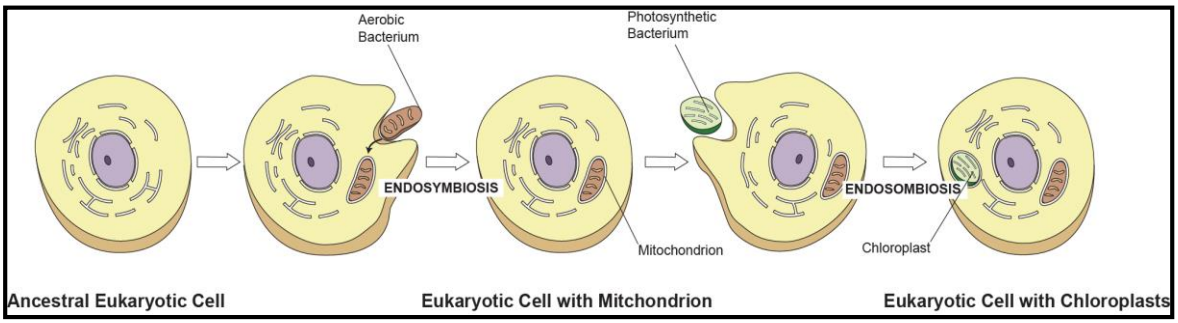
Inheritance of Traits

Name: _____ Date: _____ Group: _____

Gene Regulation and Expression

Lexile 950L



1 Most of the traits that can be observed in organisms come from the genetic information contained within their genes. The genes found in our DNA control everything about us: our hair color, our skin color, our sex, our height, etc. Imagine looking at a picture of two parents and their children. You can see that the mother has certain traits, and the father has certain traits. Their children usually have a mixture of those traits.

2 But, how does this occur, and how is it regulated? These genes are signaled at specific times. The information contained in those genes will then be used to manufacture proteins that perform specific functions. Our traits are determined by the proteins which are produced. It is important to understand that this process does not just work for humans. This process of gene regulation and expression works for all living organisms.

3 So, what is a gene? In order to understand what a gene is, you must first understand what DNA is. DNA, or deoxyribonucleic acid, is the molecule that contains all of an organism's genetic information. Each single-celled prokaryote contains a single strand of DNA. Eukaryotic cells contain a greater amount of DNA, coiled into several separate structures called chromosomes. Each cell carries the same set of chromosomes, an exact copy of that organism's genetic material. There are non-coding regions on the DNA strand. There are also coding regions. These coding regions are known as genes. If you look at the illustration above, you will see that a gene is simply a coding section of the DNA strand. But, how does the information contained in the gene become a useful protein?

4 There are internal and external signals that will trigger the process that transcribes a gene and ultimately, results in a needed protein. The signal is registered, and the required coding section of the DNA is uncoiled and made ready for the initiation of the process. The information contained in that gene is transcribed from the DNA strand to an RNA strand template. This RNA template is also known as mRNA. In a eukaryotic cell, the RNA

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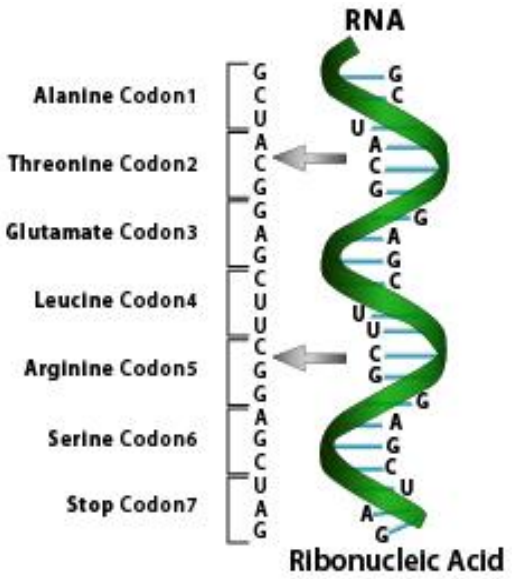

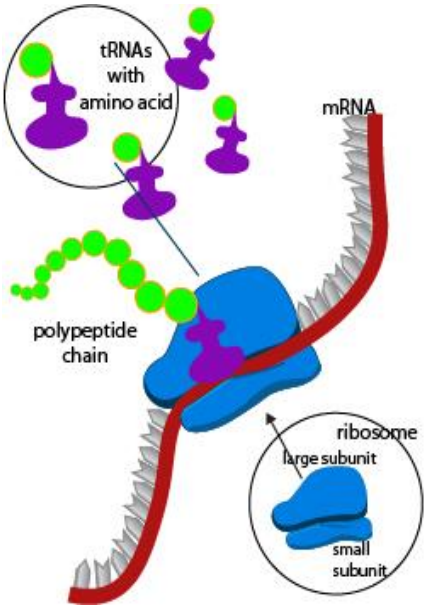

template must travel out of the nucleus, where it was created, and into the cytoplasm. The mRNA carries the information from the gene. That information will be translated into a polypeptide strand that will become a functional protein. Let us break this process down into its individual steps.

5 The first illustration above shows a model of an RNA strand. This strand holds the transcribed information from the master DNA strand coding section, or gene. You will see that the information on this strand occurs in a series of 3-letter nucleotide units, or codons. Each of these codons will then code for a specific amino acid (listed to the left of the RNA strand.) But, how does this process create a protein?

6 The second illustration shows a model of how the information contained on an mRNA strand is translated into a protein. This process occurs in the cytoplasm on the ribosomes. The mRNA strand will be "pulled" through the ribosome. The ribosome will "read" the codons. A complementary tRNA molecule will then attach the appropriate amino acid to the growing polypeptide chain. It is the codon sequence on the mRNA strand that determines the amino acid sequence of the polypeptide. The polypeptide chain will continue to grow until a "Stop" codon is reached, signaling the ribosome to stop the translation process. The polypeptide chain will then be released to take on its functional shape as a protein. The protein may be used as a structural protein, as an enzyme to catalyze a specific chemical reaction, or as a chemical message to communicate with other cells.

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7 So, why is this process important to you – and all other organisms? Every cell within a multicellular organism carries the same set of chromosomes. Each set of DNA strands carries all of the necessary genes, but not all of the genes are used (expressed) at the same time. Even in a prokaryote, with its one simple strand of DNA, only a small number of genes might be expressed at any particular time. Think of the DNA molecules as being a set of recipe books with all of the directions for everything a cell needs to make. Some proteins need to be made early in the life of a cell, while some proteins are needed as it grows and matures. Some proteins are needed for it to function throughout its life.

8 Signal molecules are sent to the genes of an embryo that will regulate which genes are transcribed during this phase in order to regulate the development of the embryo. Once the embryonic phase is completed, new signals will trigger other genes to regulate the growth of the organism. Once mature, there are still other genes that regulate the daily functions of the organism. All of these genes code for different specific proteins. It is these proteins that regulate the specific functions and traits of the organism during each phase of its life.

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1 What does the codon sequence on the mRNA strand determine?

A The gene sequence of the DNA

B The amino acid sequence of the polypeptide

C The codon that is signaled

D The signaling sequence

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2 What portion of the DNA is also known as a gene?

A The coding sections

B The non-coding sections

C The mRNA strand

D The polypeptide sequence

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3 Which is of the following statements **best** describes the structure, or makeup, of a codon?

A A codon is a 3-letter nucleotide sequence found on the tRNA.

B A codon is a growing polypeptide chain.

C A codon is a gene sequence found on the DNA strand.

D A codon is a 3-letter nucleotide sequence found on the mRNA.

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4 What is true regarding genes and DNA?

A Each DNA strand contains identical genes.

B The DNA only transcribes the genes that it needs at specific times.

C Both A and B

D None of the above

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5 Where in the cell is the information from the mRNA strand translated into a polypeptide chain?

A The ribosomes

B The cell membrane

C In the nucleus

D On the DNA strand

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6 Why is gene regulation and expression important to all living organisms?

A Specific signals trigger specific genes to be transcribed and translated.

B The proteins created from this process determine most of the organism's traits.

C Different phases of the life cycle require specific genes for growth and development.

D All of the above