon now leads to a stop command that shortens the protein in the place where the mutated codon is read; this almost always leads to loss of protein function. These mutations can occur anywhere in dna, so the effect of the mutation really depends on its location. If the mutation occurs in a gene, the result is a modified protein, but the mutation can also occur in a non-genic area of DNA. In the second case, the mutation has no effect on the organism. Figure 3. Significant minor mutations and resulting conditions. (Slides 17-18) The effects of large mutations are more pronounced than those of minor mutations. Duplication of multiple genes causes these genes to be over-expressed, while deletion results in missing or incomplete genes. Mutations that change the order of genes on the chromosome - such as deletes, inversions, insertions, and translocations - lead to genes close to each other that were previously separated either by a set of genes on the same chromosome or on another chromosome entirely. When certain genes are placed close together, they can encode for a fusion protein, a protein that would not normally exist but is created by a mutation in which two genes were combined. Some of these new proteins give cells the benefit of growth leading to tumors and cancer. Astrocytoma, a type of brain tumor, is the result of a deletion that creates a new fusion gene that allows cells to become cancerous. Figure 4. Normal human male karyotype with XY as 23. (Snapshot 19) Often large mutations lead to cells that are not viable (and die as a result of mutation). This is especially true for non-disjunctive mutations in gametes in which whole chromosomes are missing or extra. In humans, when a gamete from a male (sperm) connects its chromosomes with a gamete from a female (egg), the offspring receive 23 chromosomes from each parent to form 23 homologous pairs, as shown in the karyotype in Figure 4. However, when one of the gametes has a nondisjunction mutation, the resulting offspring end up with only one homologue in pairs (monosomy) or with three homologues in pairs (trisomy). Most of the time, these offspring are not viable. Those that result in viable offspring will have some noticeable differences due to an extra or missing chromosome; this change leads to permanent syndrome in offspring. The most famous syndrome is trisomy 21, another 21st chromosome (this karyotype is shown in Figure 5); this particular non-disjunctive mutation leads to Down syndrome. Figure 5. Karyotype illustrating trisomia 21 – the mutation that leads to Down syndrome. (Slide 20) What can affect mutations? Mutations occur naturally over time, which is the root cause of evolution. As we can see, evolution is a very slow process with net benefit to the body, but some environmental factors can affect or trigger other mutations. These induced mutations often lead to harmful diseases such as cancer. Exposure to certain chemicals is one of the environmental factors that can trigger DNA mutations. Typically, anything that we identify as carcinogenic (can cause cancer) has negative side effects on DNA, and can lead to cancer. This includes chemicals found in cigarette smoke, as well as those found in grilled meat. These chemicals belong to a larger class called mutagens, which means they can lead to changes in genetic material. Chemicals are not the only types of mutagens we encounter; there are also physical mutagens in the environment, namely radiation. Ultraviolet radiation from the sun can damage genetic material by changing the properties of nucleotides in DNA. Excessive exposure to ultraviolet radiation is known to lead to skin cancer. X-rays and gamma rays are also physical mutagens and forms of ionizing radiation; this means that these types of radiation have enough energy to remove electrons from atoms, forming ions and affecting various biomolecules. While the typical dose of X-rays taken during the medical procedure is low, it marginally increases a person's risk of cancer. Alternatively, retroviruses such as HIV naturally experience mutations at a much higher rate than other organisms, which can be attributed to the fact that they have RNA instead of DNA. The process of copying and replicating RNA is not as accurate as the DNA process. Therefore, by the time our immune system has adapted to fighting a virus like HIV, the HIV virus has mutated again and the immune system needs to start over. Mutations in HIV RNA lead to changes in protein markers on the virus targeted by the immune system, and if the target is constantly changing, it is almost impossible for the immune system to remove the virus. (Slides 21-22) Engineering connection: While mutations occur naturally over time, biological engineers are able to genetically modify different organisms. Humans have genetically modified plants and animals for thousands of years. People have achieved this by selective breeding or crossing to produce and improve specific traits such as breeding melons to be larger and have fewer seeds or breeding have more white meat and more breast meat. With the advancement of technology, engineers can directly manipulate the genetic code of plants and animals. Some examples of genetically modified (and controversial) organisms include disease-resistant papaya, vitamin A-rich rice and drought-tolerant corn. Currently, scientists are studying gene editing in the womb. If it is found that the unborn child has a disease or disability, then one day we may be able to modify the genes of the unborn child and prevent the problem from appearing in the baby. Chromosome: A long strand of DNA wrapped around a protein that stores instructions for the formation of several proteins. Humans have 46 chromosomes composed of 23 pairs of homologous chromosomes. disjunction: Normal separation of chromosomes during meiosis. A molecule that contains complete genetic information of the organism. Short for deoxyribonucleic acid. DNA replication: The process by which DNA is copied and passed on to new cells. Gamete: Sex cells. In mammals sperm and eggs. It has half the chromosomes of the mother organism. Gene: A subset of DNA that provides instructions for a cell to build a single protein. genome: Complete genetic information about the organism; contains all chromosomes. karyotype: An image of the genome of an organism with chromosomes arranged by homologous pairs. meiosis: A type of cell division that occurs in sexually reproducing organisms and usually leads to four cells with half the number of chromosomes of the parent. In humans, meiosis results in the formation of sperm or eggs with 23 chromosomes. mitosis: A type of cell division that results in two identical cells with the same number of chromosomes as the parent. monosomy: A situation where a homologue is missing in a chromosome pair. For example, if there is only one homologue for chromosome 21, it is called monomsomy 21. mutagen: A physical or chemical agent that affects genetic material. mutation: Permanent change in either the DNA nucleotide sequence during DNA replication or in the chromosome during meiosis or mitosis. non-disjunctive: Abnormal separation of chromosomes during meiosis. Protein synthesis: The process by which the instructions contained in DNA are used to produce proteins for a cell or organism. trisomy: A situation in which another chromosome is present. For example, if there are three homologues for chromosome 21, it is called trisomy 21 or Down syndrome. Questions about mutations before evaluating a lesson: At the beginning of class, get students to write short answers to three questions on a pre-teaching workbook. Tip: To save paper and ink because the color of the tiger in the photo is important for this review, view the sheet through the projector and let students write their answers on their own papers. Students' responses reveal their basic understanding of genetics, traits and mutations. Lesson Summary Evaluation Mutation Questions: After the lesson, allow students to write answers to four questions in the worksheet after the end of the work overview. Tip: To save paper and ink because the color of the tiger in the photo is important for this review, view the sheet through the projector and let students write their answers on their own papers. Students' answers reveal their understanding of the subject and content of the lesson. Home Research: Have students choose a syndrome caused by a mutation (such as extra or missing chromosomes) and write a short, 3-5 sentence paragraph on it. Be sure to mention the specific chromosome mutation that leads to the syndrome and what effects this mutation causes. This digital library content was developed by the University of Houston College of Engineering as part of the National Science Foundation GK-12 grant number DGE 0840889. However, these contents do not necessarily represent NSF policies and you should not assume federal government approval. Last modified: 28 October 2020 2020