بسم الله الرحمن الرحيم

.....

Sheet Information

Subject: Cell Biology 4th Lecture Sheet (4th Lecture In The 1st Week)

Lecture Date: 24/1/2019, Thursday

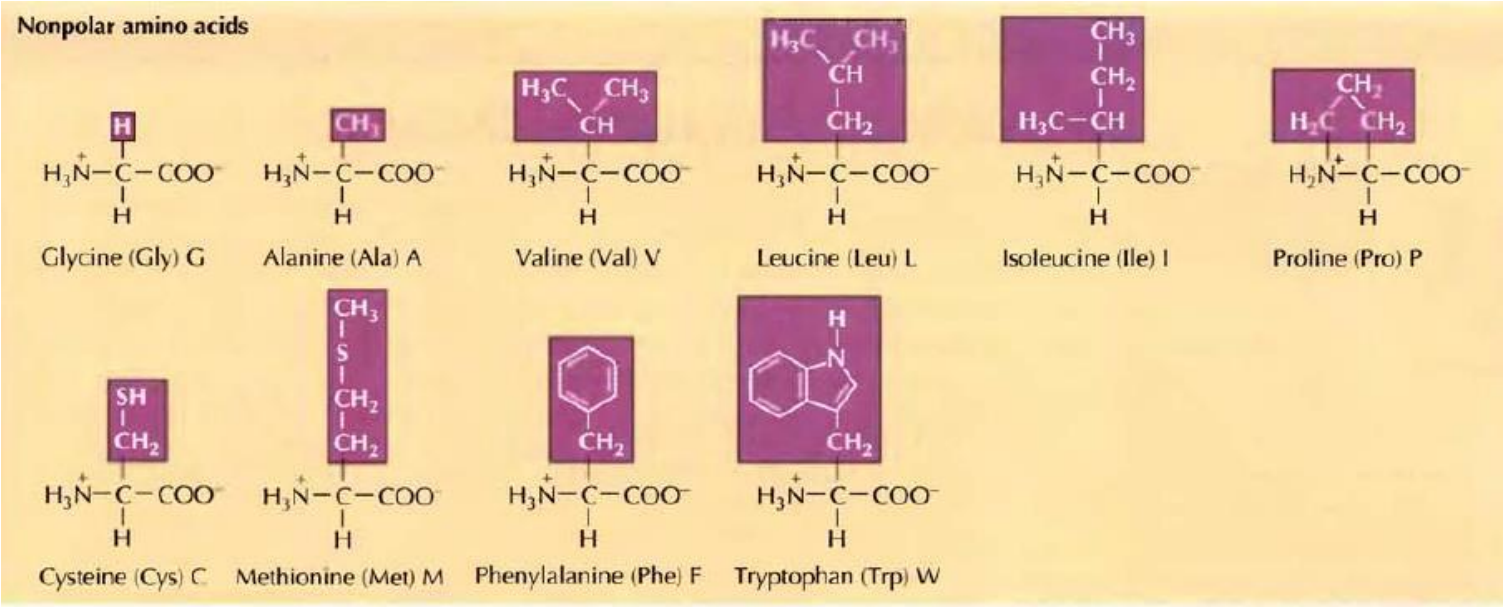
Lecturer, Record And Section: The 4th record for Dr.Amir & in the section number 2 (See the 4th note in the last page)

.....

<u>What lecturer say during lecture + slides</u>

Proteins:

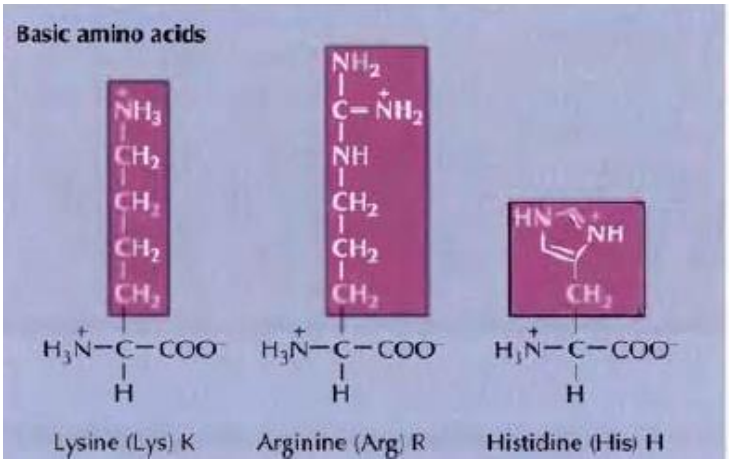
1- The most diverse group of all macromolecules, they execute the tasks directed by genetic information. Also they are polymers of 20 different amino acids
2- Classification of amino acids (according to side chain!!!)
   A- Non-polar amino acids

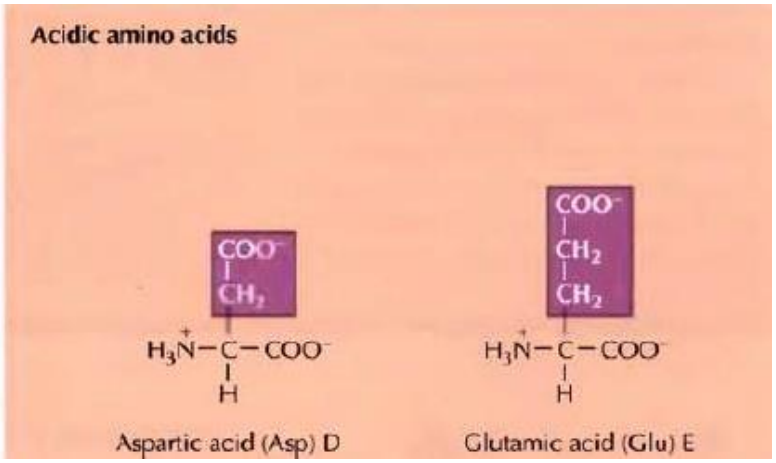


- Cysteine is a POLAR amino acid!!!! ~very important~

   B- Polar amino acids divided into two groups
   - Uncharged amino acids

- Charged amino acids: Acids And bases





- Aspartic acid (Asp) has a carboxyl group and one carbon on its side chain, it defers from Aspartate
- ~ The main difference between aspartate and aspartic acid is that the aspartate is the ionic form of aspartic acid, which is an α-amino acid used in protein synthesis. Aspartate and aspartic acid are two forms of an amino acid which mainly serve as a building block for the synthesis of proteins. Aspartate is synthesized by the human body through the transamination of oxaloacetate and therefore, aspartic acid is considered as a non-essential amino acid, (this point is not included, I have just put it for understanding). ~
- Aspartic acid (Asp) defers form Asparagine (Asn).
- Glutamic acid (Glu) has a carboxyl group and two carbons on its side chain, it defers from Glutamine (Gln).

3- Formation of poly peptide bond:
   - Carboxyl group of the 1st amino acid (OH) + amino group from 2nd amino acid (H)
   - We call this bond peptide bond and this reaction dehydration reaction
   - N-terminus (beginning) and C-terminus (end)
   - Direction from N to C

Notes:

- According to Dr. Diala you have to memorize all amino acids structures, names and 3-letter names.
- According to Dr. Amir in general you haven't to memorize any structure in slides.
- ~ So make your choice ~

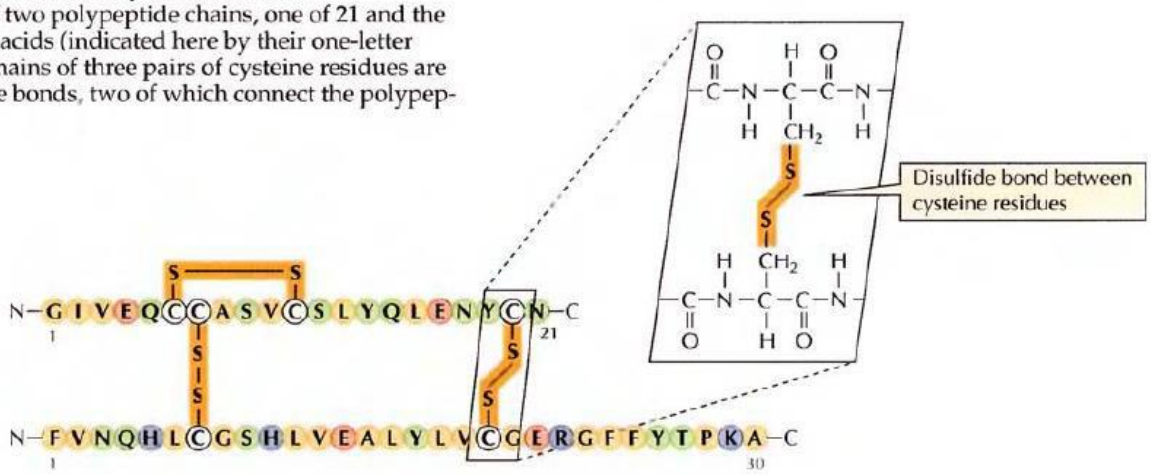
4- Protein classification by structure levels

A- Primary structure: is the sequence of amino acids in the poly peptide chain and it determines its 3D shape (folding) (figure is important) (see figure 2.16)

B- Secondary structure
   - Sec-structure is the <u>hydrogen-bonded</u> arrangement of the backbone of the protein, the polypeptide chain
   - Sec-structure is the arrangement in space of the polypeptide chain, <u>which includes regular repeating patterns</u>

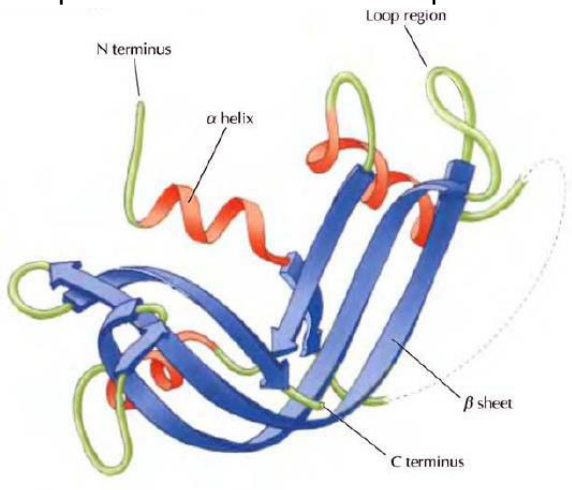
- Two kinds of repeating patterns: the alpha-helix (α-helix), and the beta-sheet (β-sheet)
- Also includes turns and loops
- Is The H-bond connects the carbonyl oxygen of one peptide unit with the amide hydrogen of another peptide unit
- R-group (side chain) bonds don't contribute to sec-structure

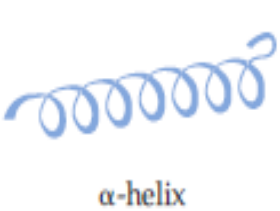
FIGURE 2.16 Amino acid sequence of insulin
Insulin consists of two polypeptide chains, one of 21 and the other of 30 amino acids (indicated here by their one-letter codes). The side chains of three pairs of cysteine residues are joined by disulfide bonds, two of which connect the polypeptide chains.

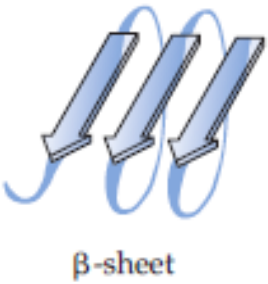


C- Tertiary structure

- Tert-structure is the folding of the polypeptide chain as a result of interactions between side chains of amino acids that lie in different regions of the primary sequence ➔ types of interaction
    1) Covalent bonds: disulfide bridge only
    2) Non-covalent bonds: for instance: Van der Waals interactions, ionic bonds, hydrophobic interactions or acid-base bonding
- Tert-structure composed of domains that are folded compacted globular structures that are composed of combinations of alpha helices and beta sheets connected by loop regions







- Hydrophobic amino acids are mainly interior whereas hydrophilic amino acids are on the surface. ~"this statement is not always true, for instance the interior amino acids of integral proteins is hydrophilic whereas hydrophobic amino acids are on the surface: example: aquaporin"~
- In Tert-structure we can add extra groups or elements to polypeptide chain like: sugar, heme, lipid (to make glycolipids), and metals like Zn

D- Quaternary structure

- Quaternary structure consists of interactions between several polypeptide chains
- Held together by the same interactions the maintain the tertiary structure
- Quaternary structure not present in all proteins

5- Protein classification by function (the finger below is very important and I will mention some notes about it)

TABLE 18.2 Classification of Proteins by Function

TYPE	FUNCTION	EXAMPLE
Enzymes	Catalysts	*Amylase*—begins digestion of carbohydrates by hydrolysis
Hormones	Regulate body functions by carrying messages to receptors	*Insulin*—facilitates use of glucose for energy generation
Storage proteins	Make essential substances available when needed	*Myoglobin*—stores oxygen in muscles
Transport proteins	Carry substances through body fluids	*Serum albumin*—carries fatty acids in blood
Structural proteins	Provide mechanical shape and support	*Collagen*—provides structure to tendons and cartilage
Protective proteins	Defend the body against foreign matter	*Immunoglobulin*—aids in destruction of invading bacteria
Contractile proteins	Do mechanical work	*Myosin and actin*—govern muscle movement

A- Integral proteins in general are transport proteins examples: aquaporin, ion channels and carrier proteins

B- Anti-body is an example of protective proteins

C- Not all hormones proteins

D- All enzymes are proteins ~ Some RNA molecules may contribute as a catalysts (enzymes), so it's better to say most enzymes are proteins. So I'm not quite sure about the point, but I have to put it because Dr. Diala said it. So this point may be edited ~

E- Storage proteins like hemoglobin acts as

- Sensor for O2
- Has a heme group
- Store O2 molecules in muscles

C- Structural protein like collagen which gives mechanical support for cell structure (skin and hair)

Cell Membrane

6- The Functions of Membranes

- Define boundaries of a cell and organelles and act as permeability barriers
- Serve as sites for biological functions, such as electron transport (for instance inner membrane of mitochondrion)

- Possess transport proteins that regulate the movement of substances into and out of cells and organelles
- Contain protein molecules that act as receptors to detect external signals
- Provide mechanisms for cell-to-cell contact, adhesion, and communication
- The main function of the cell membrane is a selective barrier

7- Organelles in the cell (the finger below is very important and I will mention some notes about it)
   A- Microfilaments and microtubules in cell represent cytoskeleton
   B- Lysosome digests old organelles, the process called autophagy
   C- Lysosome digests foreign substances, the process called phagocytosis
   D- Peroxisome detoxifies some substances in cell ~ for instance hydrogen peroxide ~

TABLE 4-2 *Organelles*

Organelle	Function
Mitochondrion	transfers energy from organic compounds to ATP
Ribosome	organizes the synthesis of proteins
Endoplasmic reticulum (ER)	prepares proteins for export (rough ER); synthesizes steroids, regulates calcium levels, breaks down toxic substances (smooth ER)
Golgi apparatus	processes and packages substances produced by the cell
Lysosome	digests molecules, old organelles, and foreign substances
Microfilaments and microtubules	contribute to the support, movement, and division of cells
Cilia and flagella	propel cells through the environment; move materials over the cell surface
Nucleus	stores hereditary information in DNA; synthesizes RNA and ribosomes
Cell wall*	supports and protects the cell
Vacuole*	stores enzymes and waste products
Plastid*	stores food or pigments; one type (chloroplast) transfers energy from light to organic compounds

*Cell walls, large vacuoles, and plastids are found in the cells of plants and some other eukaryotes, but not in the cells of animals.

8- Major components of cells
   A- Nucleic acids: DNA & RNA
   B- Membrane proteins
      - Carbohydrates
      - Proteins: 75% IMM, 50% PM
      - Lipids: 50% of mass of plasma membranes, 30% of mitochondrial membranes

9- Composition of membranes (lecturer says that the finger below isn't for memorizing but he mentions some notes about it so I will mention them)
   A- The reason behind higher percent of lipids than proteins in myelin sheath of nerve axon is hydrophobic isolation which make nerve impulse faster
   B- The reason behind higher percent of proteins than lipids in endoplasmic reticulum is its responsibility for synthesizing and exporting secretory and membrane proteins, also ribosomes binds to it.
   C- The reason behind higher percent of proteins than lipids in Golgi apparatus is its responsibility for modifying and transporting of proteins.

D- The reason behind higher percent of proteins than lipids in chloroplast thylakoids is its responsibility for photosynthesis which needs more enzymes and proteins.

E- The reason behind higher percent of proteins than lipids in mitochondrial inner membrane is that it takes a role of oxidative phosphorylation which needs more enzymes and proteins

Table 7-1 Protein, Lipid, and Carbohydrate Content of Biological Membranes

	Approximate Percentage by Weight			
Membrane	**Protein**	**Lipid**	**Carbohydrate**	**Protein/Lipid Ratio**
Plasma membrane				
Human erythrocyte	49	43	8	1.14
Mammalian liver cell	54	36	10	1.50
Amoeba	54	42	4	1.29
Myelin sheath of nerve axon	18	79	3	0.23
Nuclear envelope	66	32	2	2.06
Endoplasmic reticulum	63	27	10	2.33
Golgi apparatus	64	26	10	2.46
Chloroplast thylakoids	70	30	0	2.33
Mitochondrial outer membrane	55	45	0	1.22
Mitochondrial inner membrane	78	22	0	3.54
Gram-positive bacterium	75	25	0	3.00

10- Membrane Lipids: The “Fluid” Part of the fluid mosaic bilayer model

A- Membrane lipids are important components of the “fluid” part of the fluid mosaic model

B- Membranes contain several types of lipids

C- The main classes of membrane lipids are phospholipids, glycolipids, and sterols

D- Plasma membranes of animal cell are complex containing five major phospholipids: phosphatidylcholine, phosphatidylserine, phosphatidylethanolamine, phosphatidylinositol and sphingomyelin (sphingomyelin is the only non-glycerol phospholipid

E- The main sterol in animal cell membranes is cholesterol, which is needed to stabilize and maintain membranes

- Cholesterol maintain membrane fluidity ➔ how ➔ more concentration of cholesterol through membrane leads to ➔ more hydrophobic interactions between cholesterol and phospholipids ➔ make it more rigid ➔ which decrease the fluidity.

F- Phospholipids <u>are the most abundant lipids</u> in membranes

G- They include the glycerol-based phosphoglycerides and the sphingosine-based sphingolipids (see the figure below)

11- Glycolipids

A- Glycolipids are formed by the addition of carbohydrates to lipids

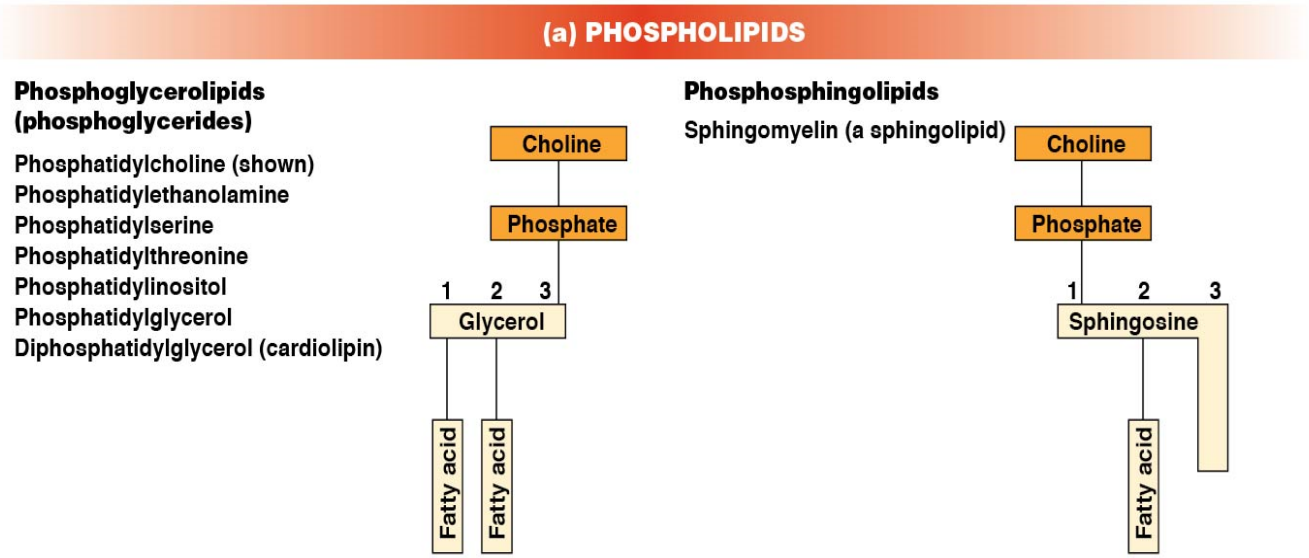
B- Some are glycerol based (the glycoglycerolipids), and some are sphingosine based (the glycosphingolipids)

C- Glycolipids <u>is lipids (not carbs)</u>

12- Composition and properties of membranes

A- Phospholipids can rotate and move laterally within a layer in two ways

- Flip-Flop move which is very rare
- Side-Side move which is common



B- Cholesterol is an essential component of animal plasma membrane. It is not present in bacteria and plant cells, but the latter cells contain sterols.

C- Asymmetric distribution of phospholipids between the two leaflets of the membrane bilayer.

- The outer leaflet: p-choline, p-sphingomyelin, p-glycolipids
- The inner leaflet: p-ethanolamine, p-serine, p-inositol (minor)
- Inositol has a role in cell signaling, cell junctions and endocytosis.
- The head groups of both p-serine and p-inositol are negatively charged, thus, the cytosolic face of the plasma membrane has a net negative charge. Another factor that makes the cytosolic face is more negative than outer face is sodium potassium pump

13- Types of membrane protein

A- Integral membrane proteins are embedded in the lipid bilayer because of their hydrophobic regions

B- Peripheral proteins are hydrophilic and located on the surface of the bilayer (both surfaces cytosolic and outer)

C- Lipid-anchored proteins are hydrophilic and attached to the bilayer by covalent attachments to lipid molecules embedded in the bilayer.

14- Lipid rafts:

A- Recent Findings Suggest Membranes Are Organized into Micro-domains

B- Membranes are Ordered through dynamic micro-domains called lipid rafts

C- Semisolid clusters (10-200 nm) of cholesterol and sphingolipids (sphingomyelin and glycolipids).

D- Sphingolipids provide a more ordered lipid structure than phospholipids. ~ more ordered means more rigidity) (less fluidity)~

E- Are enriched in glycosylphosphatidylinositol (GPI)-anchored proteins, and proteins involved in signal transduction and intracellular trafficking.

F- The lipid rafts are utilized in the replication cycle of numerous viruses.

G- Internalization receptors of many viruses localize to rafts or are recruited there after virus binding.
H- Arrays of signal transduction proteins found in rafts contribute to efficient trafficking and productive infection.
I- Some viruses are dependent on raft domains for the biogenesis of their membranous replication structures.
J- Rafts are often important in virus assembly and budding.
K- Raft components in the viral envelope may be vital for the entry to a new host cell.

IMPORTANT NOTES:

1st. Any things between ~~ is my talk and lecturer didn't say it, so it is not included, I have just put it for understanding.

2nd. In my opinion this report is adequate for understanding & mark purposes.

3rd. When I was writing this report, I have seeked to absolute accuracy and no mistakes, but it may contain mistakes. So if you want to study it study it at your own risk, and if you find any mistake please tell me about it.

4th. We (Academic Committee) arrange lectures (where the sheet starts and where it ends) according to Dr.Diala and we mention remarks made by Dr. Diala. But in this report I have mentioned the remarks made by Dr. Amir and Dr. Diala.

5th. This report is corrected by: Rua'a Nader

Written by: Jafar Sharabati