ILLUMINATIONSPACE

ADVANCED SCIENCE RESEARCH CENTER
THE GRADUATE CENTER
CITY UNIVERSITY OF NEW YORK

Bio Bracelets

Summary: This activity leads participants through the making of bio bracelets that mimic proteins.

Learning Objectives: (see NYS Learning Standards, pg 4)

- Teach kids about amino acids and the repulsive forces between them
- Teach kids about the structures of proteins and their properties
- Creative opportunities to make their own shapes and designs for their proteins
- Understand the concept of mutations in proteins and what it can lead to such as diseases or evolution

Grade Level: k-12

Materials

-colored pipe cleaners
-beads
-UV beads (optional)

Procedures

1. Start with the pipe cleaners and add beads to them. The pipe cleaner represents the protein and beads represent the amino acids. You can add as many as you'd like but leave enough space at both ends of your pipe cleaner.
2. Bend the ends of your pipe cleaners inwards so that no beads fall off.
3. Change the form of the pipe cleaners into any form you'd like. You can also intertwine more than one pipe cleaner with beads to make more complex shapes and designs.

Explanation:

Proteins have weird and odd shapes. The shapes help give each protein a unique property and purpose from helping to break down food to helping you grow. Proteins are made up of amino acids. The interactions between the amino acids are what give the proteins its shape. There are 22 known amino acids in organisms: 20 of them are in humans. Amino acids have repulsive forces. This means that they have negative and positive charges on each ends. This either attracts them to each other or repel each other.

K-5 Emphasis: What kind of shape is your protein? What does your protein do in our body? Give it any property you want.
Building Blocks of our Cells and bodies. Biological Legos

5-9 Emphasis: Can you think of some properties that proteins could have in our bodies? What about in other living things? Do you think we have the same proteins with other animals or plants? Why or why not?

9-12 Emphasis: Where would the active sites be on your protein? How can some proteins serve as catalysts? Can you think of some examples? What elements do you think compose the majority of proteins? Can you come up with an example of a mutation in a protein? Do you think all mutations are bad in proteins?

Key Concepts:

K-5:

Pipe Cleaner-a piece of wire covered with tufted fiber
Beads- a small piece of glass, stone, or similar material, typically rounded used for decorations
Proteins-consist of large molecules composed of one or more long chains of amino acids and are an essential part of all living organisms

5-9:

DNA-short for deoxyribonucleic acid, is a molecule that contains the genetic code of organisms
RNA-stands for ribonucleic acid, which is a long, single-stranded chain of cells that processes protein

Amino acids-the building blocks of proteins, are compounds that play many critical roles in your body

9-12:

Charged ions-an electrically charged atom or group of atoms formed by the loss or gain of one or more electrons
Enzymes-a type of protein that serves as a catalyst in organisms
Catalyst- a substance that increases the rate of a chemical reaction without itself undergoing any permanent chemical change
Chemical Reaction- a process that involves rearrangement of the molecular or ionic structure of a substance
Ionic structure- an ionic structure is a chemical compound composed of charged ions held together by electrostatic forces termed ionic bonding.
Active Site-a region on an enzyme that binds to a protein or other substance during a reaction
Mutation- a change in the protein sequence where one or more amino acids are changed or out of order

Connections with ASRC Research:

Researchers at the ASRC are trying to find ways to understand how proteins are wired so that they can develop ways to control its activity. Daniel Keedy, an assistant professor in the

Structural Biology Initiative, is exploring the signaling capabilities of protein tyrosine phosphatase 1B with his colleagues, which is believed to play a significant role in type 2 diabetes and possibly breast cancer.
https://asrc.gc.cuny.edu/headlines/2018/07/researchers-discover-a-way-to-peer-inside-proteins-to-see-how-they-are-wired/

Gallery:




New York State Learning Standards

3. Inheritance and Variation of Traits: Life Cycles and Traits
3-LS3-2. Use evidence to support the explanation that traits can be influenced by the environment.
LS3.A: Inheritance of Traits Many characteristics of organisms are inherited from their parents. (3-LS3-1) Other characteristics result from individuals' interactions with the environment, which can range from diet to learning. (3-LS3-2) (NYSED) Some characteristics result from the interactions of both inheritance and the effect of the environment. (3-LS3-2) LS3.B: Variation of Traits Different organisms vary in how they look and function because they have different inherited information. (3-LS3-1) The environment also affects the traits that an organism develops. (3-LS3-2)

MS. Growth, Development, and Reproduction of Organisms
MS-LS3-1. Develop and use a model to explain why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects on the structure and function of the organism.
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structure and function of the organism.
LS3.A: Inheritance of Traits. Genes are located in the chromosomes of cells, with each chromosome pair containing two variants of each of many distinct genes. Each distinct gene chiefly controls the production of specific proteins, which in turn affects the traits of the individual. Changes (mutations) to genes can result in changes to proteins, which can affect the structures and functions of the organism and thereby change traits. (MS-LS3-1) Variations of inherited traits between parent and offspring arise from genetic differences that result from the subset of chromosomes (and therefore genes) inherited. (MS-LS3-2) LS3.B: Variation of Traits In sexually reproducing organisms, each parent
contributes half of the genes acquired (at random) by the offspring. Individuals have two of each chromosome and hence two alleles of each gene, one acquired from each parent. These versions may be identical or may differ from each other. (MS-LS3- 2) In addition to variations that arise from sexual reproduction, genetic information can be altered because of mutations. Some changes are beneficial, others harmful, and some neutral to the organism. (MS-LS3-1) (NYSED) Mutations may result in changes to the structure and function of proteins. (MS-LS3-1)

HS. Inheritance and Variation of Traits
HS-LS3-2. Make and defend a claim based on evidence that inheritable genetic variations may result from: (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, (3) mutations caused by environmental factors and/or (4) genetic engineering.

LS3.A: Inheritance of Traits. Each chromosome consists of a single very long DNA molecule, and each gene on the chromosome is a particular segment of that DNA. The instructions for forming species' characteristics are carried in DNA. All cells in an organism have the same genetic content, but the genes used (expressed) by the cell may be regulated in different ways. Not all DNA codes for a protein; some segments of DNA are involved in regulatory or structural functions, and some have no as-yet known function. (HS-LS3-1) LS3.B: Variation of Traits. In sexual reproduction, chromosomes can sometimes swap sections during the process of meiosis (cell division), thereby creating new genetic combinations and thus more genetic variation. Although DNA replication is tightly regulated and remarkably accurate, errors do occur and result in mutations, which are also a source of genetic variation. (HS-LS3-2) (NYSED) Environmental factors can cause mutations in genes. Only mutations in sex cells can be inherited. (HS LS3-2) (NYSED) Advances in biotechnology have allowed organisms to be modified genetically. (HS-LS3-2) Environmental factors also affect expression of traits, and hence affect the probability of occurrences of traits in a population. Thus the variation and distribution of traits observed depends on both genetic and environmental factors. (HS-LS3-2),(HS-LS3-3)

HS. Matter and Energy in Organisms and Ecosystems

HS-LS1-6. Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements such as nitrogen, sulfur, and phosphorus to form amino acids and other carbon-based molecules.

LS1.C: Organization for Matter and Energy Flow in Organisms. The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen. (HSLS1-5) As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products. As a result of these chemical reactions, energy is transferred from one system of interacting molecules to another. (HS-LS1-6),(HS-LS1-7) (NYSED) Sugar molecules contain carbon, hydrogen, and oxygen. Their hydrocarbon backbones combine with other elements to make amino acids and other carbon-based molecules that can be assembled into larger molecules, such as proteins or DNA. (HS-LS1-6) (NYSED) Cellular respiration is a chemical process in which the bonds of food molecules and oxygen molecules are broken and new compounds are formed. In this process ATP is produced, which is used to carry out life processes. (HS-LS1-7)

HS. Natural Selection and Evolution

HS-LS4-2. Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3)

competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment.

HS. Structure and Function

HS-LS1-1. Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells.

LS1.A: Structure and Function. Systems of specialized cells within organisms help them perform the essential functions of life. (HS-LS1-1) All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins, which carry out most of the work of cells. (HS-LS1-1) (Note: This Disciplinary Core Idea is also addressed by HS-LS3-1.) Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level. (HS-LS1-2)