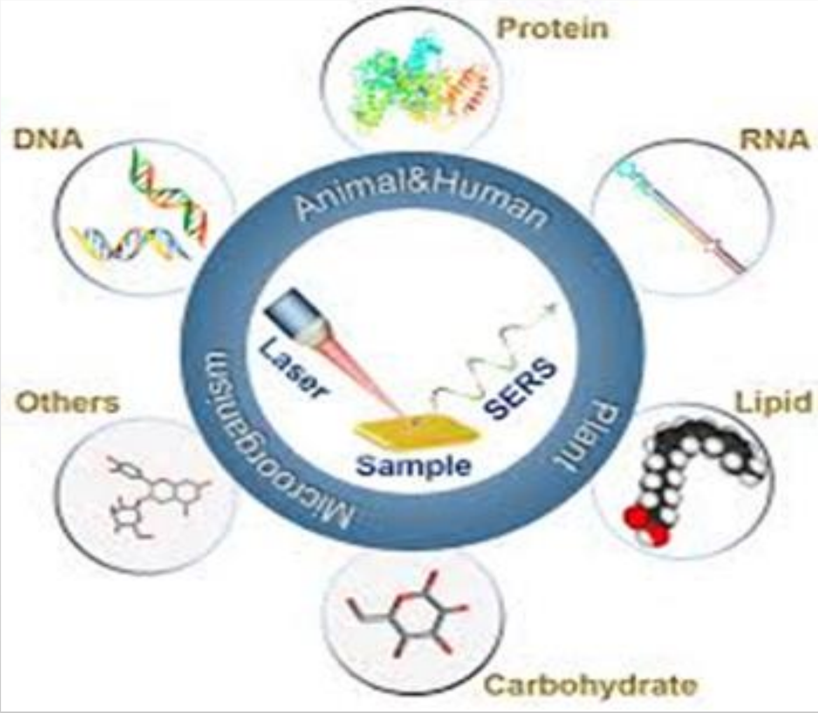
BIO-MOLECULES

Introduction:

- Certain characters in living organisms such as growth, reproduction, ability to sense, respond, etc distinguish the organism from a non-living thing. It has always been mysterious that despite being made up of non-living molecules, how a living organism performs all the above functions which characterize life. In this chapter, we shall try to identify this mystery with the study of bio molecules.
- Bio molecules are the molecules present in a living organism. These bio molecules are fundamental building blocks of living organisms.
- They support the biological processes essential for life.

Ex: carbohydrates, proteins, nucleic-acids, lipids, enzymes, vitamins, etc. Carbohydrates are involved in energy storage; the hormones catalyse the biochemical reactions; DNA/RNA store/transmit the genetic codes of a living being.



Bio molecules in life

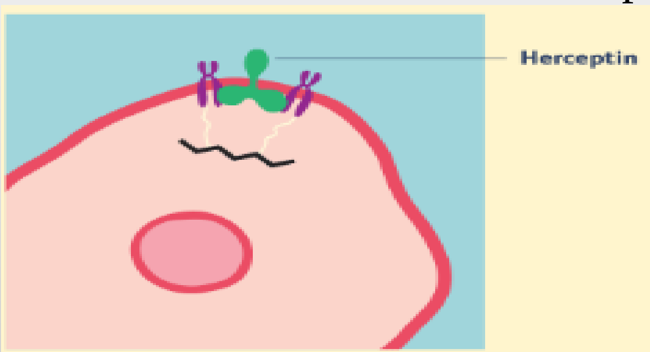
Proteins in body building

Lateral Gene transfer between Humans…..

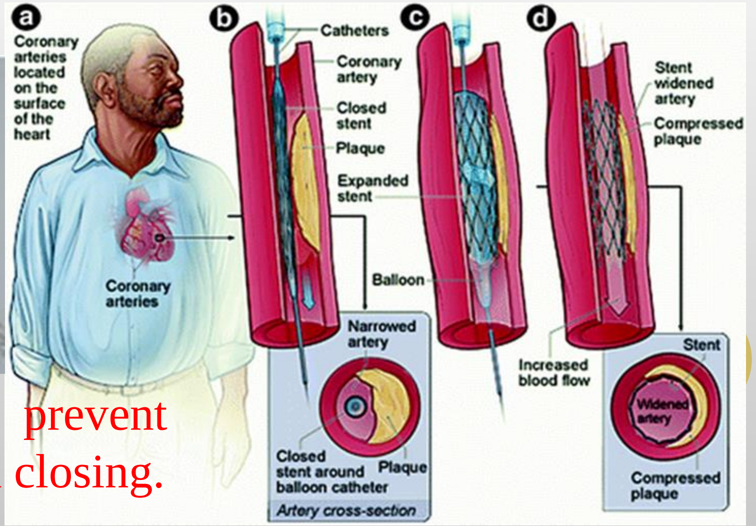
The inadequate concentration of these biomolecules shall lead to various kinds of health ailments. Therefore, the presence of biomolecules in appropriate concentrations is vital for the proper function of living beings.

BIO MOLECULES & ENGINEERING

- During World War II the need for large quantities of Penicillin of acceptable quality brought together chemical engineers and microbiologists to focus on penicillin production.
- This created the right conditions to start a chain of reactions that lead to the creation of the field of bio molecular engineering.
- **Bio molecular engineering** is the application of engineering principles and practices to the purposeful manipulation of molecules of biological origin.
- This gave valuable solutions to issues and problems in the life sciences related to the environment, agriculture, energy, industry, food production biotechnology and medicine.
- Herceptin, a humanized Mab for breast cancer treatment, became the first drug designed by a bio molecular engineering.
- Research in this field may lead to new drug discoveries, improved therapies, and advancement in new bioprocess technology.

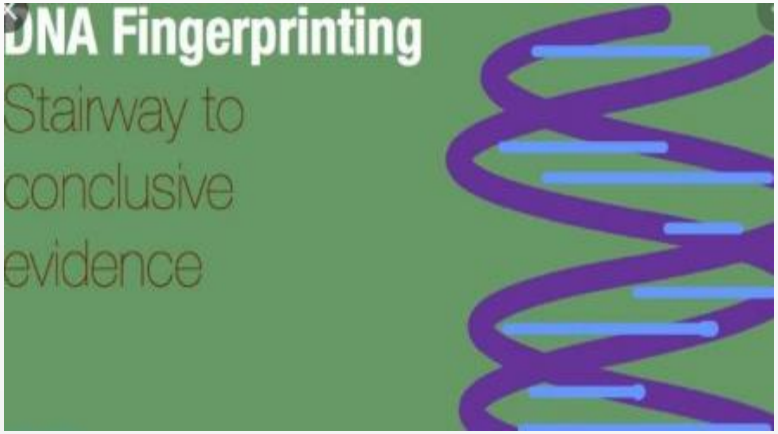


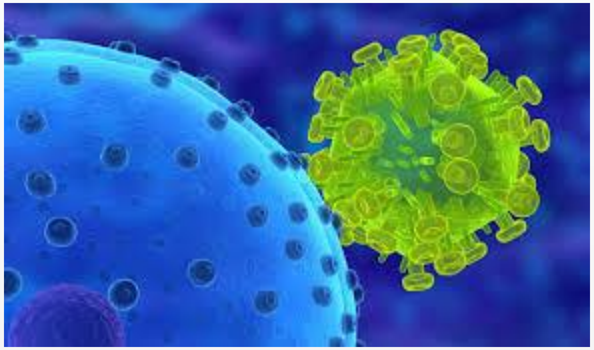
Herceptin works to block receptors and stop signal responsible for cancer cell growth and division



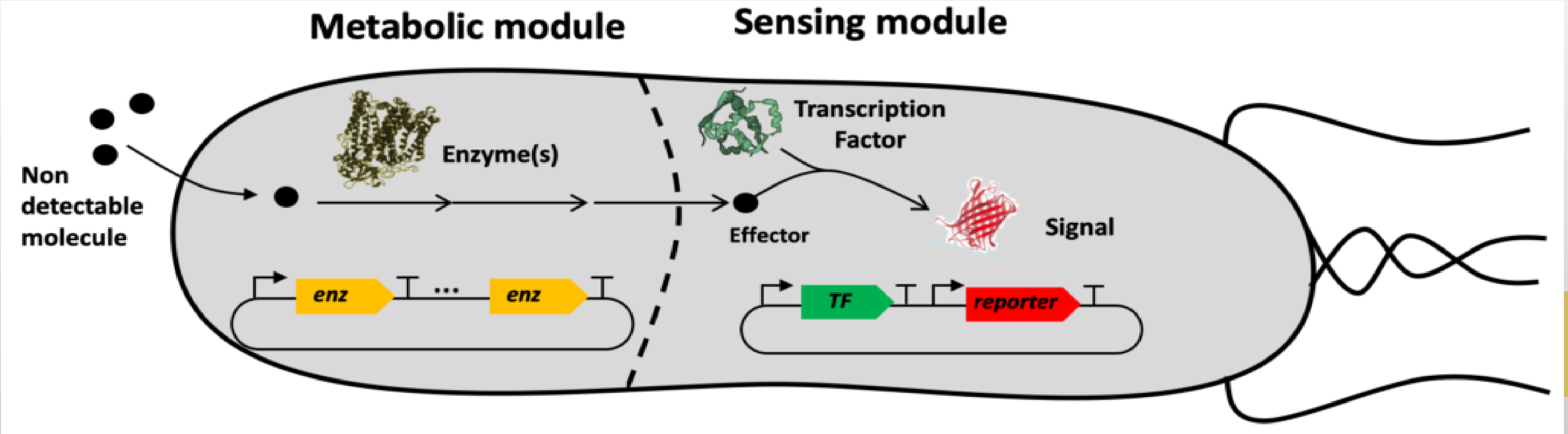
Bio Molecules to prevent Blood vessels from closing.

- Besides, various techniques such as DNA fingerprinting is based on the study of the bio molecules and widely used in forensic laboratories for identification of criminals, determine paternity of an individual or in the research of biological evolution.



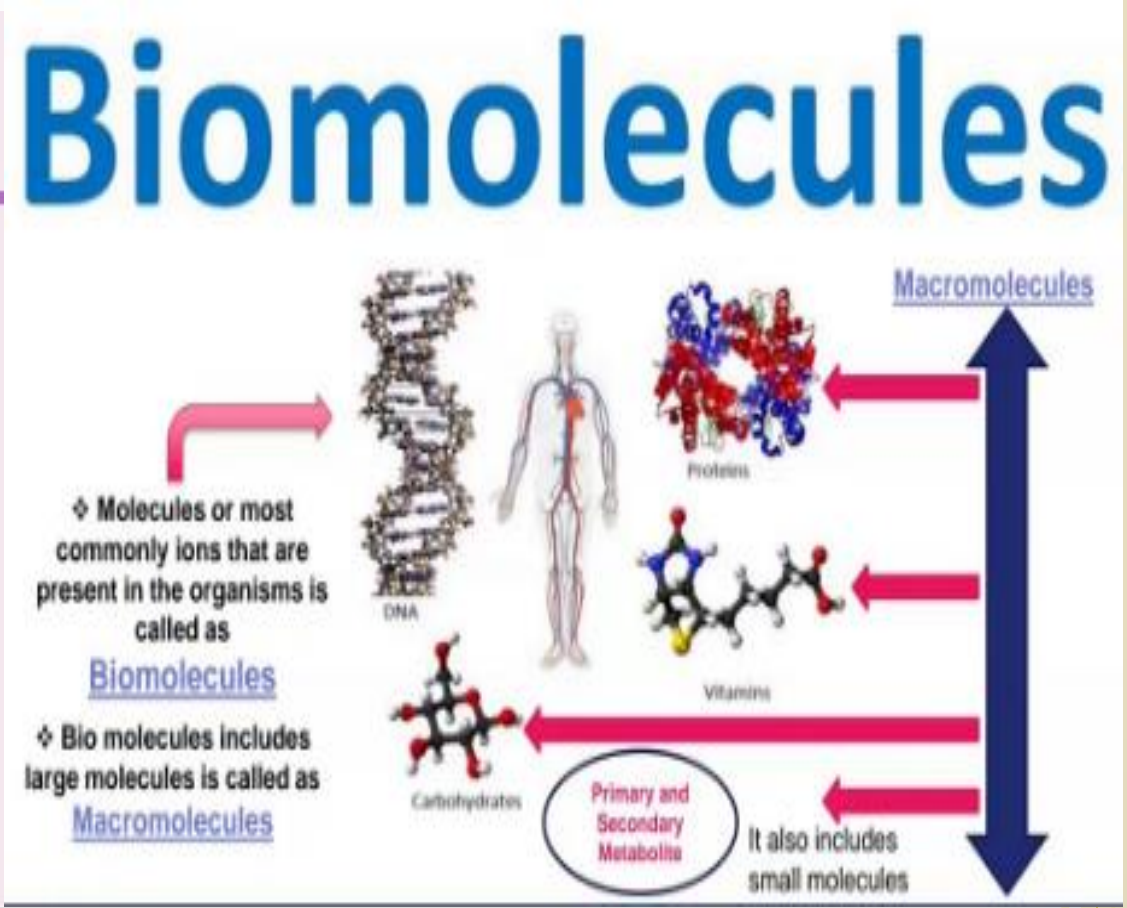


Software- defined Bio sensing



Function:

- Carbohydrates
  - Energy, support and recognition
- Proteins
  - Enzymes, structure, recognition, transport pigments, signals, mov't
- Lipids
  - Cell membrane structure energy storage, signals cellular metabolism (VitK..)
- Nucleic Acids
  - Hereditary and protein information, energy, signals



In this chapter, we shall focus on Proteins, Nucleic acids, Haemoglobin, antibodies & enzymes.

Proteins

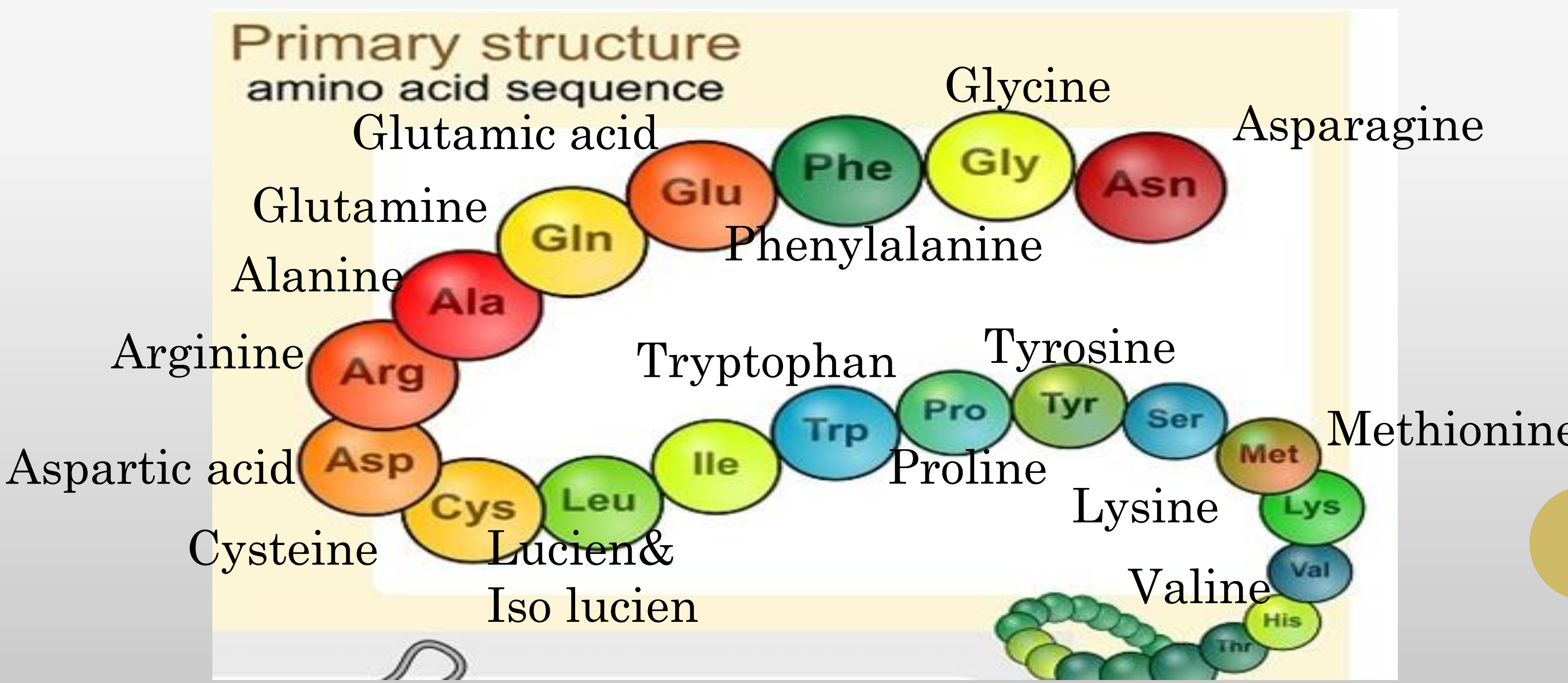
- Proteins are polymers of α-amino acids. They are essential for growth and maintenance of a living being's. They occur naturally in milk, cheese, pulses, peanuts, fish, meat, etc.
- Amino acids contain an amino ($–NH_2$) and carboxyl ($–COOH$) functional groups. The amino acids can be classified as α, β, γ, δ and so on, on the basis of the relative position of the amino group with respect to the carboxyl group.
- The linkage/bond between molecules of amino acids is known as Peptide bond.
- Change in the biological activity of a protein due to change in the ambient temperature or pH level denaturizes proteins.
- Curdling of milk or coagulation of egg white on boiling is an example of denaturation of Proteins.

Structure & Functions Of Proteins

- The structure of protein sets the foundation for its interaction with other molecules in the body and, therefore, determines its function.

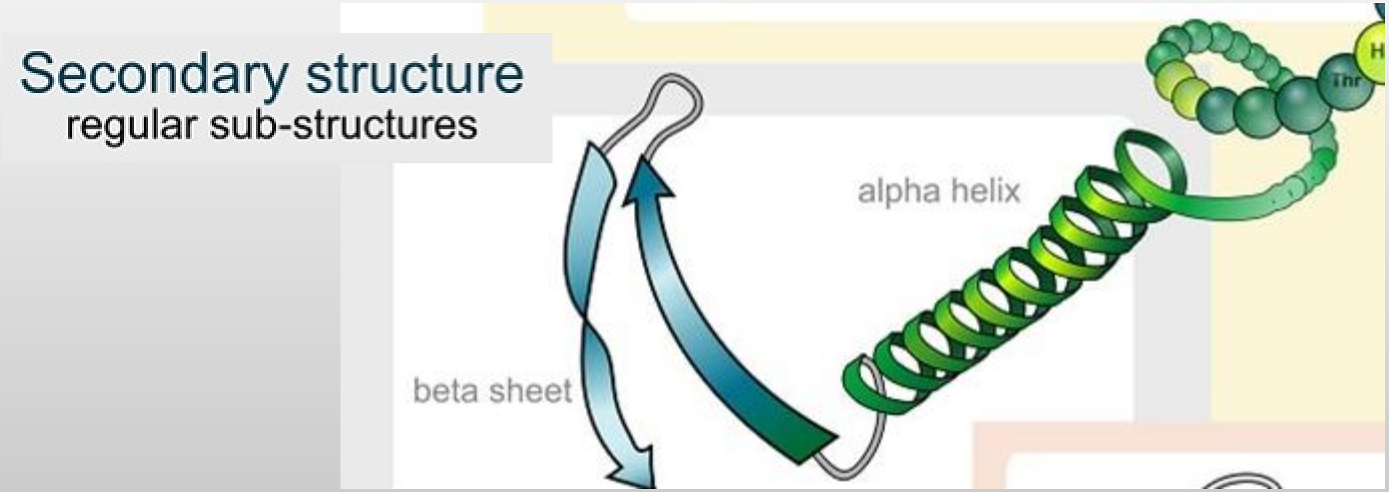
Primary protein structure

- Proteins are made up of a long chain of amino acids. Even with a limited number of amino acid monomers – there are only 20 amino acids commonly seen in the human body – they can be arranged in a vast number of ways to alter the three-dimensional structure and function of the protein. The simple sequencing of the protein is known as its primary structure.



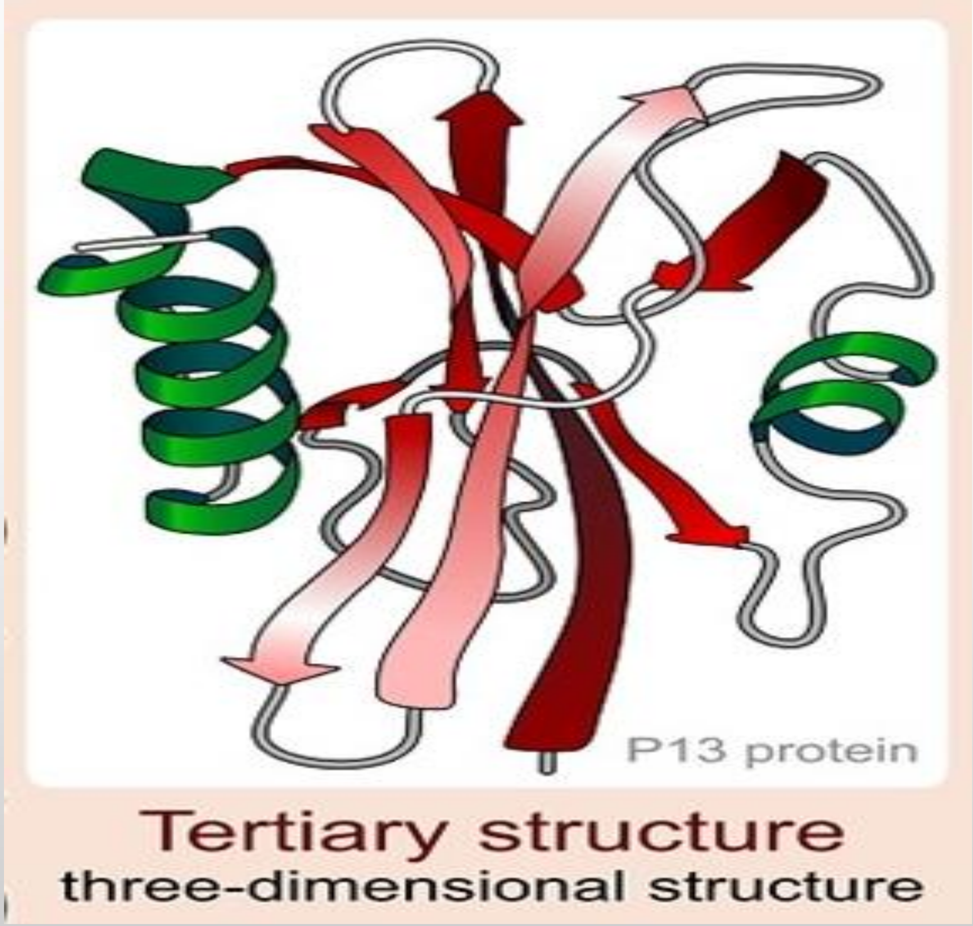
Secondary protein structure

- The secondary protein structure depends on the local interactions between parts of a protein chain, which can affect the folding and three-dimensional shape of the protein. There are two main things that can alter the secondary structure:
- α-helix: N-H groups in the backbone form a hydrogen bond with the C=O group of the amino acid 4 residues earlier in the helix.
- β-pleated sheet: N-H groups in the backbone of one strand form hydrogen bonds with C=O groups in the backbone of a fully extended strand next to it.
- There can also be a several functional groups such as alcohols, carboxamines, carboxylic acids, thioesters, thiols, and other basic groups linked to each protein. These functional groups also affect the folding of the proteins and, hence, its function in the body.



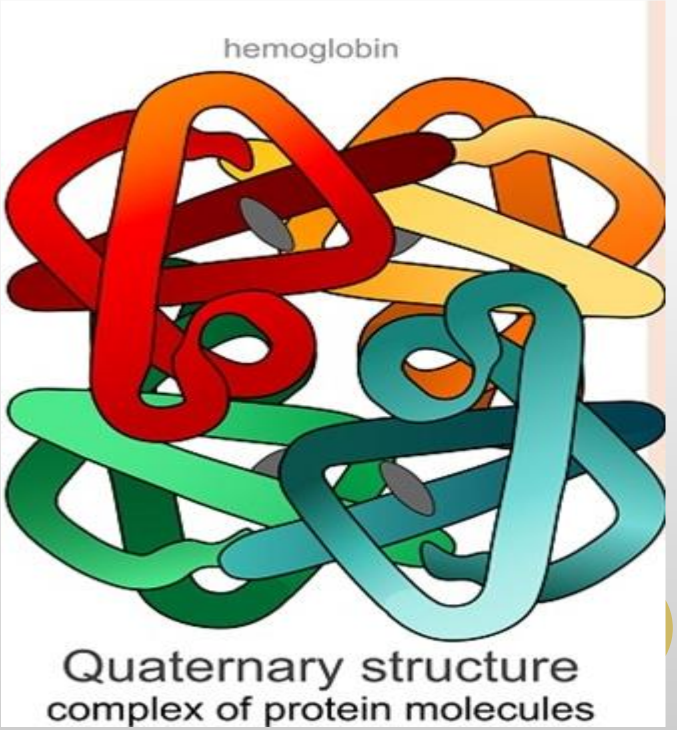
Tertiary structure

- The tertiary structure of proteins refers to the overall three-dimensional shape, after the secondary interactions. These include the influence of polar, nonpolar, acidic, and basic R groups that exist on the protein.



Quaternary protein

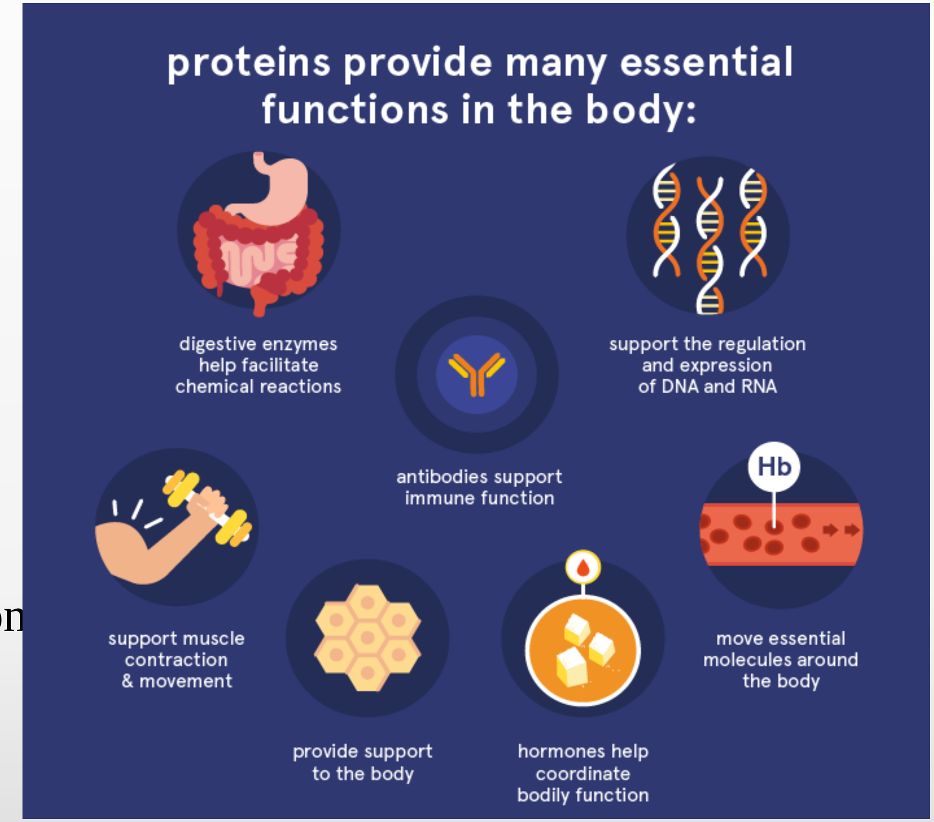
- The quaternary protein structure refers to the orientation and arrangement of subunits in proteins with multi-subunits. This is only relevant for proteins with multiple polypeptide chains.
- Proteins fold up into specific shapes according to the sequence of amino acids in the polymer, and the protein function is directly related to the resulting 3D structure.
- Proteins may also interact with each other or other macromolecules in the body to create complex assemblies. In these assemblies, proteins can develop functions that were not possible in the standalone protein, such as carrying out DNA replication and the transmission of cell signals.
- The nature of proteins is also highly variable.
- For example, some are quite rigid, whereas other are somewhat flexible. These characteristics also fit the function of the protein. For example, more rigid proteins may play a role in the structure of the cytoskeleton or connective tissues. On the other hand, those with some flexibility may act as hinges, springs, or levers to assist in the function of other proteins.



Protein functions:

- Proteins play an important role in many crucial biological processes and functions. They are very versatile and have many different functions in the body, as listed below:

- Act as catalysts
- Transport other molecules
- Store other molecules
- Provide mechanical support
- Provide immune protection
- Generate movement
- Transmit nerve impulses
- Control cell growth and differentiation



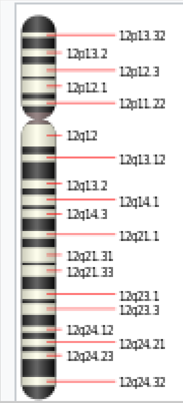
The extent to which the structure of proteins has an impact on their function is shown by the effect of changes in the structure of a protein. Any change to a protein at any structural level, including slight changes in the folding and shape of the protein, may render it non-functional.

Structure & Functions Of Keratin

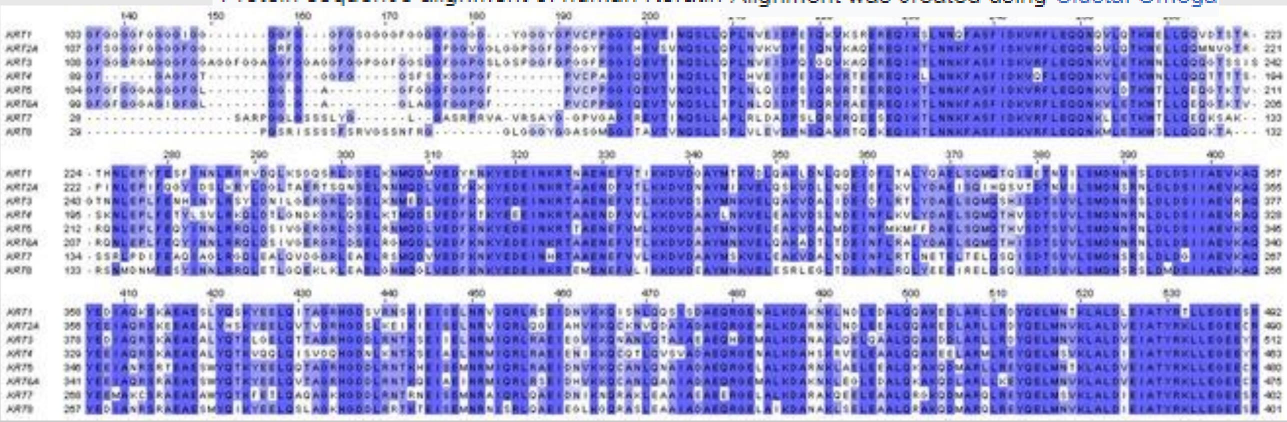
Keratin:

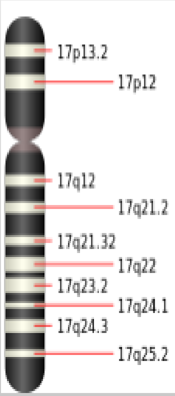
- It is an ubiquitous biological material, represents a group of insoluble, usually high-sulfur content and filament-forming proteins, constituting the bulk of epidermal appendages such as hair, nails, claws, turtle scuttles, horns, whale baleen, beaks, and feathers.
- The *α-keratins* are found in all vertebrates. They form the hair (including wool), outer layer of skin, horns, nails, claws and hooves of mammals and the slime threads of hagfish.
- The harder *β-keratins* are found only in living reptiles and birds. They are found in the nails, scales, and claws of reptiles.
- The human genome encodes 54 functional keratin genes, located in two clusters on chromosomes 12 and 17. This suggests that they originated from a series of gene duplications on these chromosomes.

Chromosome 12



Protein sequence alignment of human Keratin Alignment was created using Clustal Omega

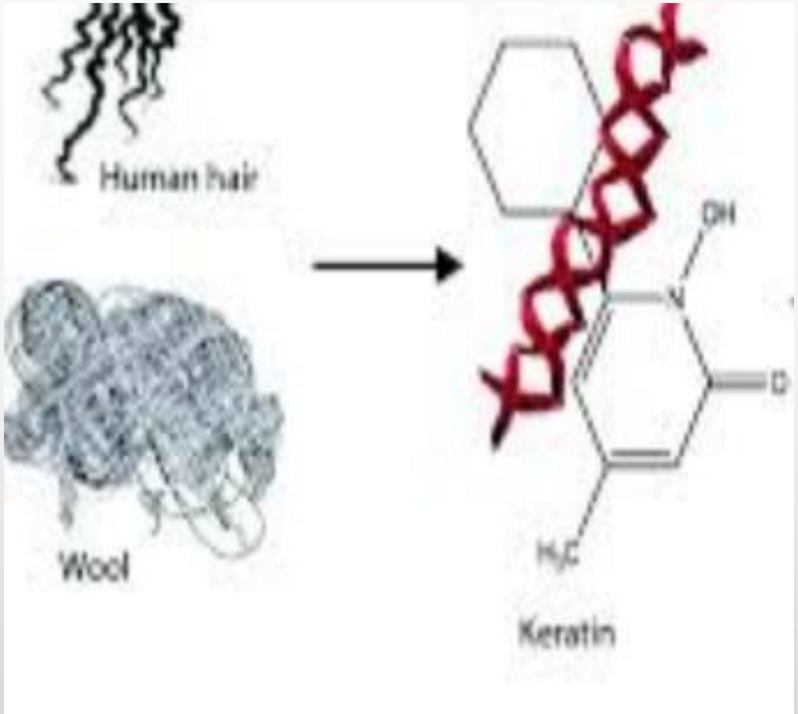


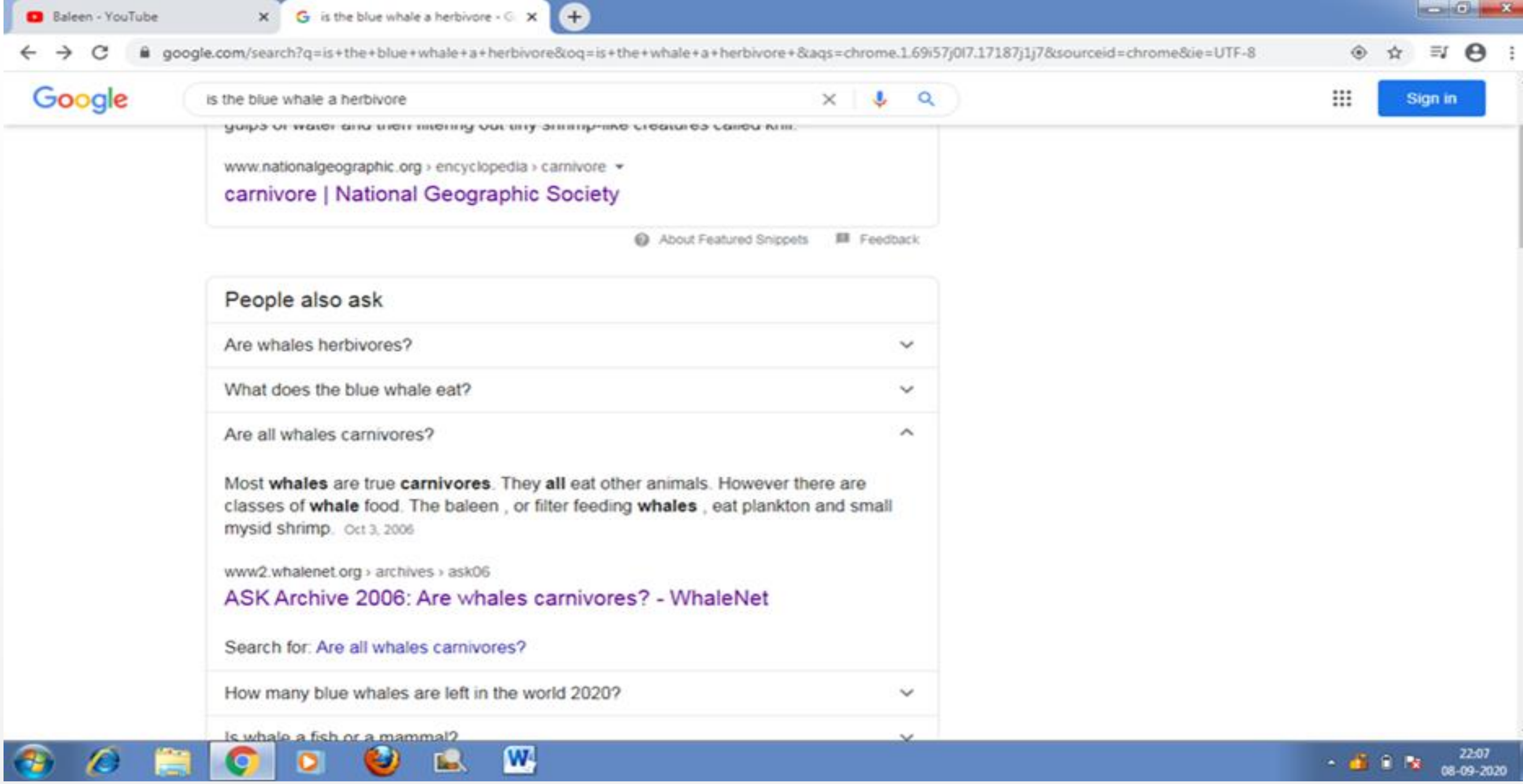


Chromosome 17

Functions of keratin:

- Strengthens hair
- Coats and repairs damaged hair
- Maintains healthy skin
- Skin pigmentation and protection
- Toughens nails and bony structures




Baleen - YouTube
is the blue whale a herbivore - G
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Most whales are true carnivores. They all eat other animals. However there are classes of whale food. The baleen , or filter feeding whales , eat plankton and small mysid shrimp. Oct 3, 2006
www2.whalenet.org › archives › ask06
ASK Archive 2006: Are whales carnivores? - WhaleNet
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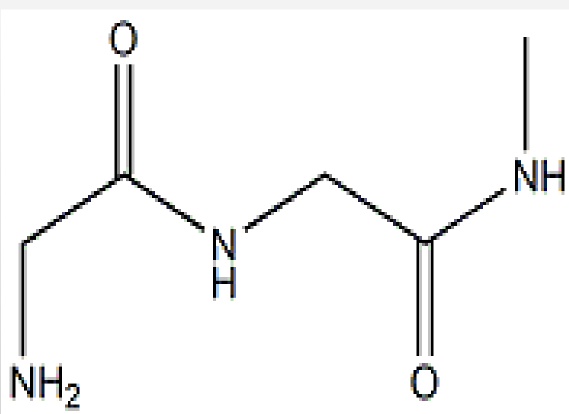
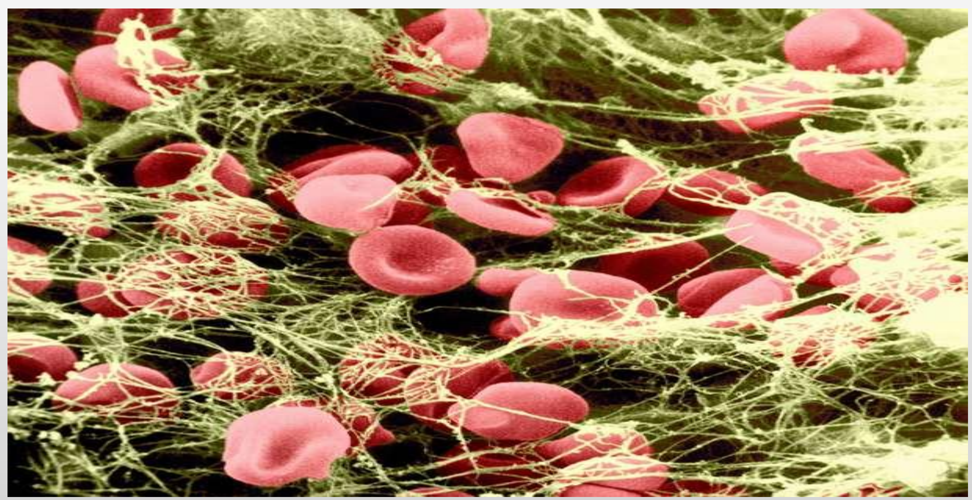
Structure & Functions Of Fibrin

- Fibrin is a fibrous, **non-**globular protein involved in the clotting of blood.
- Fibrin is a hydrogel formed by the enzymatic reaction between thrombin and fibrinogen, the key **proteins** involved in blood clotting.
- Action of the protease thrombin on fibrinogen causes polymerize. This polymerized fibrin, together with platelets, forms a haemostatic plug or clot over a wound site.
- It supports extensive cell growth and proliferation, plays a significant role in wound healing and has been used in the fabrication of skin grafts.





fibrin in blood clotting
Red blood cells (erythrocytes) trapped in a mesh of fibrin threads. Fibrin, a tough, insoluble protein formed after injury to the blood vessels, is an essential component of blood clots.

HAEMOGLOBIN

- Haemoglobin is the red colouring matter of blood which is present in the red blood cells. It is a conjugated protein consisting of haeme and the protein globin.
- The structure of Haemoglobin can be classified as

a. Structure of Haeme, the prosthetic group.

b. Structure of Globin, the protein part— apo-protein

a. Structure of Heme:

- It is an iron porphyrin. The porphyrins are cyclic compounds with “tetra pyrrole” structure.
- Four pyrrole rings called I to IV are linked through methylene bridges.
- The outer carbon atoms, which are not linked with the methylene bridges, are numbered 1 to 8.

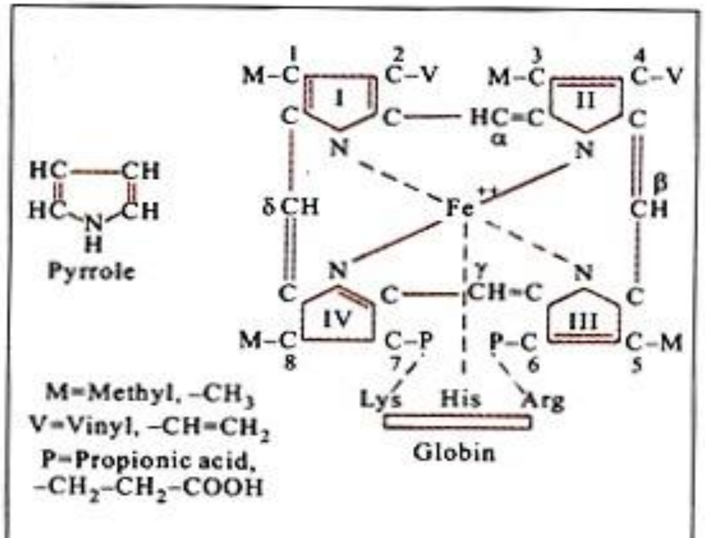
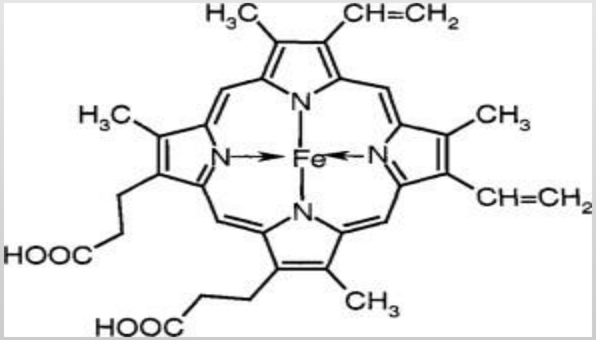


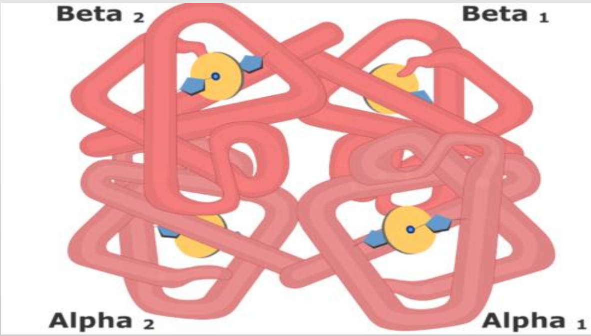
Fig. 9.1 : Structure of Heme

- The methylidene bridges are designated as α, β, γ, δ, respectively.
- Iron in the ferrous state is bound to the nitrogen atom of the pyrrole rings.
- Iron is also linked internally (5th linkage) to the nitrogen of the imidazole ring of Histidine of the polypeptide chains.
- The propionic acid of 6th and 7th position of haeme of III and IV pyrroles are also linked to the amino acids Arg and Lys of the polypeptide chain, respectively.

b. Structure of Globin:

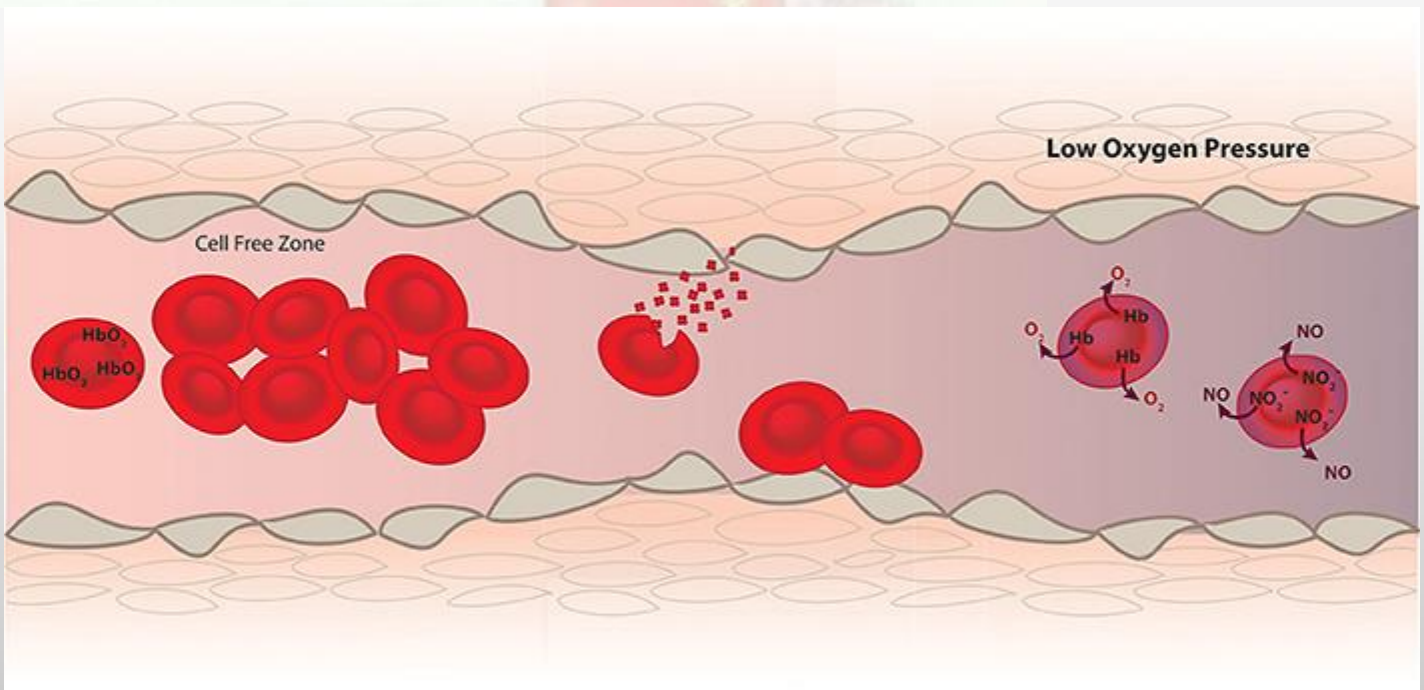
- The globin of hemoglobin is a protein which is composed of 4 parallel layers of closely packed polypeptide chains.
- Two of the chains (α-chains) have identical amino acid composition of 141 amino acids. The two other chains may be two of the 4 polypeptide chains designated as β, γ, δ, and ε (epsilon). Each is having 146 amino acids.
- The total number of amino acids in globin is 574.
- α chains have Val-Leu-Ser in N terminal residues and Lys-tyr-Arg in C terminal residues.
- β chains have Val-His-Leu in N-terminal residues and Lys-tyr-His in C-terminal residues.
- γ chains have Gly-His-Phe. N-terminal residues and Arg-Tyr-His in C-terminal residues.
- Hemoglobin molecule and its sub-units contain mostly hydrophobic amino acids internally and hydrophilic amino acids on their surfaces. So they form "'Heme pockets".
- In **"heme pockets"** α subunits are of size necessary for entry of O_2 molecule but the entry of O_2 molecule in β subunit is blocked by valine residue.





Functions of hemoglobin

- Imparts red color to the blood.
- Helps to carry out the oxygen and other gases assisting the respiratory system.
- It buffers the blood pH and maintains it to the tolerable limits.
- Source of physiological active catabolites.
- Genetic resistance to malaria, etc.



ANTIBODIES

Structure:

- An antibody, also known as an immunoglobulin, is a Y-shaped structure which consists of four polypeptides — two heavy chains and two light chains. This structure allows antibody molecules to carry out their dual functions: antigen binding and biological activity mediation.
- Each function is carried out by different parts of the antibody: fragment antigen-binding (Fab fragment) and fragment crystallisable region (Fc region).
- Fab fragment is a region on an antibody that binds to antigens. It is composed of one constant and one variable domain of each of the heavy and the light chain. These domains shape the paratope — the antigen-binding site — at the amino terminal end of the monomer.
- Fc region is the tail region of an antibody that interacts with cell surface receptors called Fc receptors and some proteins of the complement system. This property allows antibodies to activate the immune system. The Fc regions of immunoglobulin Gs bear a highly conserved N-glycosylation site.

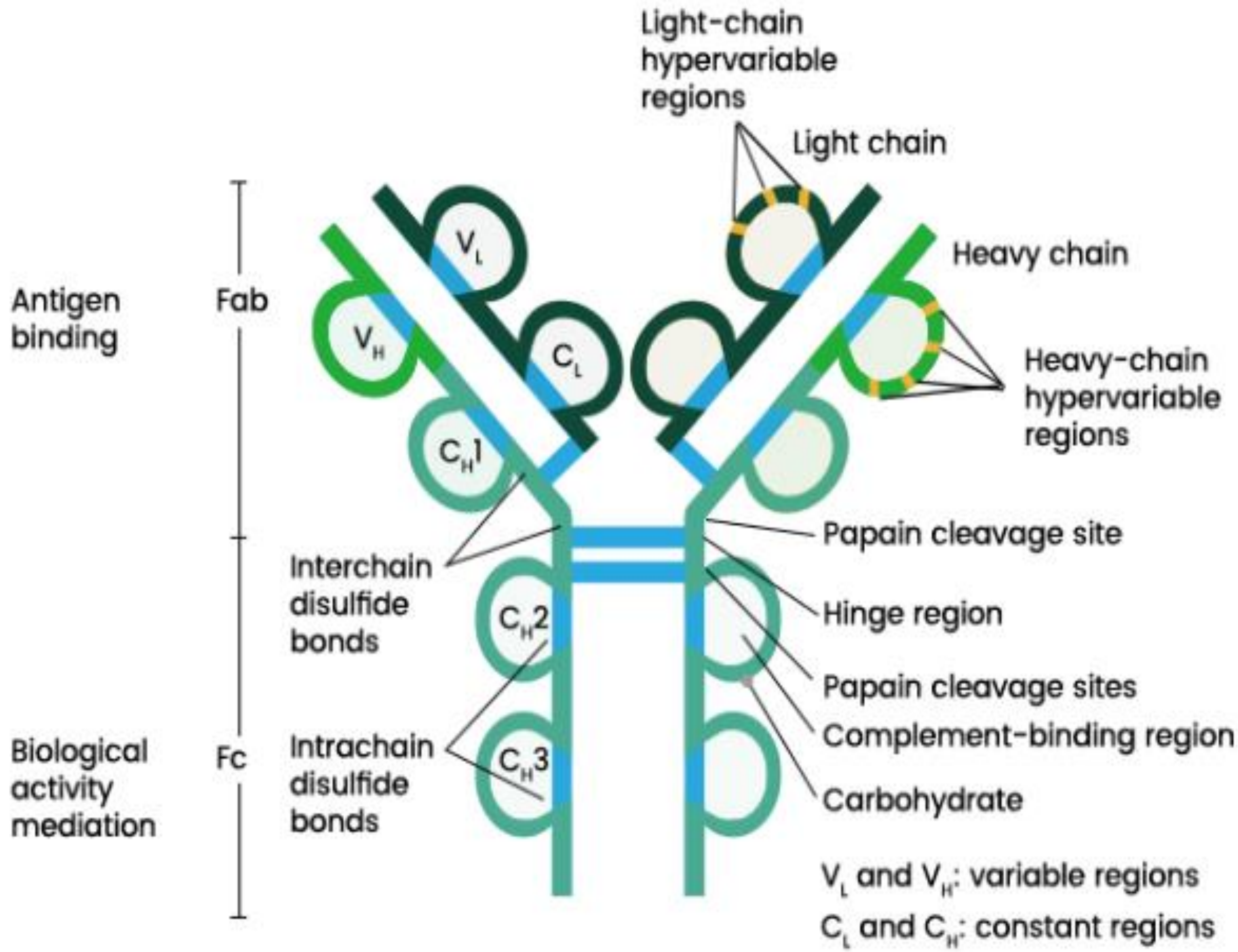
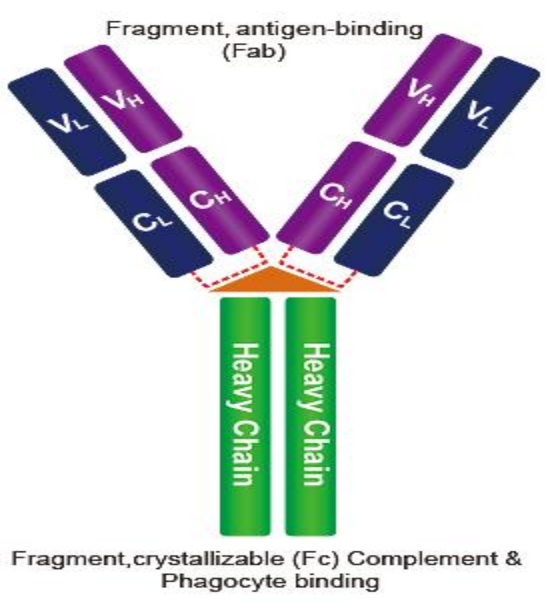


Fig 1. Antibody structure diagram

Different Types of Antibodies

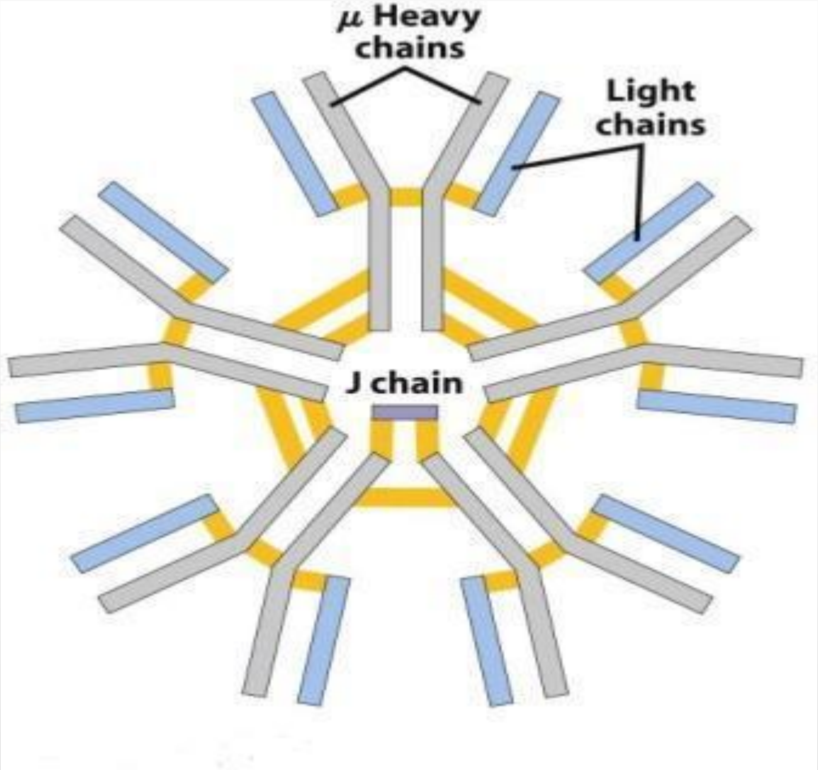
There are five immunoglobulin classes of antibody molecules found in serum: IgG, IgA, IgM, IgE and IgD.

- **IgG antibody structure and function:** Immunoglobulin G (IgG) antibodies are large globular proteins made of four peptide chains. It contains two identical γ (gamma) heavy chains and two identical light chains thus a tetrameric quaternary structure.
- IgG provides long term protection because it persists for months and years after the presence of the antigen that has triggered their production. IgG protects against bacteria, viruses, neutralises bacterial toxins, triggers complement protein systems and binds antigens to enhance the effectiveness of phagocytosis.



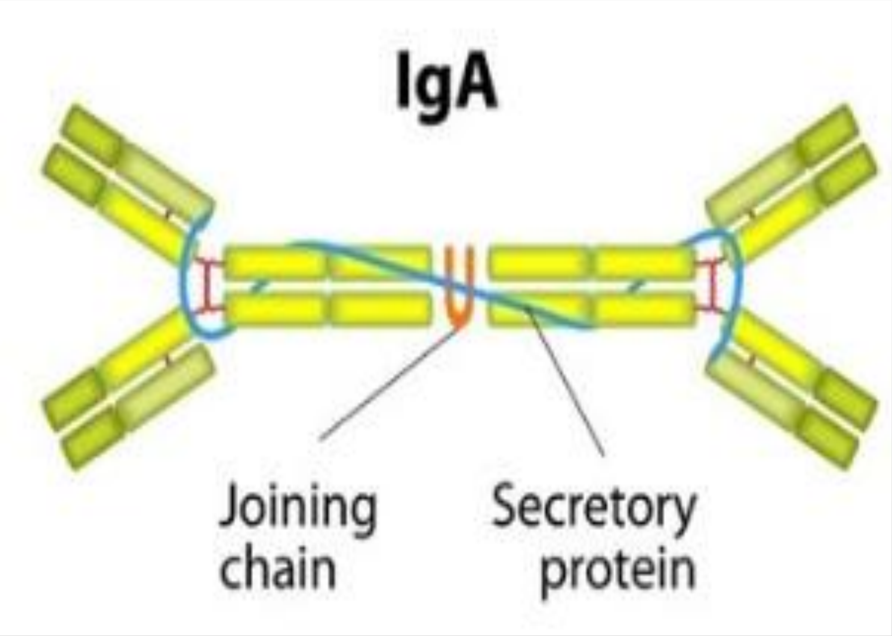
IgM antibody structure and function: Immunoglobulin M (IgM) antibodies are constructed of five or six units which are each comprised of two heavy-chains (μ-chains) and two light chains, bound together by disulfide bonds and a so-called J-chain.

- IgM is involved in the ABO blood group antigens on the surface of RBCs. IgM enhances ingestions of cells by phagocytosis.



IgA antibody structure and function: Immunoglobulin A (IgA) antibodies consist of heavy (H) and light (L) chains. Each H chain is comprised of the constant region, hinge region and the Variable (V) region.

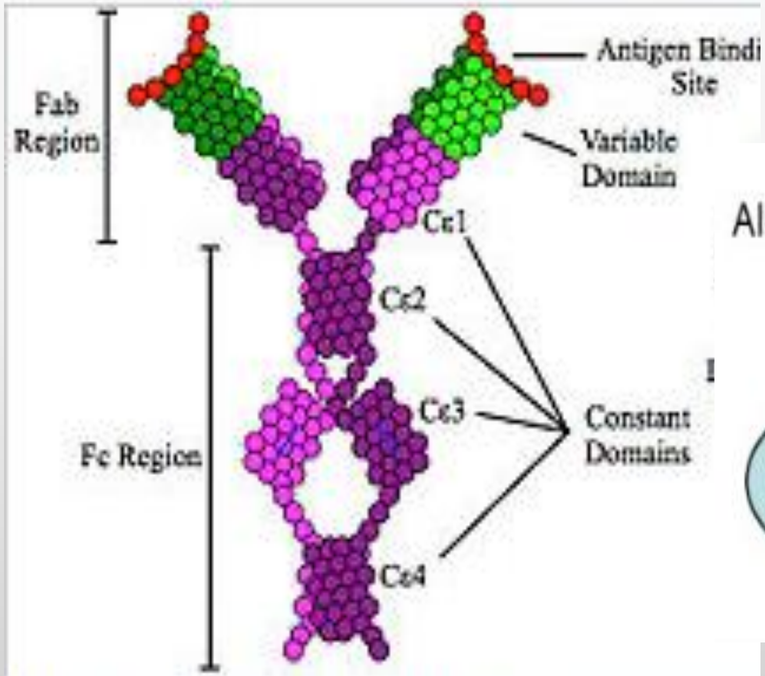
- The main function of IgA is to bind antigens on microbes before they invade tissues. It aggregates the antigens and keeps them in the secretions. IgA is also first defence for mucosal surfaces such as the intestines, nose, and lungs.



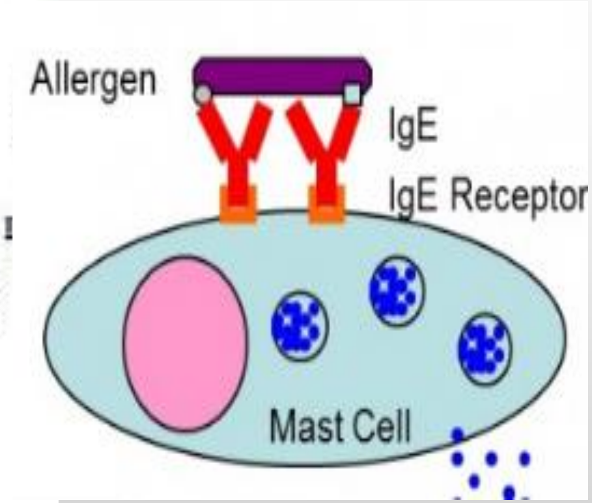
IgE antibody structure and function:

Immunoglobulin E (IgE) antibodies have only been found in mammals. IgE is synthesised by plasma cells. Monomers of IgE consist of two heavy chains (ε chain) and two light chains, with the ε chain containing 4 Ig-like constant domains (Cε1-Cε4).

- IgE bind to mast cells and basophils which participate in the immune response. Some scientists think that IgE's purpose is to stop parasites.

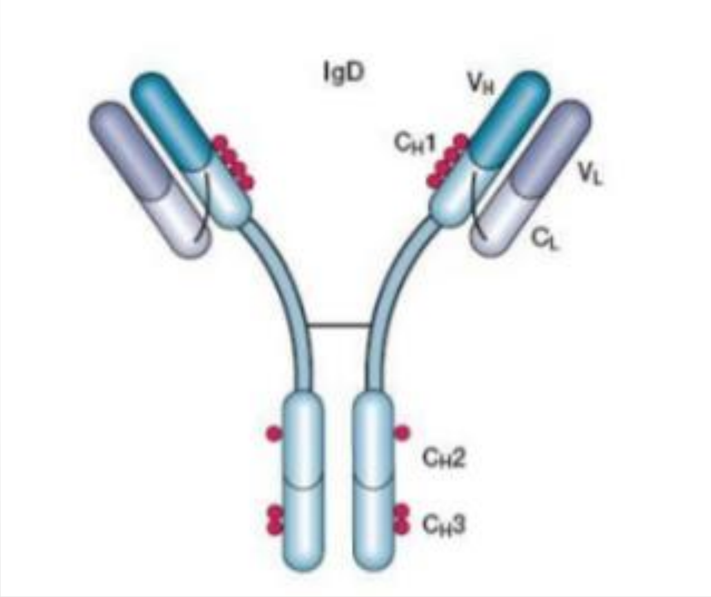


The structure of the IgE antibody



IgD antibody structure and function:

- Immunoglobulin D (IgD) antibodies are expressed in the plasma membranes of immature B-lymphocytes. IgD is also produced in a secreted form that is found in small amounts in blood serum. IgD plays a role in the induction of antibody production.



1. https://www.youtube.com/watch?v=vxWf-66lymg
(Imp for Notes)

2. https://www.youtube.com/watch?v=Cvu1ApHkhYM
(Antibody Function)

3. https://www.youtube.com/watch?v=NOK6drNPNck
((IgM & IgG in Covid test)

4.https://www.technologynetworks.com/immunology/articles/antigen-vs-antibody-what-are-the-differences-293550 (Vaccine reaction against antigens)

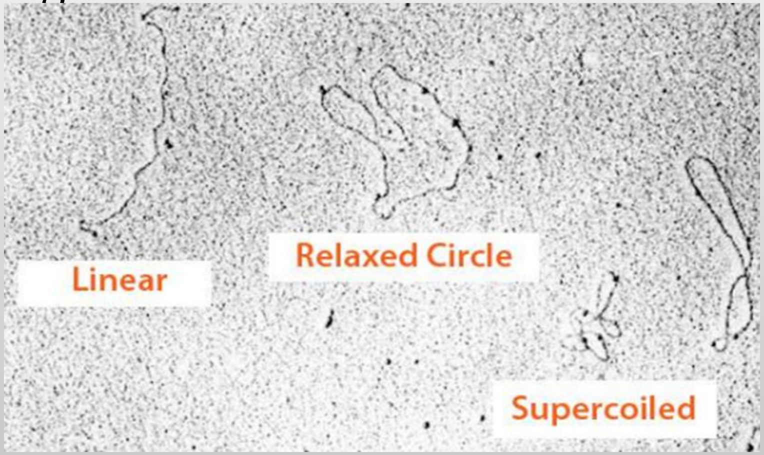
5. https://www.cancer.ca/en/research-horizons/2/3/4/how-can-antibodies-fight-cancer/
(Antibody action in Cancer cell -animated)

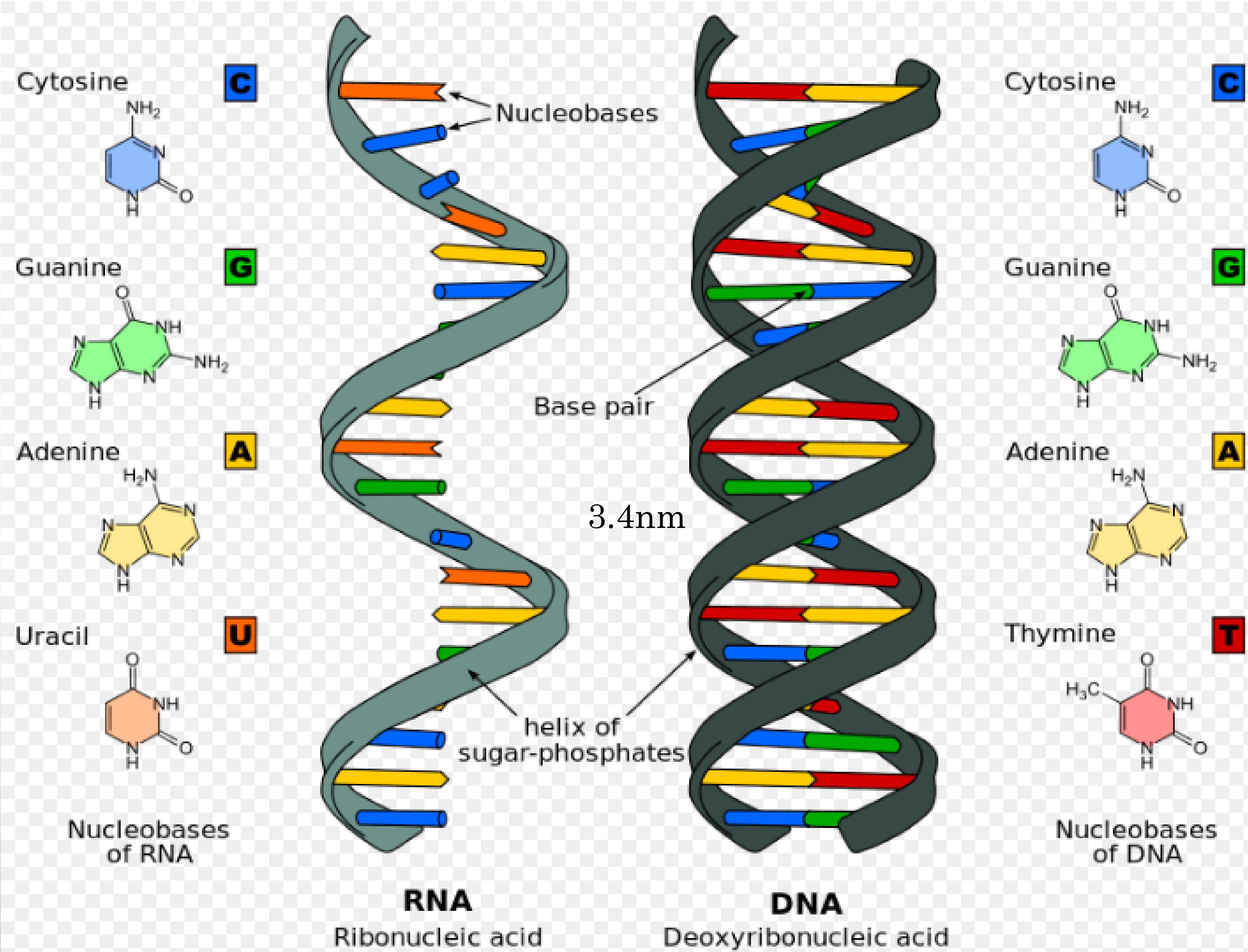
6. https://www.youtube.com/watch?v=sJ8Sz0CcNKo (Phagocytosis)

7. https://www.youtube.com/watch?v=xEHGIRpGyh4 (Haemoglobin carrying oxygen)

NUCLEIC ACIDS

- **Nucleic Acid**: Nucleic acids are polymers of nucleotides present in the nucleus of all living cells. They play an important role in the biosynthesis of proteins. Also, they store and transmit the genetic codes of a living being from the parent to its offspring.
- Mainly, there are two types of nucleic acids - deoxyribonucleic acid (DNA) and ribonucleic acid (RNA).
- DNA contains the deoxyribose sugar, while RNA contains the ribose sugar. The main and only difference between ribose and deoxyribose sugar is that ribose has one more -OH group than deoxyribose, which has -H attached to the second carbon in the ring.
- DNA is double-stranded and RNA is a single-stranded molecule.
- Base pairing in DNA and RNA is slightly different as DNA uses the bases adenine, thymine, cytosine, and guanine and RNA uses the bases adenine, uracil, cytosine, and guanine.



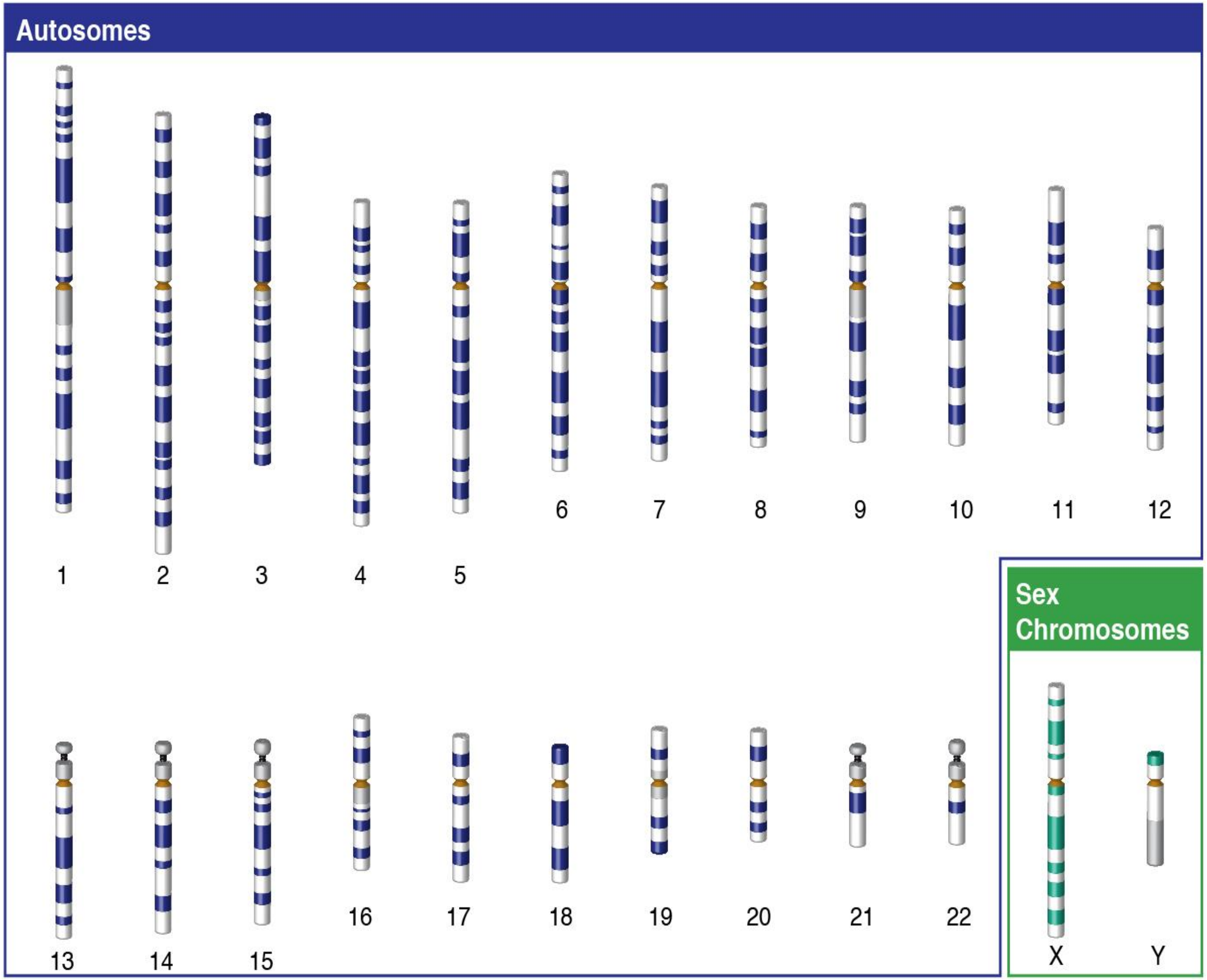


Cytosine
C
Guanine
G
Adenine
A
Uracil
U
Nucleobases of RNA
Nucleobases
Base pair
3.4nm
helix of sugar-phosphates
RNA
Ribonucleic acid
DNA
Deoxyribonucleic acid
Cytosine
C
Guanine
G
Adenine
A
Thymine
T
Nucleobases of DNA

Structure of DNA

- DNA is made up of molecules called nucleotides. Each nucleotide contains a phosphate group, a sugar group and a nitrogen base.
- The four types of nitrogen bases are adenine (A), thymine (T), guanine (G) and cytosine (C).
- The order of these bases is that determines DNA's instructions or genetic code.
- Human DNA has around 3 billion bases, and more than 99 % of those bases are the same in all people, according to the U.S. National Library of Medic
- Watson, Crick, and Wilkins proposed in the early 1950s a model of a double-stranded DNA molecule.
- The two strands of this double-stranded helix are held by hydrogen bonds between the purine and pyrimidine bases of the respective linear molecules.
- The pairing between purine and pyrimidine nucleotides on the opposite strands are very specific and are dependent upon hydrogen bonding of **A** with **T** and **G** with **C**.
- This common form of DNA is said to be right handed. **A** to pair only with **T** by two hydrogen bonds and **G** only with **C** by three hydrogen bonds .
- Thus, the **G–C** bonds are much more resistant to denaturation than **A–T** rich regions.

- DNA is the information molecule. It stores instructions for making other large molecules, called proteins. These instructions are stored inside each cells and distributed among 46 long structures called chromosomes.
- These chromosomes are made up of thousands of shorter segments of DNA, called genes. Each gene stores the directions for making protein fragments.
- DNA is well-suited to perform biological function because of its molecular structure and the development of a series of high performance enzymes.
- The match between DNA structure and the activities of these enzymes is so effective and well-defined that DNA has become, over evolutionary time, the universal information-storage molecule for all forms of life.
- Nature has yet to find a better solution than DNA for storing, expressing, and passing along instructions for making proteins.
- A person's DNA contains information about their heritage, and can sometimes reveal whether they are at risk for certain diseases.
- DNA tests, or genetic tests, are used for a variety of reasons, including to diagnose genetic disorders, to determine whether a person is a carrier of a genetic mutation that they could pass on to their children, and to examine whether a person is at risk for a genetic disease.


Autosomes
1
2
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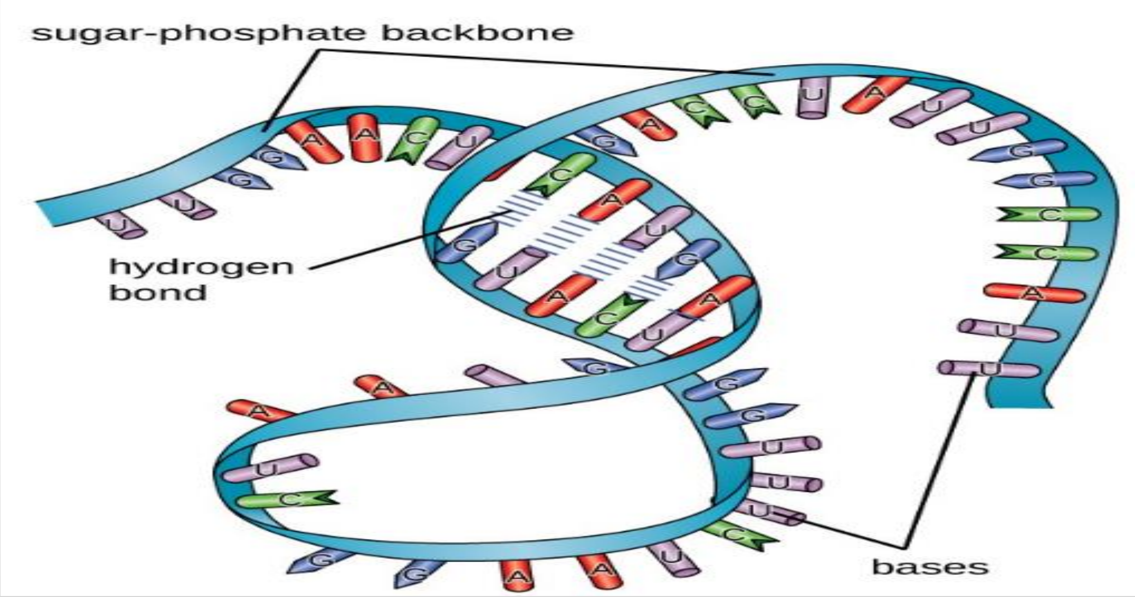
20
21
22
Sex Chromosomes
X
Y

Structure of RNA

- RNA is typically single stranded and is made of ribo-nucleotide that are linked by phospho-di-ester bonds. A ribo-nucleotide in the RNA chain contains ribose sugar, one of the four nitrogenous bases (A,U,G and C), and a phosphate group.
- The relative instability of RNA makes it more suitable for its more short-term functions. The RNA-specific pyrimidine **uracil** forms a complementary base pair with adenine and is used instead of the thymine used in DNA. Even though RNA is single stranded, most types of RNA molecules show extensive intra-molecular base pairing between complementary sequences within the RNA strand.

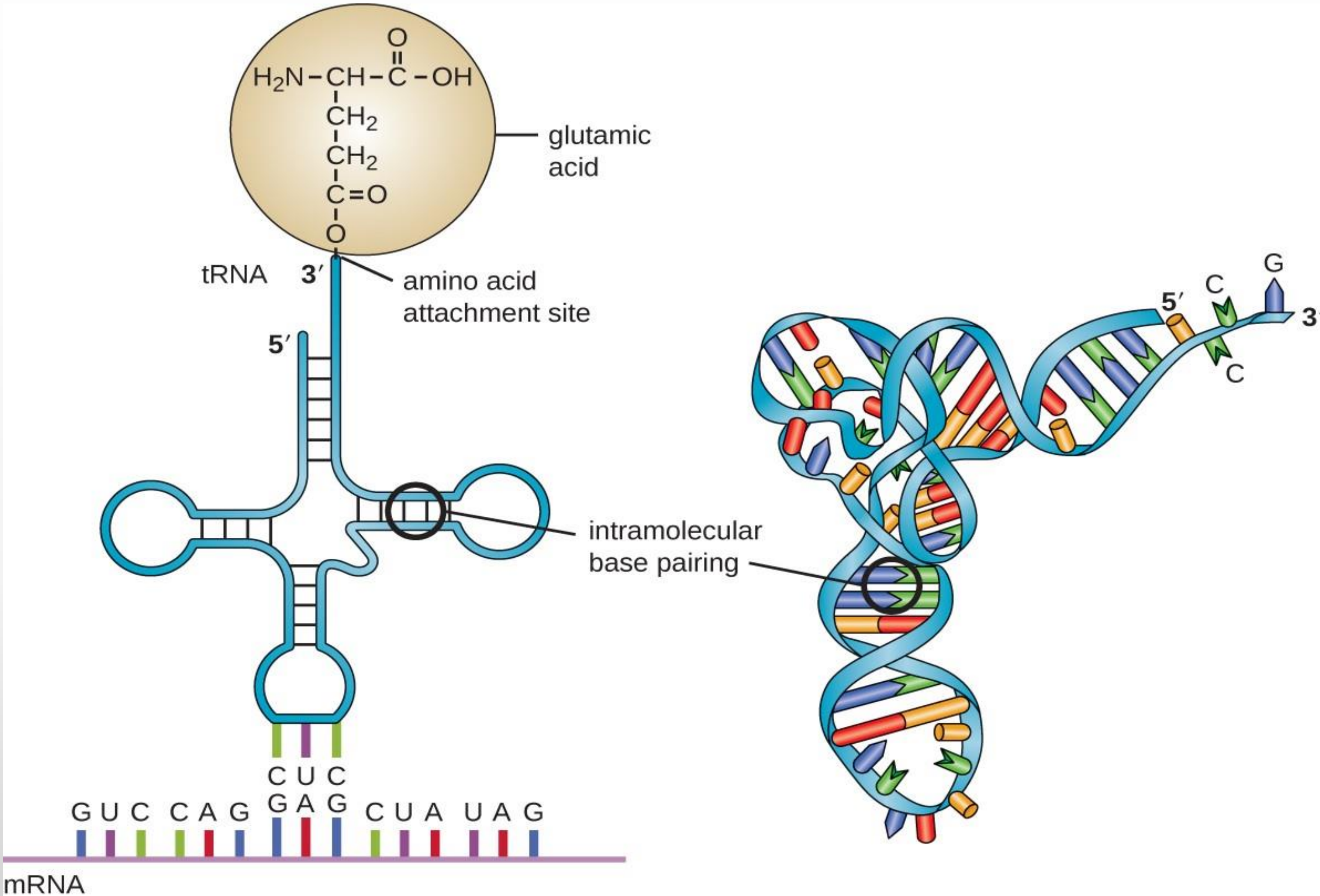


https://www.news-medical.net/life-sciences/-Types-of-RNA-mRNA-rRNA-and-tRNA.aspx

TYPES AND FUNCTIONS OF RNA

- Based on the role in protein synthesis, RNA's are of three types. They are messenger RNA(mRNA), transfer RNA(tRNA), and ribosomal RNA(rRNA), which are present in all organisms. These RNA primarily carry out biochemical reactions, similar to enzymes and play an important role in both normal cellular processes and diseases.
- In protein synthesis, mRNA carries genetic codes from the DNA in the nucleus to ribosomes.
- Ribosomes are composed of rRNA and protein. The ribosome protein subunits are encoded by rRNA and are synthesized in the nucleolus.
- Once fully assembled, they move to the cytoplasm, where they act as key regulators of translation, they "read" the code carried by mRNA.
- A sequence of three nitrogenous bases in mRNA specifies incorporation of a specific amino acid in the sequence that makes up the protein.
- Molecules of tRNA which contain fewer than 100 nucleotides, bring the specified amino acids to the ribosomes, where they are linked to form proteins.

https://www.youtube.com/watch?v=1THyMOk3WU0



tRNA 2-dimensional structure

tRNA 3-dimensional structure

https://www.risingtidebio.com/review-dna-genetic-testing/

Enzymes

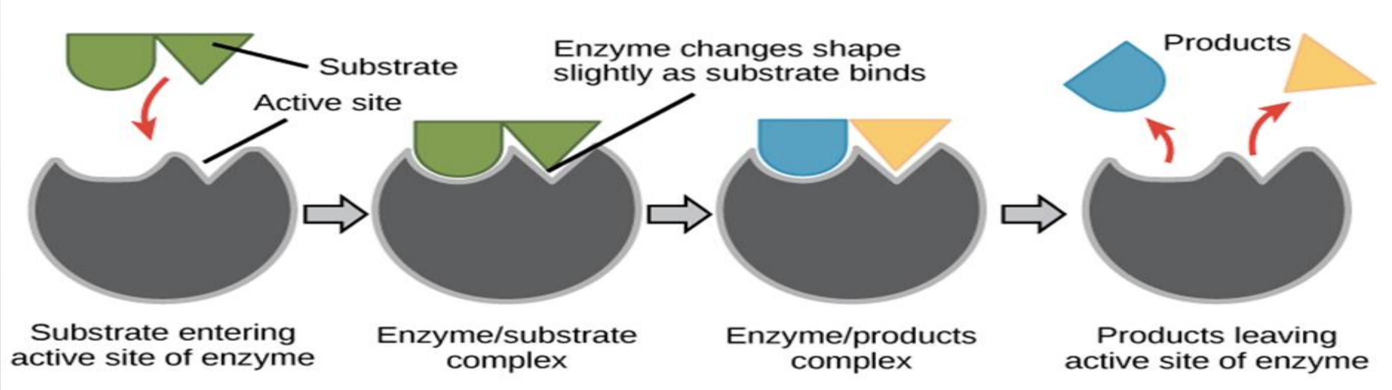
Introduction:

- The human body is composed of different types of cells, tissues, and other complex organs. For efficient functioning, our body releases some chemicals to accelerate biological processes such as respiration, digestion, excretion and few other metabolic activities to sustain a healthy life. Hence, enzymes are pivotal in all living entities which govern all the biological processes.

Definition: ***"Enzymes can be defined as biological polymers that catalyse biochemical reactions."***

Enzyme Structure:

- Enzymes are a linear chain of amino acids, which give rise to a three-dimensional structure. The sequence of amino acids specifies the structure, which in turn identifies the catalytic activity of the enzyme.
- The initial stage of metabolic process depends upon the enzymes, which react with a molecule called the substrate. Enzymes convert the substrates into other distinct molecules called the products.
- https://www.youtube.com/watch?v=a0yGDipKWlo (Digestive enzymes & Function)

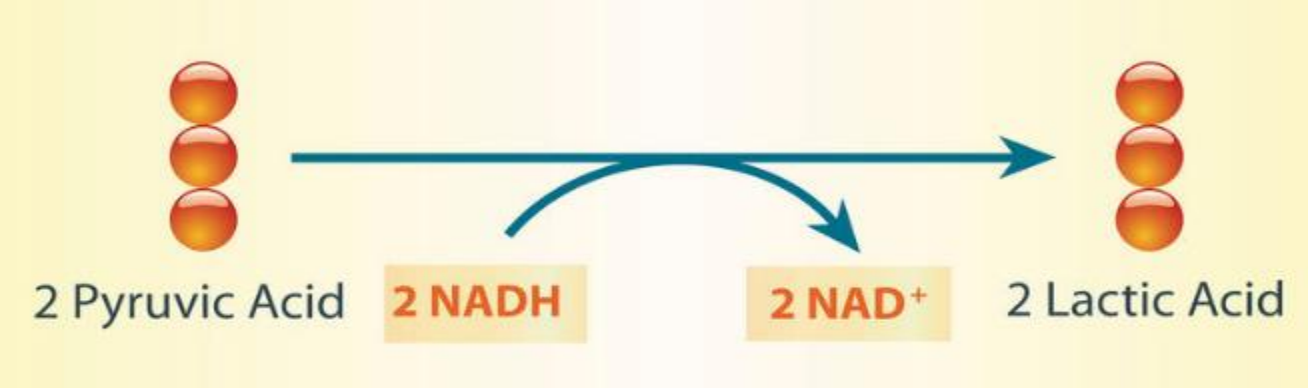


Application	Enzymes used	Uses
Biofuel industry	Cellulases	Break down cellulose into sugars that can be fermented to produce cellulosic ethanol.[111]
	Ligninases	Pretreatment of biomass for biofuel production.[111]
Biological detergent	Proteases, amylases, lipases	Remove protein, starch, and fat or oil stains from laundry and dishware.[112]
	Mannanases	Remove food stains from the common food additive guar gum.[112]
Brewing industry	Amylase, glucanases, proteases	Split polysaccharides and proteins in the malt.[113]:150–9
	Betaglucanases	Improve the wort and beer filtration characteristics.[113]:545
	Amyloglucosidase and pullulanases	Make low-calorie beer and adjust fermentability.[113]:575
	Acetolactate decarboxylase (ALDC)	Increase fermentation efficiency by reducing diacetyl formation.[114]
Culinary uses	Papain	Tenderize meat for cooking.[115]
Dairy industry	Rennin	Hydrolyze protein in the manufacture of cheese.[116]
	Lipases	Produce Camembert cheese and blue cheeses such as Roquefort.[117]
Food processing	Amylases	Produce sugars from starch, such as in making high-fructose corn syrup.[118]
	Proteases	Lower the protein level of flour, as in biscuit-making.[119]
	Trypsin	Manufacture hypoallergenic baby foods.[119]
	Cellulases, pectinases	Clarify fruit juices.[120]
Molecular biology	Nucleases, DNA ligase and polymerases	Use restriction digestion and the polymerase chain reaction to create recombinant DNA.[1]:6.2
Paper industry	Xylanases, hemicellulases and lignin peroxidases	Remove lignin from kraft pulp.[121]
Personal care	Proteases	Remove proteins on contact lenses to prevent infections.[122]
Starch industry	Amylases	Convert starch into glucose and various syrups.[123]

FERMENTATION

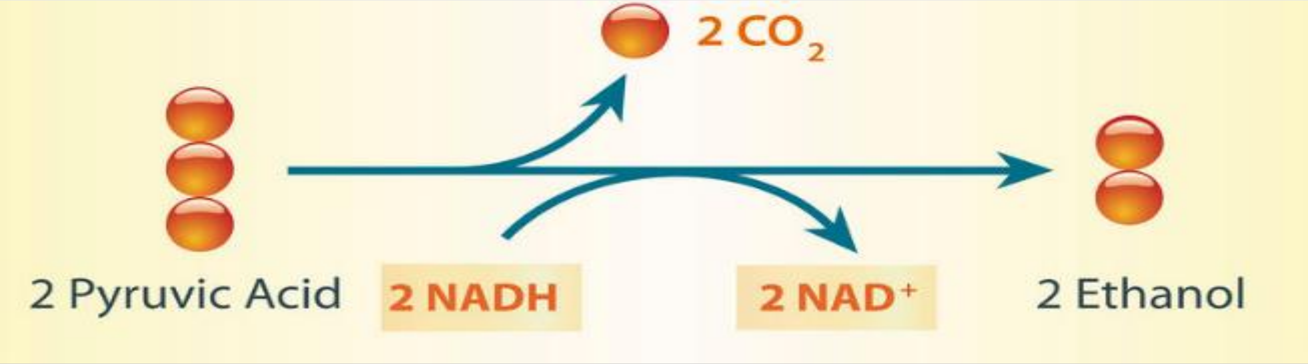
- Most living organisms use oxygen to form ATP from glucose. However, living organisms can also form ATP without oxygen.
- This is true in some plants, fungi and also in many bacteria. These organisms undergo aerobic respiration when oxygen is present, but when oxygen is in short supply, they undergo **anaerobic respiration**.
- An important way of forming ATP without oxygen is called **fermentation**.
- Fermentation is a chemical process by which carbohydrates, such as starch and glucose, are broken down anaerobically.
- Fermentation has many health benefits and is used in the production of alcoholic beverages, bread, yogurt, apple cider vinegar and kombucha. It is also used in industry to generate ethanol as a source of biofuel.
- There are two types of fermentation
- Lactic acid fermentation
- Alcoholic fermentation

- In **lactic acid fermentation** pyruvic acid changes to lactic acid. In the process, NAD^+ forms from NADH. This type of fermentation is carried out by the bacteria in yogurt. It is also used by your own muscle cells when you work them hard and fast.



Have you noticed-when you run in a race your muscles feel tired and sore afterward? This is because your muscle cells used lactic acid fermentation for energy. This causes lactic acid to build up in the muscles. So muscles feel tired and sore.

- In **alcoholic fermentation**, pyruvic acid changes to alcohol and carbon dioxide. This type of fermentation is carried out by yeasts and some bacteria. It is used to make bread, wine, and biofuels.



Industrial Applications

- Fermentation is widely used for the production of alcoholic beverages, for instance, wine from fruit juices and beer from grains. Potatoes, rich in starch, can also be fermented and distilled to make gin (a clear alcoholic spirit distilled from grain or malt) and vodka (a clear alcoholic spirit distilled from potatoes).
- Acetic acid fermentation can also be used to turn starches and sugars from grains and fruit into sour tasting vinegar and condiments including apple cider vinegar.
- Fermentation is used in industry to generate **ethanol** for the production of biofuel. It is an attractive renewable resource because it originates from feed stocks including grains and crops such as corn, sugar cane and sugar beets, grass, agricultural and forestry residues.
- Fermentation is also used in producing hydrogen gas. For example in *Clostridium pasteurianum*, where glucose is converted to butyrate, acetate, carbon dioxide and hydrogen gas.
- In acetone-butanol-ethanol fermentation, carbohydrates such as starch and glucose are broken down by bacteria to produce acetone, n-butanol and ethanol.

IMPORTANT QUESTIONS

1. What are biomolecules?
2. Name some biomolecules.
3. What are the major functions of biomolecules?
4. What happens if there is inadequate concentrations of biomolecules?
5. Refer a case study that initiated the development of bio-molecular engineering.
6. What is the first humanized mod in bio-molecular engineering field?
7. Name some areas where bio-molecular techniques are applying widely.
8. Describe the structure of bio-molecule – protein.
9. How proteins play a crucial role in biological process?
10. What is keratin. Where we find keratin.
11. How fibrin is produced? What is its importance.
12. Explain the structure and function of Hemoglobin.
13. What are antibodies? Explain different types of antibodies and their functions.
14. What are nucleic acids.
15. Explain the structure of DNA with a neat labeled diagram.
16. Explain the structure of RNA with a neat sketch.
17. What are types of RNA and what is its function.
18. What are enzymes?
19. Explain the applications of enzymes in industries.
20. Define fermentation and write their industrial applications.