PEER Life Science Cells Are Us Building Proteins Notes Outline Key

**Introduction**

* Proteins are a type of macromolecule made up of amino acids.
* Proteins perform various jobs in the cell. They make structures in the cell and act as signaling molecules.
* Genes on chromosomes in the nucleus direct protein building.

**Why It Matters**

* Proteins embedded in the cell membrane can function to recognize adjacent cells and recognize chemicals outside of the cells like hormones, drugs, and neurotransmitters.
* Proteins inside of cells act as enzymes to help chemical reactions occur or help turn genes on/off.
* Peptides (small proteins) can be secreted as hormones and chemicals to send signals to cells.
* Genes found on DNA are important because they direct the creation of proteins. Many diseases involve damage to certain proteins which interferes with their normal function.
* When we eat proteins, they are digested or broken down into amino acids. These building blocks of proteins are taken into cells and used to make new proteins.

**What We Know**

* Proteins are very large molecules that can be 2 to 20 times larger than other molecules in cells. Proteins often determine the shape and structure of cells. They also are responsible for:
  + Recognizing and interacting with other molecules
  + Promoting reactions between other chemicals
* Amino acids are the building blocks of proteins. There are 20 amino acids in the body. Nine of these are “essential” amino acids which cannot be made in the body and have to be acquired through the diet.
* Because proteins are such large molecules and there are 20 amino acids to choose from when making a protein, there is a huge variety of proteins you can make. If you had a protein made up of 300 amino acids, the number of possible proteins you could make would be 20^300.
* There are four levels of protein structure due to coiling and folding caused by different amino acids. The levels are:
  + Primary structure: simple chain of amino acids.
  + Secondary structure: chains that are coiled or form pleated sheets.
  + Tertiary structure: coiled or pleated chains that are folded.
  + Quaternary structure: folded protein consisting of more than one amino acid chain.
* Parts of proteins can be connected by strong sulfur-sulfur bonds. We can see how these bonds affect the shape of proteins on our own heads! These are the bonds that can control the shape of hair (whether it is curly or straight) and can be manipulated by chemicals in a hair perm.
* Amino acids that have an/have no electric charge are not attracted to water and are attracted to lipids and each other. Chains made up of these amino acids form a coil.
* Proteins that fit well with other molecules, like a key in a lock, can participate in reactions with those molecules.
* In membranes, protein structure affects function in two ways:
  + Non-charged/uncharged parts coil in the membrane, acting like an anchor
  + Portions or the protein that are attracted to water, stick out both sides of the membrane, available to interact with other molecules

**How We Know**

* Proteins can be made visible by denaturing them so they precipitate out of solution.
* In order to separate proteins from other chemicals in the cells, lipids and salts must be removed, and different kinds of proteins must be separated from each other. There are six steps to accomplish this.
  1. Centrifuge:this machine allows broken up cells to be spun very quickly to separate cell components by weight.
  2. Remove the lipids: this can be done by mashing the cells and stirring the debris into a mixture of two different solvents that do not dissolve in each other, so that the lipids go into one layer and the proteins into the other.
  3. Remove salts: this can be done through a process called dialysis in which salts move from an area of high concentration to low concentration.
  4. Separate and Purify: substances in mixtures can be separated through a process called chromatography. These methods can separate substances by attraction to other substances (how they adsorb) or size/weight.
  5. Determine amino acid sequence: this can be done by digesting amino acids one at a time and identifying them.
  6. Determine the 3-D structure: this can be done by exposing purified protein to x-rays and examining how the rays are deflected by the protein. Knowing the 3-D structure of proteins helps scientists understand how the protein binds and interacts with other molecules.

**Common Hazards**

* Most lead exposure in children in the U.S. is through lead-based paint and from dust found in deteriorating buildings.
* Name three negative effects lead has on the body:
  + Interferes with red blood cell formation
  + Brain damage
  + Slowed growth and development
  + Learning and behavior problems
  + Hearing and speech problems
  + Seizures
  + Coma
  + Death
* Lead damages the brain and cardiovascular system by inhibiting enzymes, especially those that make heme in red blood cells antioxidant chemicals. Lead generates reactive oxygen molecules and intensifies oxidative stress and cellular inflammation.
* Hexane has six carbon atoms bound to hydrogen. It can cause liver damage and wasting away of nerve fibers (peripheral neuropathy).
* Hexane also kills glial cells found in the brain and spinal cord and causes filaments inside of nerves to become clustered/clumpy.
  + This prevents materials from being transported down nerves and inhibits communication.
* Diseases like Creutzfeldt-Jakob Disease (mad cow disease) are caused by prions, which are proteins that trigger normal proteins in the brain to fold abnormally.