Biology 2.3

Biochemistry

> *"Through faith we understand that the worlds were framed by the word of God, so that things which are seen were not made of things which do appear." Hebrews 11:3*

Cellular chemistry

1. Metabolism is the sum of all cellular chemical rxns.
2. Anabolism: biosynthesis, synthesis. Making molecules
3. Catabolism: breaking molecules
4. All rxns are controlled by enzymes (functional proteins)

Life

1. Requires the blueprints for using energy, and for making enzymes, cell structure
2. scenario: DNA code -> enzymes -> metabolism
3. Requires the ability to duplicate itself and direct cellular replication
4. Requires ability to organize chemical rxns to catabolize and anabolize
5. "Molecular machines display a key signature or hallmark of design, namely, irreducible complexity. In all irreducibly complex systems in which the cause of the system is known by experience or observation, intelligent design or engineering played a role in the origin of the system... We find such systems within living organisms." — Scott A. Minnich

Origin questions

1. Where did the original design of life come from?
2. Where did the building materials come from to conform to the design?
3. Which came first the materials or the design?
4. Where did the energy come from to make the design and how was it harnessed?

Three roles for biological molecules

1. Enzymatic: functional. e.g., metabolic catalysts
2. Structural: building materials of the cell. e.g., cell wall, organelles
3. Storage: energy and material
4. Information: contains meaningful code of instructions to guide metabolism

Four important biological molecules

1. Carbohydrates: structural and storage
2. Proteins: structural and enzymatic
3. Lipids: structural and storage
4. Nucleic Acids: information

Carbohydrates

1. Purpose: Structural and storage: Making and breaking carbohydrates supply energy, store energy, and provide structural materials.
2. Organic compounds containing C, H, O. (many different kinds)

3. Monomers: monosaccharides
    a. Glucose (6C), Fructose (6C), Ribose (5C), Galactose (6C), Glycerate (3C)
4. Dimers: disaccharides
    a. Sucrose (table sugar), lactose (milk)
5. Polymers: Polysaccharides
    a. Long chains of monosaccharides and disaccharides
    b. Starch: Primary plant energy storage molecule (food).
    c. Cellulose: Primary plant structural molecule (cell wall).
    d. Glycogen: Primary animal energy storage molecule (food).

Proteins

1. Purpose: Functional (enzymatic, catalytic) and structural material.
2. Many kinds, all unique, small and big: enzymes, hormones, antibodies, antigens (used to identify organisms, even individuals, uniqueness, forensics), etc.
3. Monomers: Amino Acids are the building blocks for proteins.
    a. Of the hundreds of amino acids that exist, living organisms use only 20 different amino acids.
    b. 50 to several thousand a.a.'s make a protein
4. The amino group (-NH2) is associated with all amino acids.
5. The carboxylic acid (-COOH) is associated with all amino acids.
6. A hydrogen (H) atom is associated with all amino acids.
7. A fourth atom or molecule bonded with the amino acid identifies what kind of amino acid it is.
8. Amino acids bond together by dehydration synthesis between the amino group and the carboxylic acid. The resulting bond between amino acids (COOH + NH2) is called a peptide bond.
9. Polypeptide molecules are a chain of amino acids linked together with peptide bonds.
10. The amino acid sequence in polypeptide chains creates different shapes and functions.
11. Long polypeptide molecules that fold and function are called proteins.

Enzymes

1. Enzymes are proteins the function as organic catalysts.
2. An enzyme affects the rate of a chemical reaction by acting on a substrate to produce a product.
    a. Enzyme and substrate => product
    b. Enzymes are never changes by the reaction.
3. Very specific: one enzyme to one substrate.
4. Metabolism is controlled by the serial action of many enzymes. Every chemical reaction in a cell requires a unique enzyme. Thousands of reactions requires thousands of proteins.
5. One enzyme for one chemical reaction allows for control of cell metabolism.
6. Coenzymes are inorganic molecules that aid enzymes. e.g., vitamins
7. Enzymes are affected by heat, radiation, pH, and chemicals.
8. All living things require enzymes

Lipids

1. Purpose: structural and storage
2. Five types of lipids" fats, oils, waxes, phospholipids, sterols
3. Fats
    a. 1 glycerol + 3 fatty acids chains.
    b. dehydration/hydrolysis synthesis
    c. saturated vs. unsaturated.

4. Oils
    a. Lipids that are liquid at room temperature: e.g. corn, olive oils.
5. Waxes
    a. 2 Fatty acids + 1 alcohol on long chains of C.
6. Phospholipids
    a. 1 glycerol + 2 fatty acids chains + phosphate.
    b. In cell membranes
    c. Hydrophilic: charged
    d. Hydrophobic: non-charged
7. Sterols
    a. 4 C rings + a C chain
    b. Cholesterol

Nucleic Acids

1. Purpose: Carry the information code of life
2. Molecules of heredity, chromosomes
3. Association of nucleic acids with heredity was discovered in 1953
4. Monomers: nucleotides
5. Polymers: RNA and DNA
6. Each gene codes for a specific protein.
7. Chromosomes are DNA chains of genes.
8. Chromatin refers to the DNA, RNA and associated proteins in a cell.

DNA

1. Purpose: Stores the genetic code for an organism.
2. Double stranded helix (2 nucleic acid molecules bonded side by sided and twisted)
3. Nucleotide: Sugar (5 C, deoxyribose), phosphate, and base (adenine, thymine, guanine, cytosine)
4. A-T forms a double bond, and C-G forms a triple bond.
5. The sequences of bases (a,t,g,c) determines the genetic code for organisms.

Replication of DNA

1. Semi-conservative duplication: The way the DNA molecules is duplicated for the next generation.
2. An enzyme splits the 2 strands of DNA apart
3. Both of the old strands act as templates for new strands of DNA.
4. Another enzyme synthesizes new strands for each of the 2 old strands. An old strand is paired with a new strand. This is called Semi-conservative duplication.

RNA

1. Purpose: involved in translating the DNA code into protein.
2. Sugar (5C ribose) + phosphate + base (A,U, C,G)
3. 3 kinds: mRNA (messenger), rRNA (ribosomal), and tRNA (transfer)
4. **Transcription**: DNA code is transcribed to mRNA molecule (mirror-image code)
    a. mRNA carries message to rRNA in cytoplasm
5. **Translation**: rRNA translates mRNA code into amino acid chain (polypeptides, enzymes)
    a. tRNA brings amino acids to the rRNA and are matched with the appropriate mRNA codes needed to form the proper sequence of amino acids for a specific protein.

Unified scenario

1. DNA -> RNA -> enzymes -> metabolism -> cell and organism characteristics

Biochemistry facts

1. Of the ninety-two naturally occurring elements, only about twenty-four of them are found in living organisms.
2. Ninety-nine percent of the human body's mass is made up of only six elements: hydrogen, carbon, calcium, nitrogen, oxygen, and phosphorus.
3. You are what you eat.
4. Living things maintain organization but recycle materials.
5. Physical life is sustained because of cell activity, which is making and breaking molecules.
6. Lipids are the only polymers that do not synthesize by dehydration synthesis.
7. Keratin is a protein found in human hair and nails, spider web, bird beaks, and more.
8. Albumin is the most abundant protein in the blood.
9. All the DNA from one cell in your body would stretch two meters.
10. All of the DNA in your body would stretch from earth to the sun 600 times.
11. Ribulose 1,5 bisphosphate carboxylase found in leaves and algae is the most abundant protein in the world.
12. Our brain uses glucose exclusively for energy.
13. 1.4 x 1022 (ten billion, trillion) bonds must be catabolized each minute to sustain an average human at rest.
14. Evolutionists believe that you have more in common with a mud worm genetically than you do with a spider or octopus or cockroach.
15. Most proteins last only a couple days before breaking down.
16. The genetic code and alphabet is universal for all organisms.
17. Titin is the largest known protein (~30,000 amino acids).
18. The chemical name for titin is the longest word in the English language with 189,819 letters. (Methionylthreonylthreonylglutaminylarginyl...isoleucine).