SNS COLLEGE OF TECHNOLOGY

(AN AUTONOMOUS INSTITUTION)

COIMBATORE-35

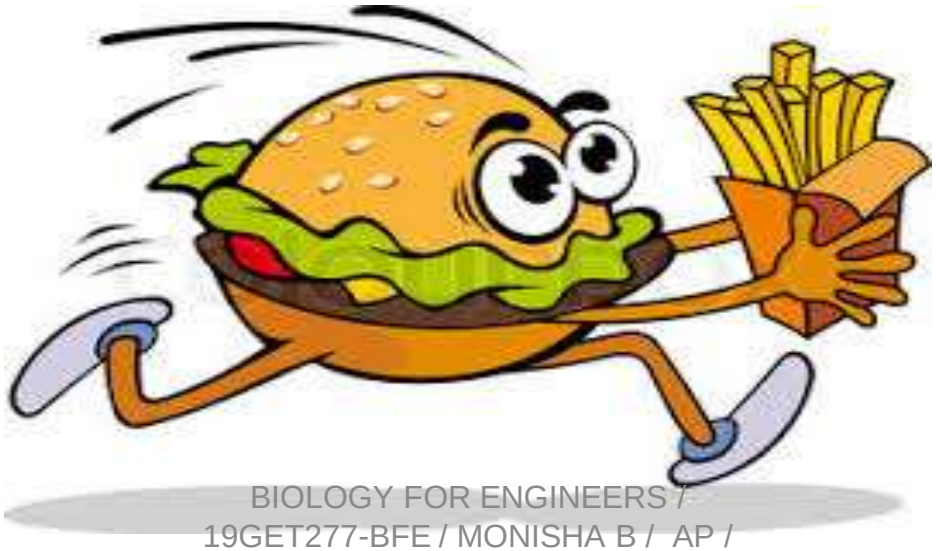
IV YEAR / VII SEMESTER

19GET277-BIOLOGY

FORENGINEERS

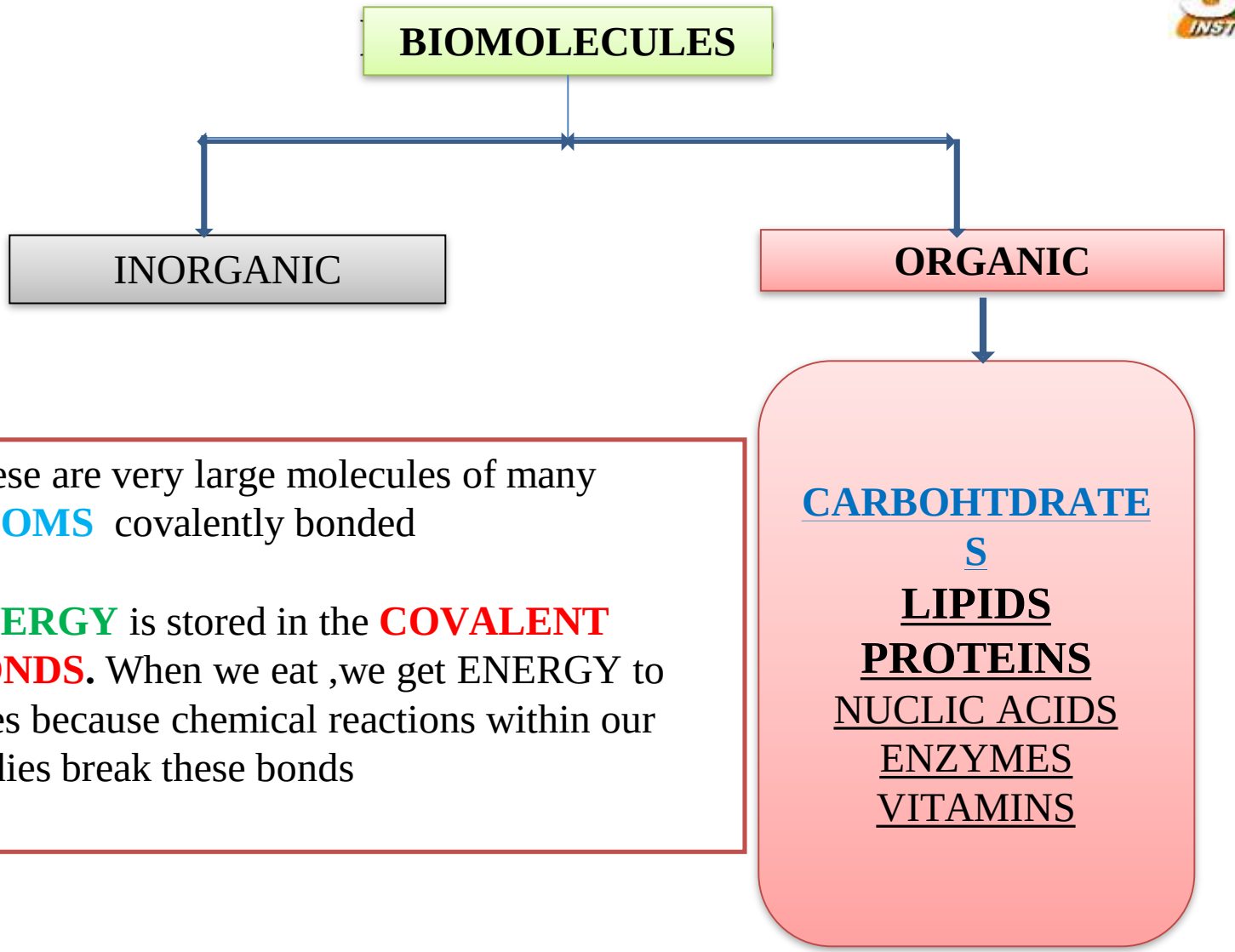
INTRODUCTION OF BIOMOLECULES

CARBOHYDRATES

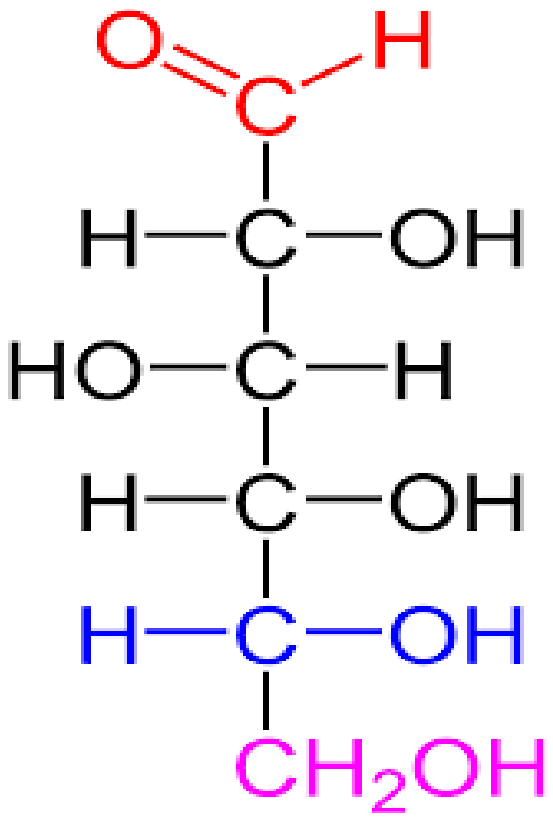


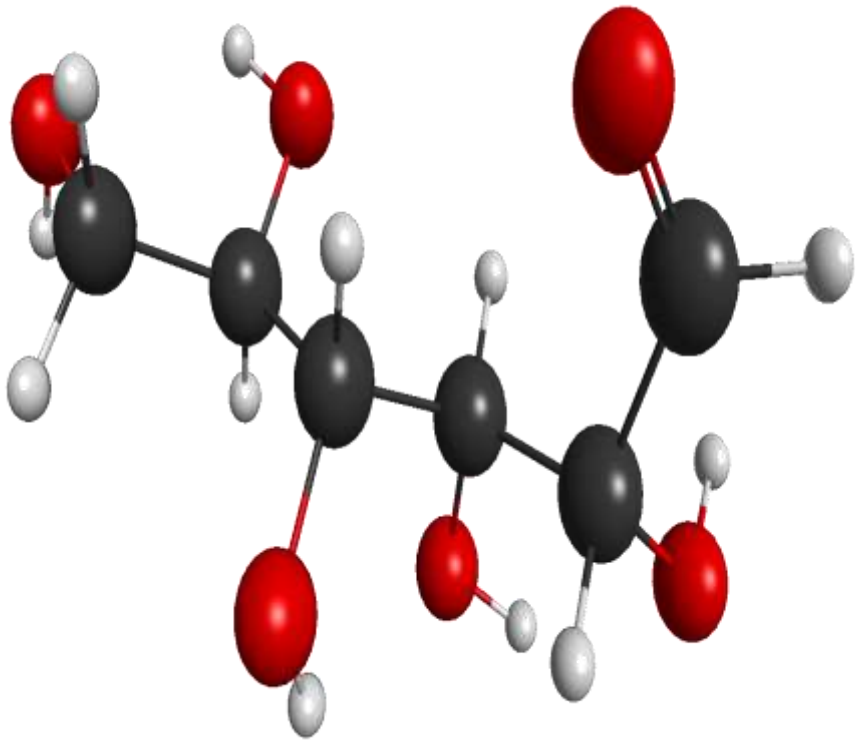
iomolecule is the molecule that is present in all living organisms, involved in the maintenance and metabolic process

- All Biomolecule contain CARBON $^{6}_{12}C$
- Carbon is the most versatile and prominent element of life
- Other elements –
  - **HYDROGEN(H)**
  - **OXYGEN(O)**
  - **NITROGEN (N)**
  - **SULPHUR (S)**
  - **SODIUM (Na)**
  - **CALCIUM (Ca)**
  - **MAGNESIUM (Mg)**


BIOMOLECULES
INORGANIC
ORGANIC
These are very large molecules of many ATOMS covalently bonded
ENERGY is stored in the COVALENT BONDS. When we eat ,we get ENERGY to lives because chemical reactions within our bodies break these bonds
CARBOHTDRATES
LIPIDS
PROTEINS
NUCLIC ACIDS
ENZYMES
VITAMINS

Carbohydrates





CARBOHYDRATES

THE MOST ABUNDANT ORGANIC MOLECULES IN NATURE

HYDRATE DE CARBON i.e. HYDRATE OF CARBON or

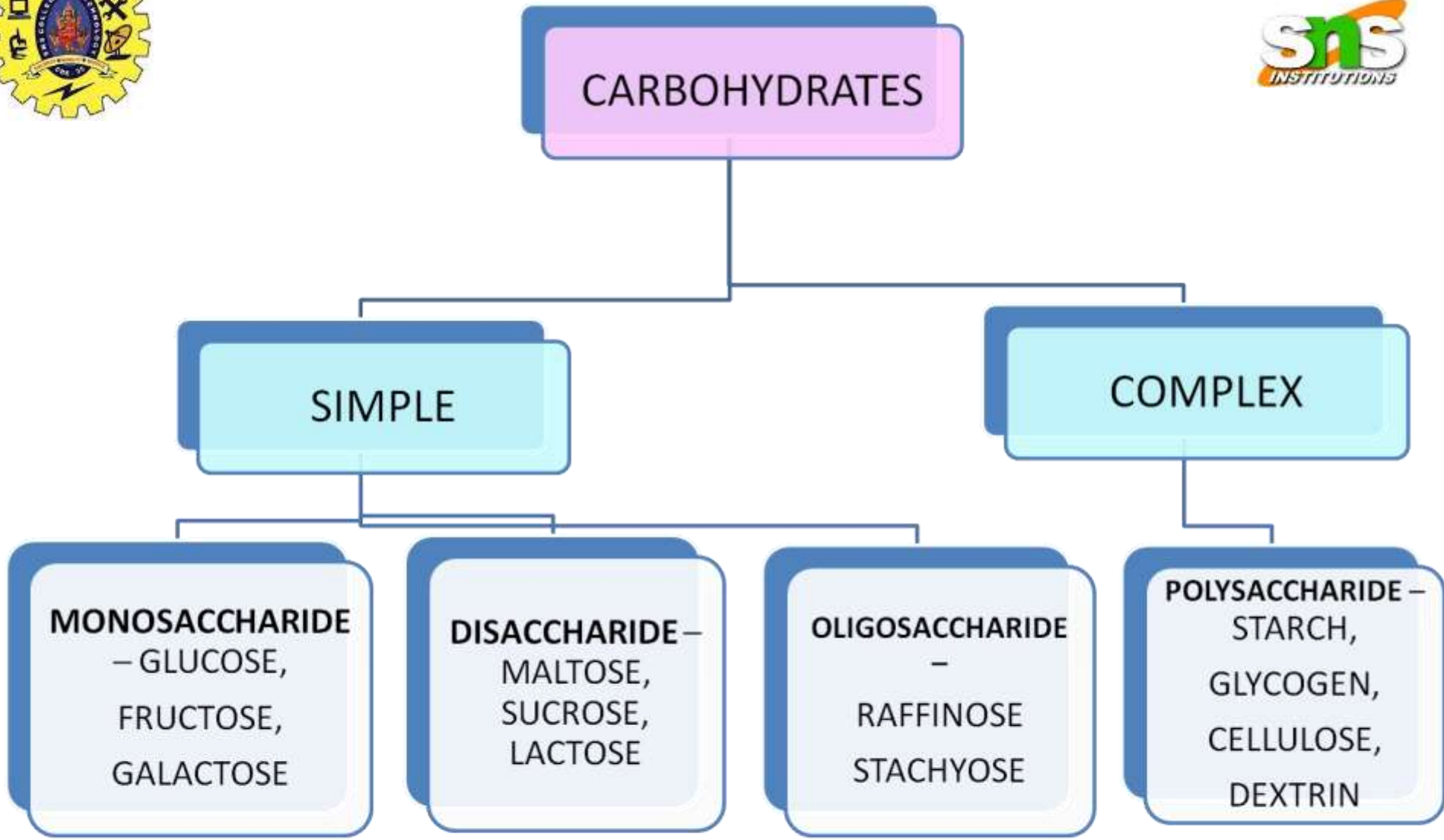
$C_n(H_2O)_n$

- Main source of **ENERGY**

- Provide some **STRUCTUR**
- **PRECURSOR**s of many organic compounds – FATS, AMINO ACIDS
- **STORAGE FORM** of ENERGY

(Glycogen Animals)

(Starch Plants)


CARBOHYDRATES
SIMPLE
COMPLEX
MONOSACCHARIDE – GLUCOSE, FRUCTOSE, GALACTOSE
DISACCHARIDE – MALTOSE, SUCROSE, LACTOSE
OLIGOSACCHARIDE – RAFFINOSE STACHYOSE
POLYSACCHARIDE – STARCH, GLYCOGEN, CELLULOSE, DEXTRIN

MONOSACCHARIDES

BASED ON No OF C ATOMS

✓**TRIOSES** ($C_3H_6O_3$) –GLYCERALDEHYDE, DIHYDROXYACETONE

✓**TETROSE** ($C_4H_8O_4$) – ERYTHROSE, THREOSE

✓**PENTOSE** ($C_5H_{10}O_5$) – RIBULOSE, ARABINOSE

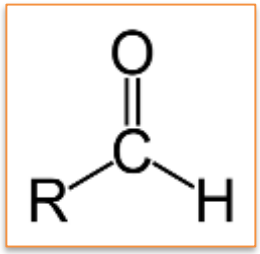
✓**HEXOSES** ($C_6H_{12}O_6$) – GLUCOSE, FRUCTOSE, GALACTOSE

✓**HEPTOSES** ($C_7H_{14}O_7$) – GLUCOHEPTOSE

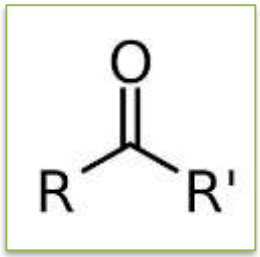
SO ON……

BASED ON FNCTIONAL GROUP

ALDOSE-GLECEALDEHY, GLUCOSE

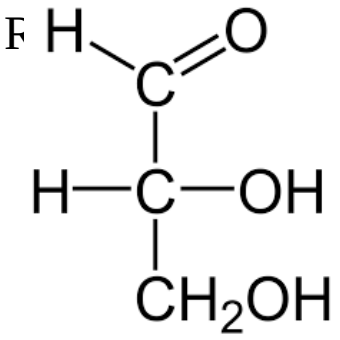


KETOSE – DIHYDROXYACETONE, FRUCTOSE

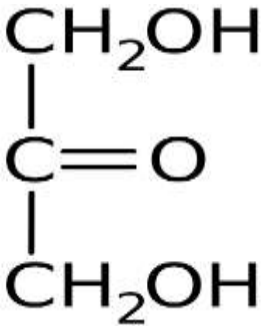


STRUCTURE OF MONOSACCHARIDE

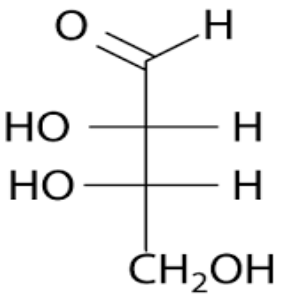
GLYCERALDEHYDE

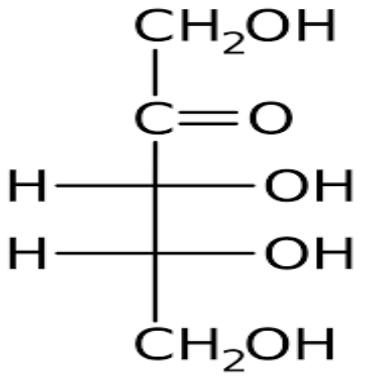


DIHYDROXYACETONE

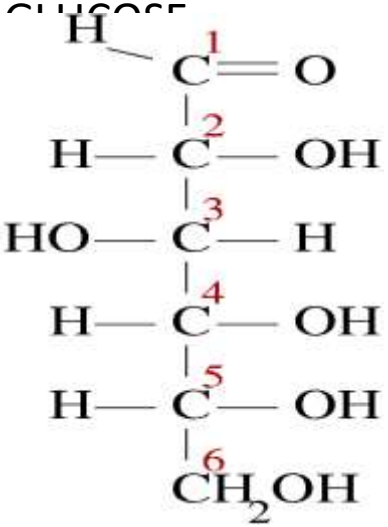


ERYTHROSE

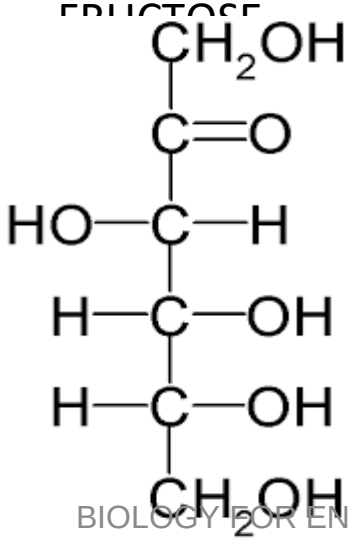


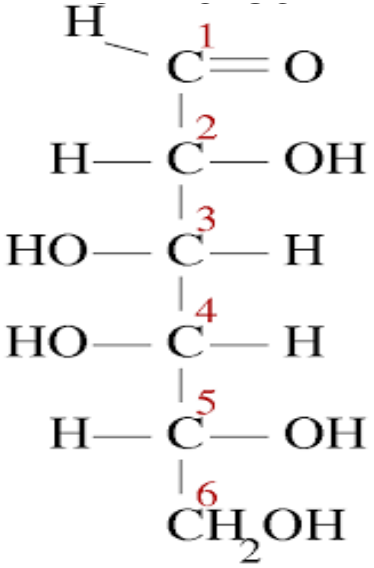


GLUCOSE



FRUCTOSE



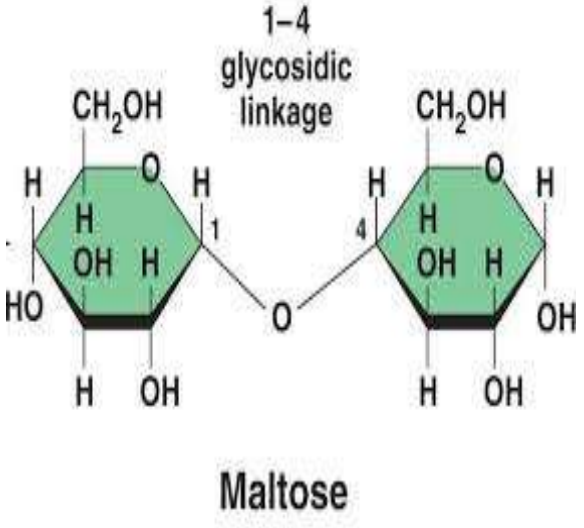


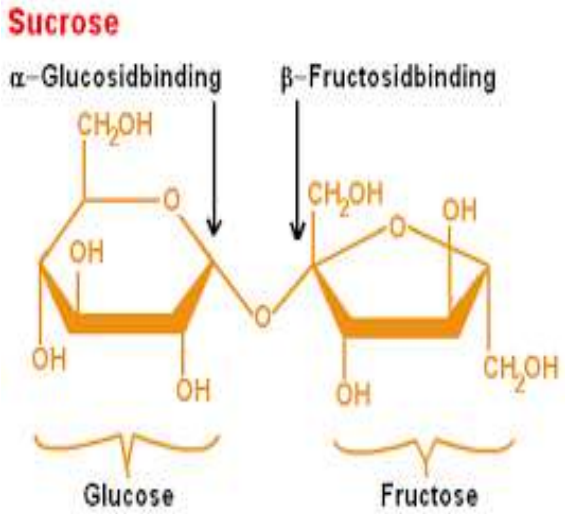
OLIGOSACCHARIDES

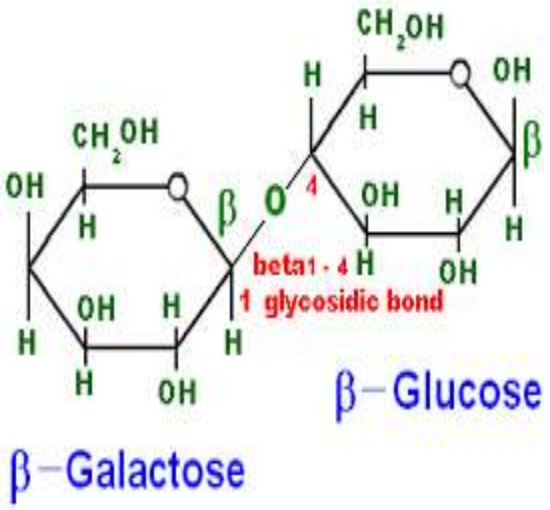
CARBOHYDRATES THAT CONTAINS **2-9** MONOSACCHARIDE UNITS CONNECTED BY GLYCOSIDIC LINKAGE.

DISACCHARIDES : **2** MONOSACCHARIDE UNITS (SIMILAR OR DISSIMILAR)
CRYSTALLINE, WATER SOLUBLE, SWEET IN TASTE

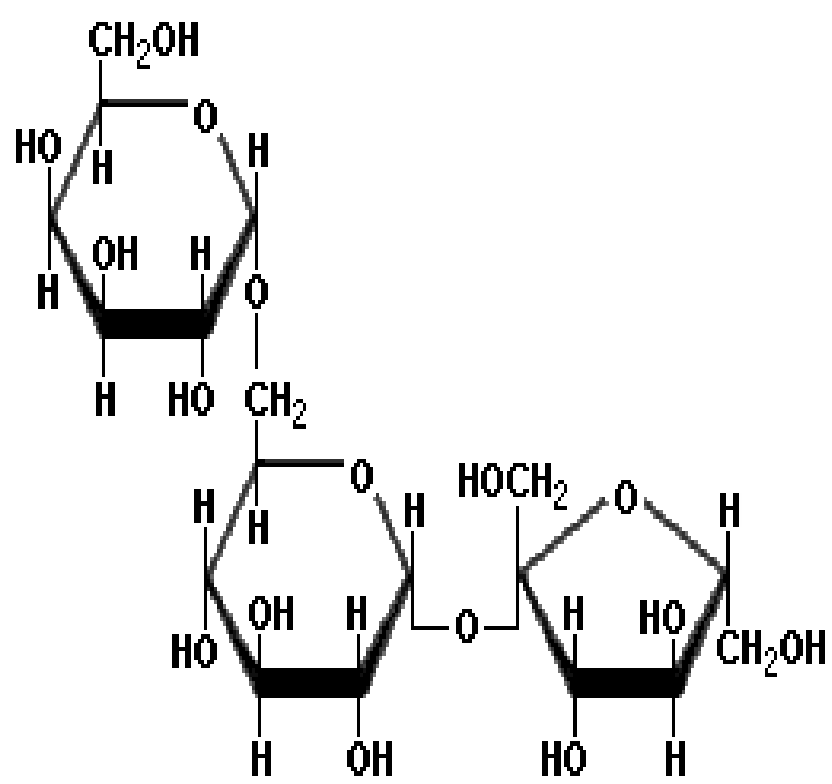
MALTOSE : MALT SUGAR , SUCROSE : CANE SUGAR LACTOSE :





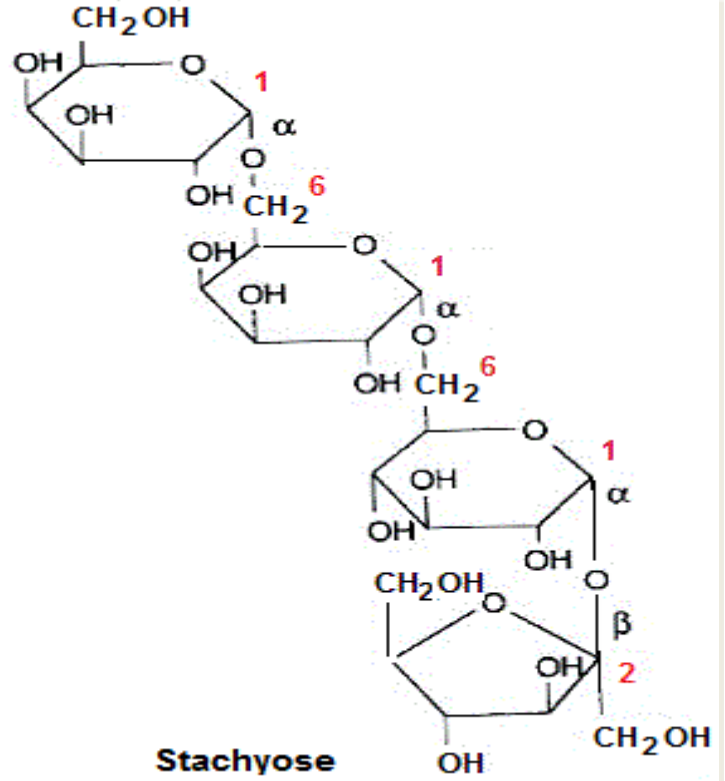


TRISACCHARIDES



RAFFINOSE

TETRASACCHARIDES



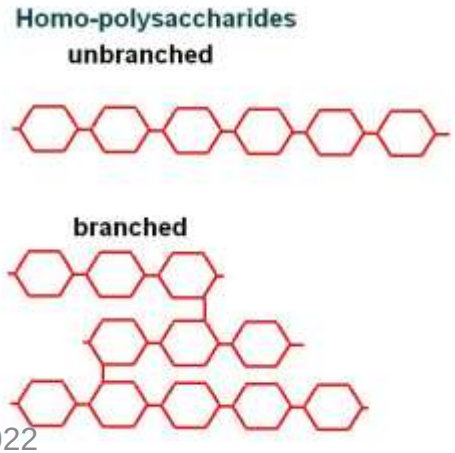
THE **SMALLEST** AND THE **COMMONEST OLIGOSACCHARIDES** ARE **DISACCHARIDES**

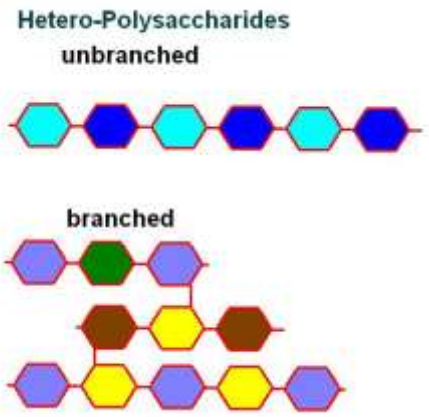
POLYSACCHARIDES

- ✓KNOWN AS GLYCANS
- ✓REPEATING MONOSACCHARIDE UNITS CONNECTED BY GLYCOSIDIC BONDS
- ✓ALMOST INSOLUBLE
- ✓NOT SWEET
- ✓IDEAL STORAGE AND STRUCTURAL COMPONENTS
- ✓2 TYPES –

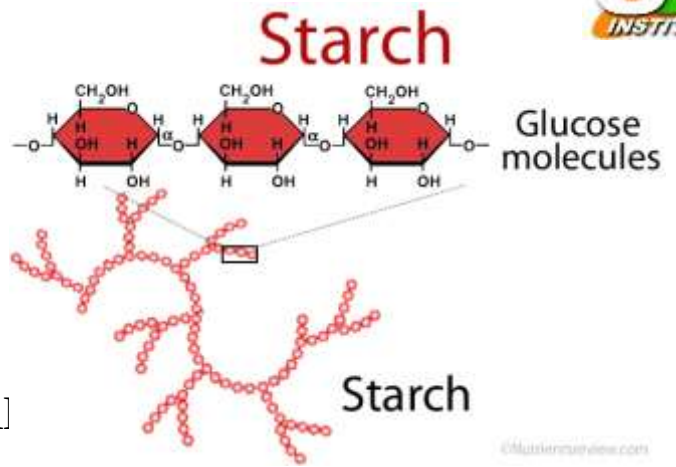
a) **HOMOPOLYSACCHARIDES**
(ONLY ONE TYPE OF MONOSACCHARIDE MONOMERS)
STARCH, GLYCOGEN, CELLULOSE

b) **HETAROPOLYSACCHARIDES**
(CONDENSATION OF 2 OR MORE TYPES OF MONOSACCHARIDES)
PEPTIDOGLYCAN, HYALURONIC ACID, AGAR, CHITIN





STORAGE POLYSACCHARIDES

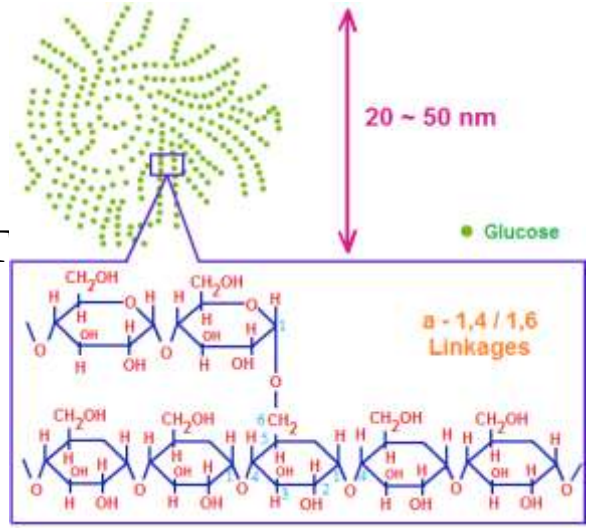


STRACH = AMYLOSE + AMYLOPECTIN

- CARBOHYDRATE RESERVE OF PLANTS
- IMPORTANT DIETARY SOURCE FOR ANIMA
- HOOPOLYMER OF GLUCOSE : GLUCAN

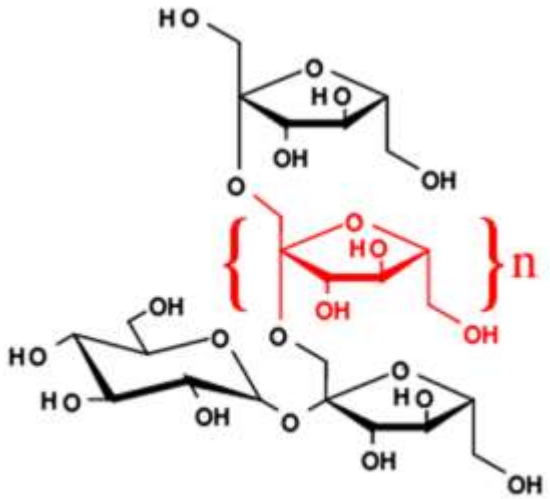
GLYCOGEN

- CARBOHYDRATE RESERVE IN ANIMAL : ANIMAL ST
- HIGH CONCENTRATION IN LIVER, MUSCLE , BRAIN
- MADE UP OF GLUCOSE UNIT



INULIN

- POLYMER OF FRUCTOSE : FRUCTOSAN
- FOUND IN DAHLIA, GARLIC, ONION etc
- NOT REDAILY METABOLISED IN HUMAN BODY
- READILY FILTERED THROUHG THE KIDNEY; USED FOR KIDNEY FUNCTION TEST

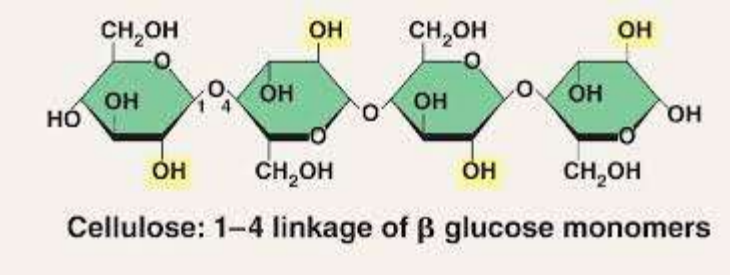


Inulin

STRUCTURAL POLYSACCHARIDES

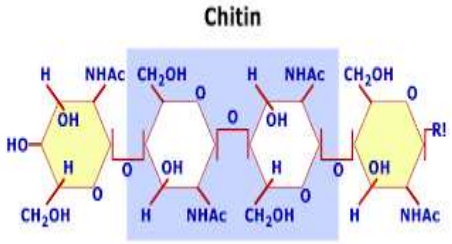
CELLULOSE

- MOST ABUNDANT ORGANIC SUBSTANCE IN PLANT KINGDOM
- PREDOMINANT CONSTITUENT OF PLANT CELL WALL
- TOTALLY ABSENT IN ANIMALS



CHITIN

- SECOND MOST ABUNDANT ORGANIC SUBSTANCE
- COMPLEX CARBOHYDRATE OF HETAROPOLYSACCHARIDE
- FOUND IN INSECTS ,PROVIDE STRENTH AND ELASTICITY



THANK YOU.....

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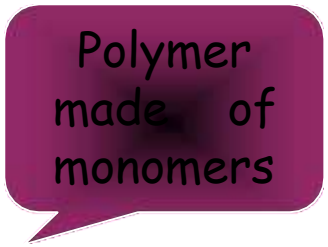
CARBOHYDRATES, LIPIDS, AND PROTEINS

Introduction

- **Macromolecule**
  - "Macro" = big
  - Definition: big ol' molecule
  - Carbs, lipids, and proteins are ALL members of this group
- **Polymer**
  - "Poly" = many
  - Definition: a macromolecule made of repeating units called "**monomers**" (mono = one)
  - Carbs, lipids, and proteins are ALL also members this group



How to MAKE C/L/P's

- **Dehydration Synthesis**
  - "dehydration" = to remove water
  - "synthesis" = to make
  - Definition: the process of CREATING carbs, lipids, and proteins by removing water
  - Animation of this process

    Dehydration Synthesis-Hydrolysis

How to BREAK C/L/P's

Hydrolysis

- "hydro" = water
- "lysis" = to destroy
- Definition: the process of DESTROYING carbs, lipids, and proteins by the addition of water
- How our bodies break down the foods we eat into the monomers that make them up (only monomers can be absorbed)
- Animation of this process:

  Dehydration Synthesis-Hydrolysis

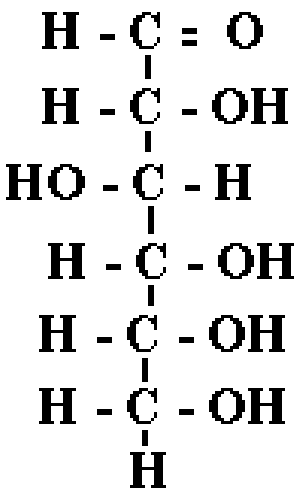
Carbohydrates

- Sources
  - Grain based foods
- **Chemical make-up**
  - carbo - contains C
  - hydrate – contains O and H (in 2:1 ratio like in water)
- Carbs are our main energy source (55%-65% of daily caloric intake)

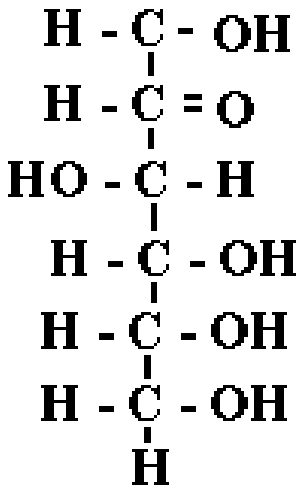
Carbohydrates (cont.)

- Carbs are polymers made up of monomers
- What are the monomers (building blocks) of carbs?
  - Several names (all mean the same thing)
    - Monosaccharides
    - Simple sugars
  - Who are the simple sugars?
    - "-ose" = sugar
    - All have general formula – $C_6H_{12}O_6$
    - Ex. Glucose, galactose, fructose (are isomers of one another)

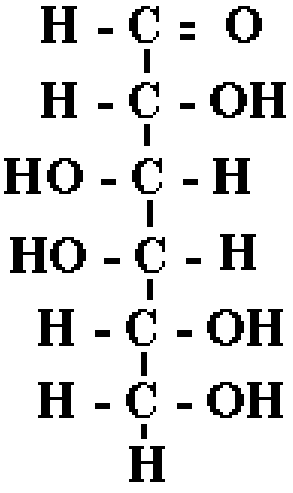
- Simple sugar structural formulas:



glucose



fructose



galactose

Carbohydrates (cont.)

- **Disaccharides**
  - di = two
  - saccharide = sugar
  - Definition – double sugar made up of two simple sugars chemically combined
  - Introducing the disaccharides!
    - *Sucrose* (table sugar) = glucose + fructose
    - *Lactose* (milk sugar) = glucose + galactose
    - *Maltose* (malt sugar) = glucose + glucose

Carbohydrates (cont.)

Polysaccharides

- "poly" = many
- "saccharide" = sugar
- Definition – a carbohydrate made up of many simple sugars chemically combined together
- Also called "complex carbohydrates"
- Introducing the polysaccharides!
  - *1. Starch*- energy storage for plants.
    - Test for starch: Lugol's stain- turns starch purple
  - *2. Cellulose (fiber)*– contained within cell walls of plants (give structure)
  - *3. Glycogen* – energy storage for animals (mostly found in the muscle tissue)
  - *4. Chitin*- exoskeleton of some animals

Carbs

- How the body uses glucose from food:
  - 1. energy for life processes
  - 2. extra glucose: stored as glycogen for later use
  - 3. extra, extra glucose: stored as fat for M U C H later use

Energy from food

- How much energy does each macronutrient have?
- Calories: units of energy given off by a food

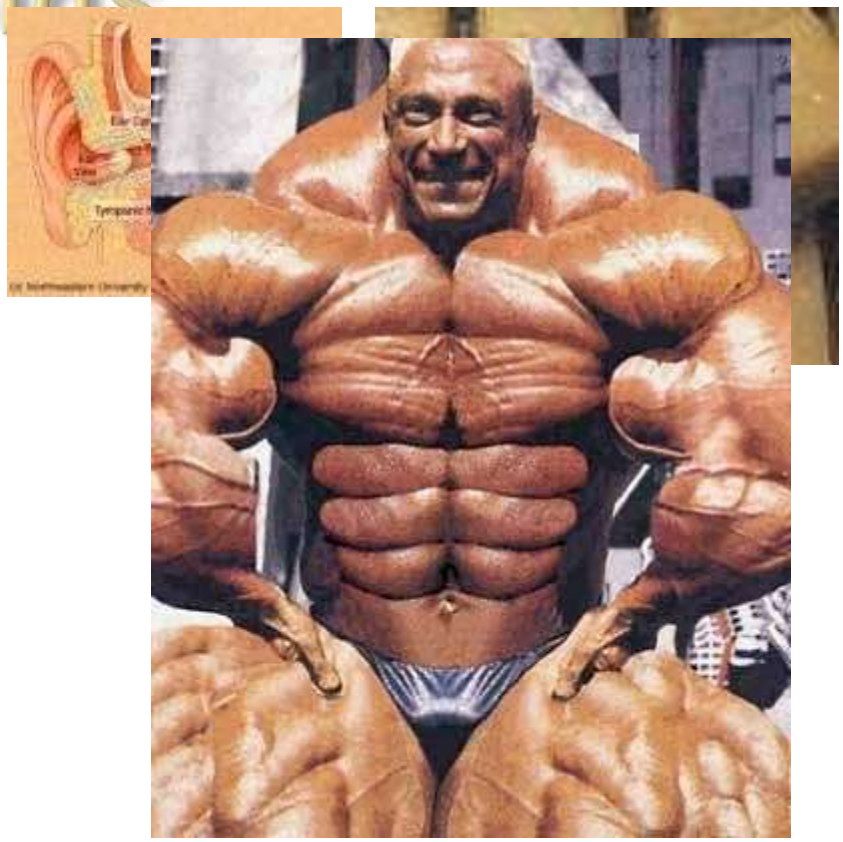
- Carbs: 4 cal/gram
- Protein: 4 cal/gram
- Fat: 9 cal/gram

Lipids

- Dietary Sources
  - High fat sources
- **Chemical make-up**
  - Contains C, H, and O
- Lipids are our secondary energy source (mostly stored for use later)

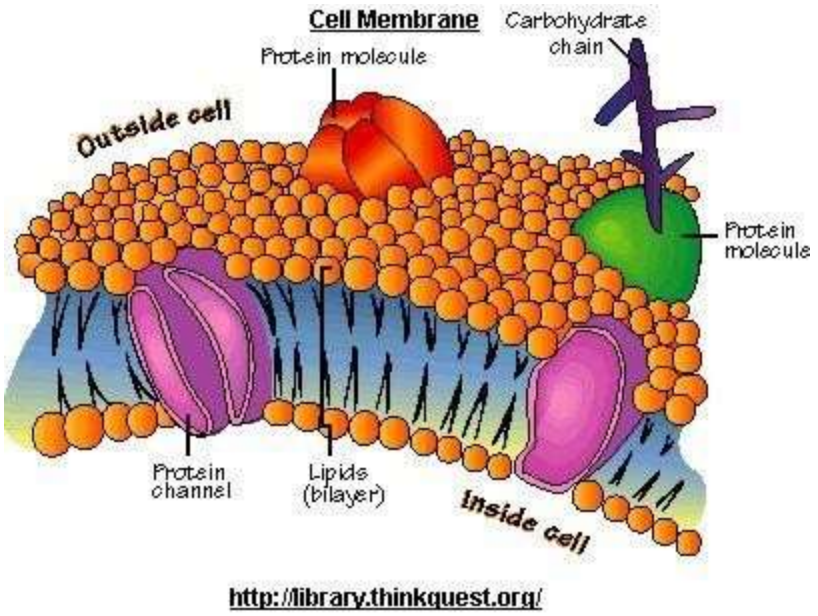
Lipids

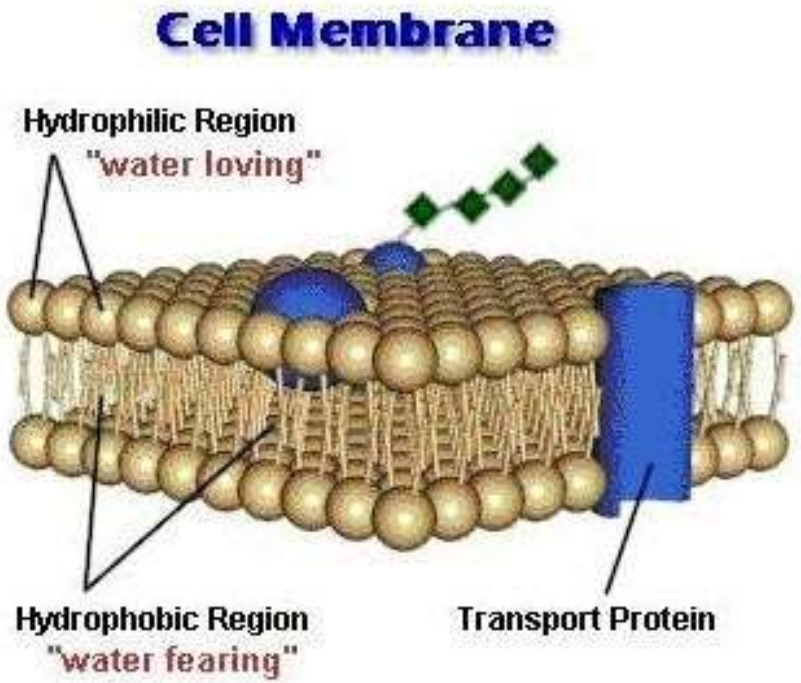
- Categories of lipids
  - Waxes
    - Ear wax
    - Bees wax
  - Steroids
    - Cholesterol
    - Hormones
  - Lecithin
    - Wraps nerve cells
    - Why is this important?
  - Fats/Oils
    - Animal fat- solid at room temperature
    - Plant oils- liquid at room temperature



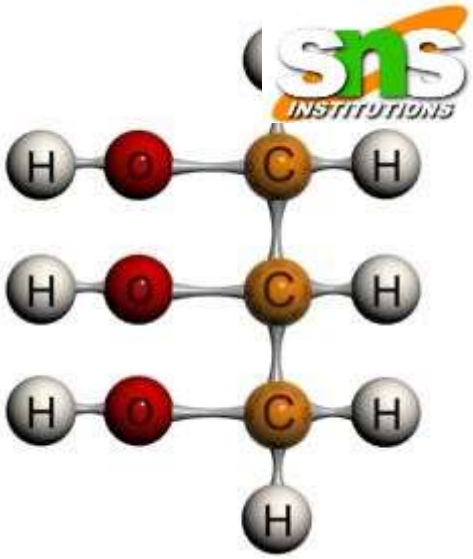
Uses of Lipids

- Long-term energy storage
- Production of cell membranes





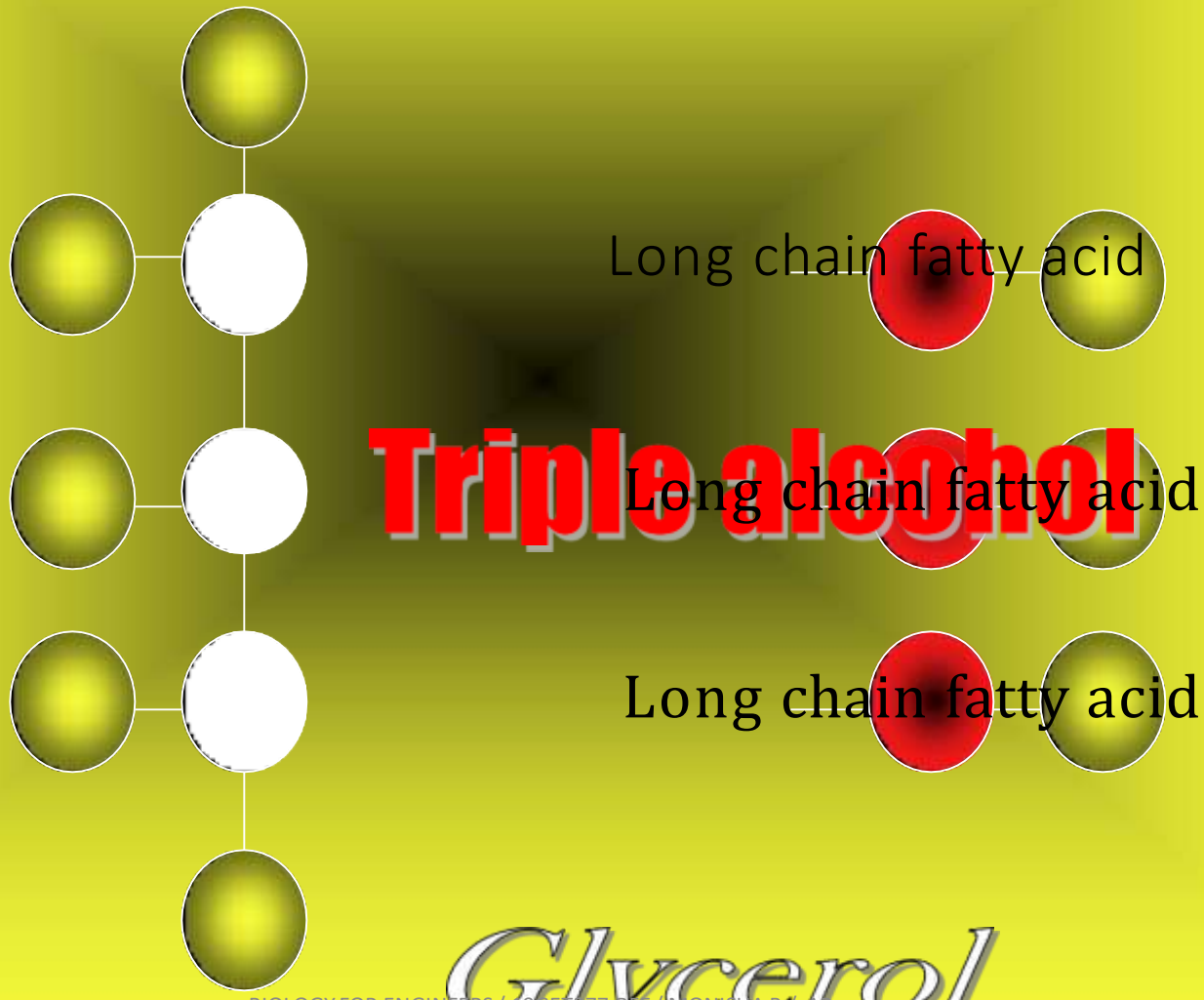
How to build a li



- Monomers — Draw this ----→
  - Glycerol
    - Three carbon alcohol
  - Long chain fatty acids (carbon chain)
    - Several different types
      - Saturated, unsaturated, polyunsaturated
- Created by…
  - DEHYDRATION SYNTHESIS
- Broken down by…
  - HYDROLYSIS

Fats, Carbs, and Proteins

Lipids



Types of fats

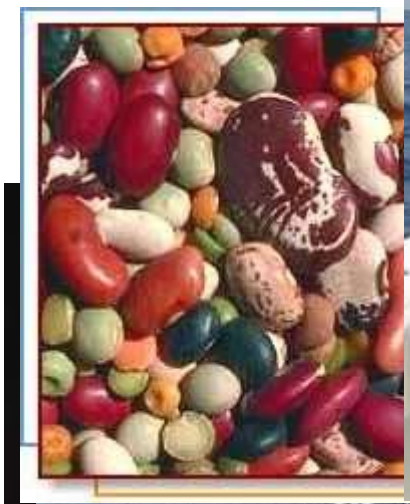
- Saturated fats
  - Fats that have all of their carbons filled with hydrogens
  - NO double bonds in long chain fatty acid
- Unsaturated fats
  - Fats that don't have all of their carbons filled with hydrogens
  - Must contain a double bond line in long chain fatty acids
- Which ones are more healthy?
  - Unsaturated

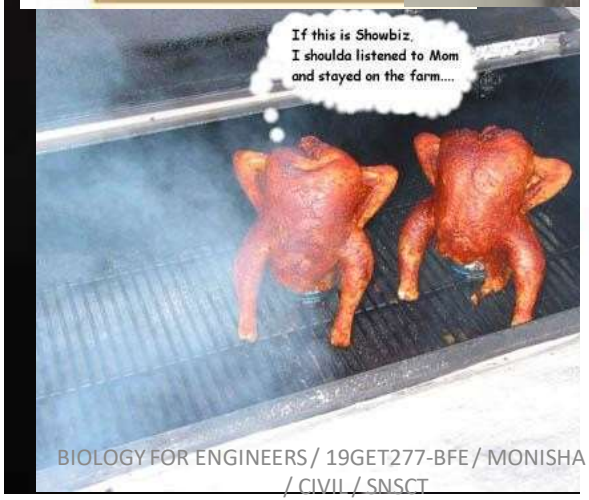
PROTEINS

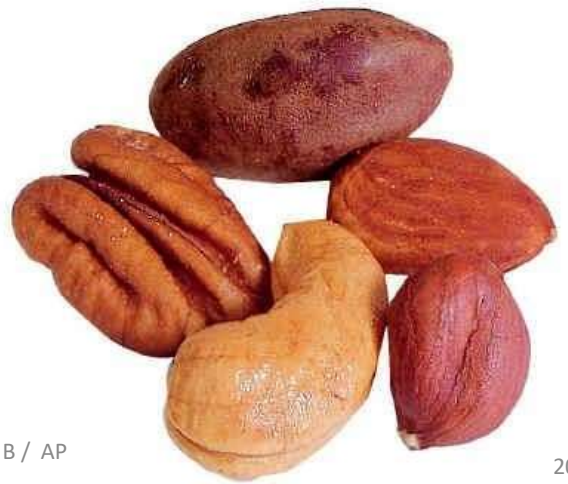
The most important compound in your body!!!!

Dietary Sources

- Beef
- Chicken
- Fish
- Nuts
- Beans







Chemical make-up of proteins

- Chemical make-up of carbs?
  - C, H, O
- Chemical make-up of lipids?
  - C, H, O
- Chemical make-up of proteins?
  - C, H, O, N and sometimes S

Function of Proteins

- Main function of carbs?

  Primary source or short term energy

- Main function of lipids?

  Secondary source or long term storage, insulation, cell membrane structure

- Main function of proteins
  - Growth
  - Repair

Two main types of proteins

- Structural- build things
- Globular- travel through the body independently

Structural proteins

- Muscle tissue
  - Actin and myosin fibers
- Keratin
  - Hair
  - Nails
  - Rhino horn
- Collagen
  - Connective matrix
  - Keeps skin smooth (breaks down as you get older)

Globular Proteins

- Hemoglobin
  - O_2 binds with use of iron to carry oxygenated blood around the body
- Insulin
  - Opens muscles to allow glucose to enter
  - Controls glucose levels in the bloodstream
- Antibodies
  - Help fight infection in the body
  - Produced by white blood cells

Globular proteins (cont.)

- Enzymes
  - Also called organic catalysts
  - Reduce activation energy of a reaction
    - Lowers amount of energy needed to start reaction
    - Helps reaction go faster

Structure of proteins

- Consist of monomers called amino acids
  - 20 different types of amino acids make up all proteins
  - 8 are “essential” amino acids
    - Means that your body can’t produce them naturally
- Contains C, H, O, N, and S (only one amino acid contains S)
- Built just like every other organic compound!
  - Dehydration synthesis
- Broken down just like every other organic compound!
  - Hydrolysis

Structure of Proteins (cont)

- Proteins organized on four different levels
  - Primary (1°)
  - Secondary (2°)
  - Tertiary (3°)
  - Quaternary (4°)

Structure of Proteins (cont)

Primary (1°)

- Unique sequence of amino acids

Secondary (2°)

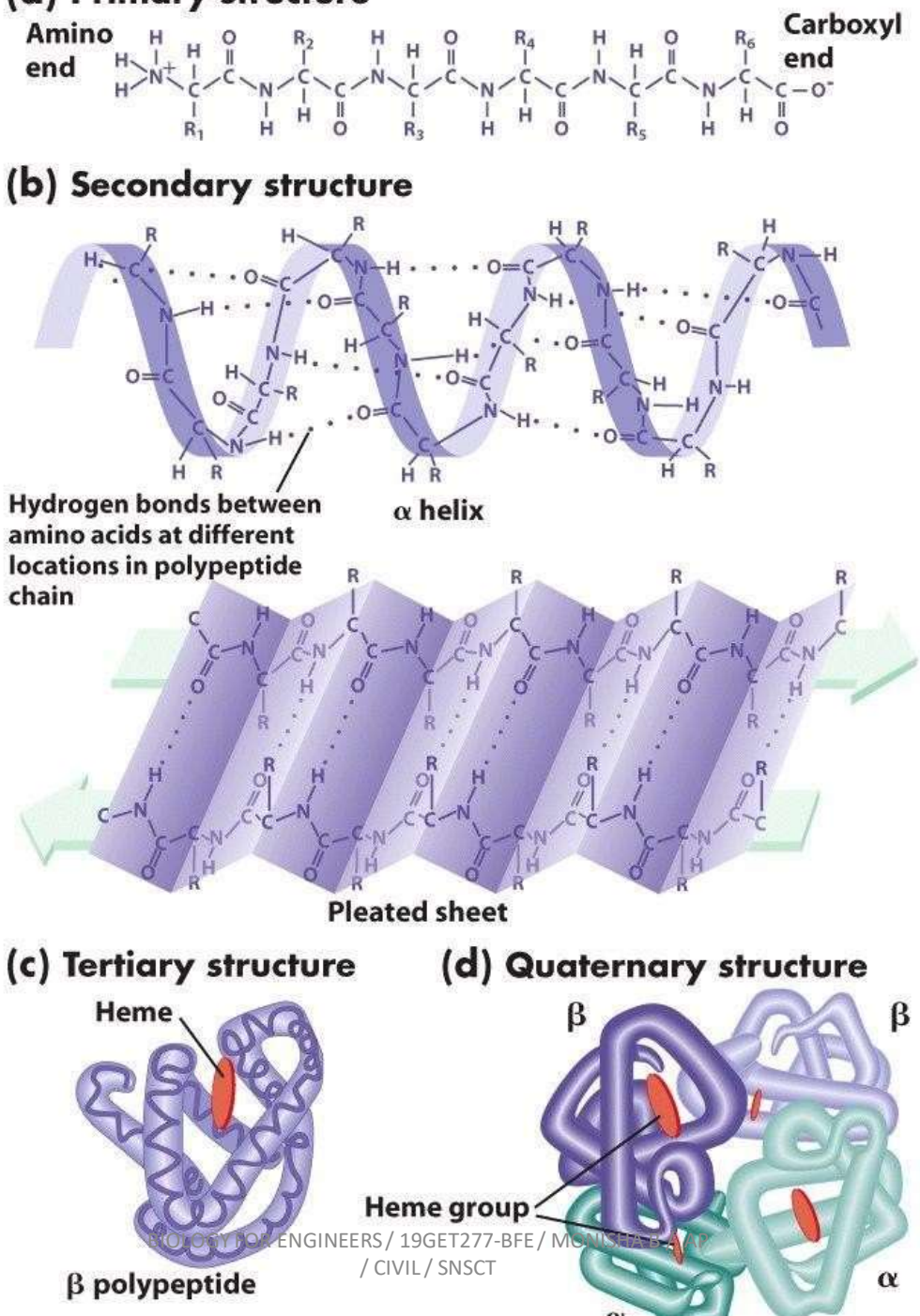
- Alpha helix
  - Amino acid sequence coils up with use of H bonds
- Beta sheet
  - Amino acid sequence “pleats” with use of H bonds

Tertiary (3°)

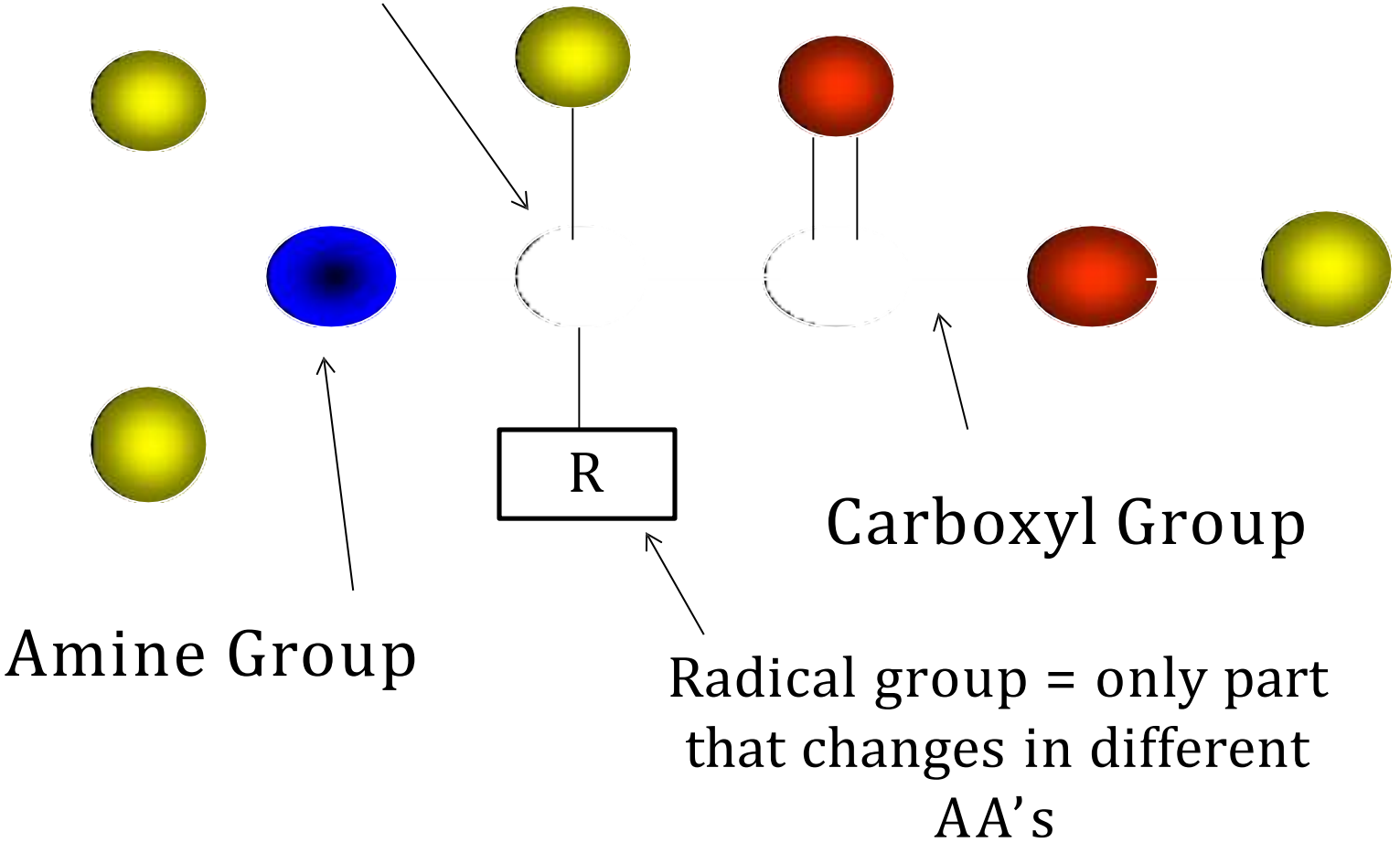
- Alpha helix and beta sheets fold onto one another to form a “subunit”

Quaternary (4°)

- Subunits bond together


(a) Primary structure
Amino end
Carboxyl end
(b) Secondary structure
Hydrogen bonds between amino acids at different locations in polypeptide chain
α helix
Pleated sheet
(c) Tertiary structure
Heme
β polypeptide
(d) Quaternary structure
β
β
Heme group
α

General Structure for an Amino Acid



utting Together The Building Blocks (co

Peptide

Two characteristics of a peptide bond

a. Carbon – nitrogen bond

b. Double bonded oxygen on carbon atom

Enzyme terms to know

- **Enzyme** = protein that speeds up (reduces activation energy) of a process
- **Substrate** = substance enzyme interacts with
- **Enzyme-substrate complex** = joining together of substrate and enzyme
- **Active site** = open face of enzyme to which the substrate attaches

"Lock and Key"

- Enzymes work in a "lock and key" relationship
  - Active site of enzyme is shaped to connect with very SPECIFIC substrates
  - If the shapes don't fit, the enzyme can't do its job
  - After the joining of the substrate and enzyme, substrate (and NOT enzyme- the enzyme must stay the same so it can be used again) is changed in some way to help speed up reaction

Denaturation

- When bonds of active site break the shape of a protein
- Makes them unable to do their jobs correctly
- Can happen for many reasons:

THANK YOU

SNS COLLEGE OF TECHNOLOGY

(AN AUTONOMOUS INSTITUTION) COIMBATORE-35

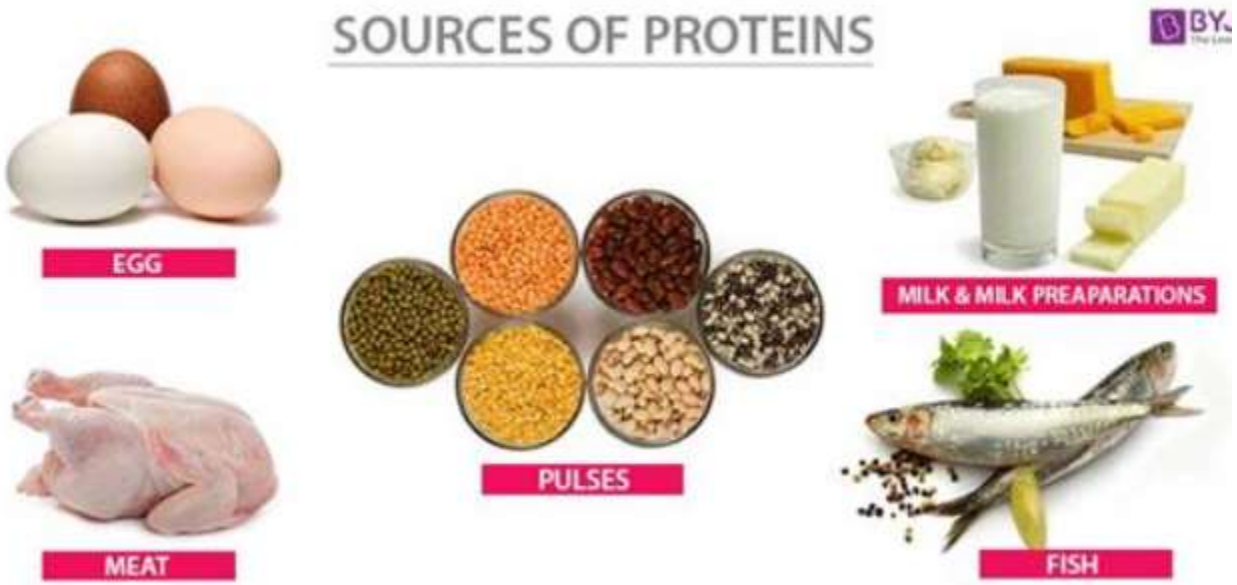
IV YEAR / VII SEMESTER

19GET277-BIOLOGY FOR ENGINEERS

Protein

Proteins are composed of amino acids, arranged into different groups. These fundamental amino acids sequences are specific and its arrangements are controlled by the DNA. Since our body cannot synthesize these essential amino acids by its own, we should have plenty of protein foods in our everyday diet to keep our body metabolisms stable.

Sources of Protein



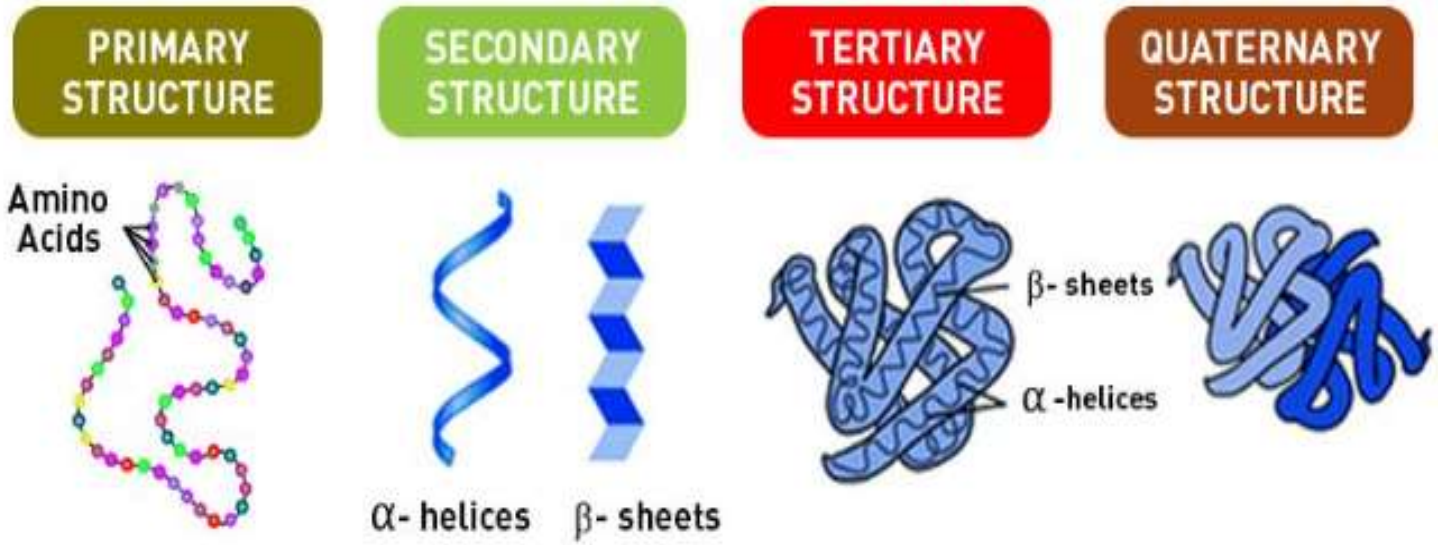
Functions of Proteins

- **Enzymes:** Enzymes mostly carry out all numerous chemical reactions which take place within a cell. They also help in regenerating and creating DNA molecules and carry out complex processes.
- **Hormones:** Proteins are involved in the creation of various types of hormones which help in balancing the components of the body. For example hormones like insulin, which helps in regulating blood sugar and secretin. It is also involved in the digestion process and formation of digestive juices.
- **Antibody:** Antibody also known as an immunoglobulin. It is a type of protein which is majorly used by the immune system to repair and heal the body from foreign bacteria. They often work together with other immune cells to identify and separate the antigens from increasing until the white blood cells destroy them completely.
- **Energy:** Proteins are the major source of energy that helps in the movements of our body. It is important to have the right amount of protein in order to convert it into energy. Protein, when consumed in excess amounts, gets used to create fat and becomes part of the fat cells.

Biological role of Protein

Aspect	Functions	Examples
Storage	Legume Storage, albumin, and proteins.	Supplies food during the early stage of the seedling or embryo.
Hormone Signalling	Counterpart activities of different body parts.	Glucagon and Insulin.
Transport	It transport substances throughout the body through lump or blood cells.	Hemoglobin.
Contraction	To carry out muscle contraction.	Myosin.
Digestive Enzyme	Breaks down nutrients present in the food into smaller portions so that it can be easily absorbed	Pepsin, Amylase, and Lipase

Structural classification of proteins



Classification of protein on the basis of composition

This Classification of protein is based on shape or structure and composition. They are classified into three types;

- fibrous
- globular
- derived protein.

Fibrous protein:

- They are elongated or fiber like protein.
- Axial ratio (length: breadth ratio) is more than 10
- They are static in nature with simple structure.
- They have less biological functions
- They are mostly present in animals

Examples;

Fibrous proteins are further classified as- simple and conjugated

i. **Simple fibrous protein:**

Examples; Scleroprotein (Keratine, elastin, collagen, fibroin etc)

Scleroprotein or Albuminoids: they make animal skeleton and they are water insoluble.

ii. Conjugated fibrous proteins:

Examples; pigments present in chicken feather.

Globular protein:

•They are spherical or globular in shape.

•Axial ratio is always less than 10

•They are dynamic in nature (can flow or move) with higher degree of complexity in structure.

•They have variety of biological functions

•Examples; enzymes, hormones etc

•Globular protein is further classified on the basis of composition or solubility.

Simple or homo globular protein:

They are composed of amino acids only.

Some examples are;

a. Protamine

- They are positively charged (basic) proteins mostly present in animals and fishes (sperm)
- Protamines binds with DNA in embryonic stage and later replaced by histone
- It is soluble in water and ammonium hydroxide solution
- It is not coagulated by heat
- It precipitate out in aqueous solution of alcohol
- Protamine are rich in arginine and lysine whereas devoid of sulfur containing and aromatic amino acids.

b. histone:

- They are basic protein but weak base in comparison to protamine.
- Histone is low molecular weight protein and are water soluble.
- It is not coagulated by heat.
- Histone is present in nucleic acids as nucleohistone binding with DNA.

c.Albumin:

- It is the most abundant protein in nature
- It is most commonly found in seeds in plants and in blood and muscles in animals.
- Molecular weight of albumin is 65000 KD
- It is water soluble and can be coagulated by heat
- Plant albumins; Leucosine, Legumelins etc
- Animal albumins; serum albumin, myosin, lactalbumin, ova-albumin etc

d.Globulin:

•Pseudoglobulin (water soluble) and Euglobulin (water insoluble)

e. Glutelins:

•Water insoluble. Eg. Glttenin (wheat), glutelin (corn), oryzenin (rice)

f. Prolamine:

- They are storage protein found in seeds.
- They are water insoluble. But soluble in dilute acid or detergents and 60-80% alcohol.
- They are coagulated by heat
- Prolamine is rich in proline and glutamine
- Examples; Gliadin (wheat), zein (corn), Hordein (barley), Avenin (oats)

Complex or conjugate or hetero globular protein:

- These proteins in which protein are always linked by non-protein moiety to become functional. So, they are composed of both protein and non- protein components. The non-protein component is known as prosthetic group.
- On the basis of prosthetic group, they are classified as follows;

a. Metalloprotein:

- They have metal prosthetic group.
- Some metals such as Hg, Ag, CU, Zn etc, strongly binds with proteins such as collagen, albumin, casein by –SH group of side chain of amino acids.

Eg. Ceruloplasmin; contains copper as prosthetic group

- Some other metals such as Calcium weakly binds with protein. Eg. Calsequestrin, calmodulin
- Some metals such as Na, K etc do not binds with protein but associate with nucleic acids protein.

b.Chromoprotein:

They have colored prosthetic group.

Some examples are;

Haemoprotein: Haemoglobin, myoglobin, chlorophyll, cytochrome, peroxidase, haemocyanin

Flavoprotein: Riboflavin (Vit B2) give yellow/orange color to FAD requiring enzymes

c.Glycoprotein/Mucoprotein:

They have carbohydrate as prosthetic group

Eg. Antibody, complement proteins, Heparin, Hyaluronic acid

d. Phosphoprotein:

They have phosphate group as prosthetic group.

Eg. Caesein (milk protein binds with calcium ion to form calcium salt of caseinate)

Ovovitellin; present in egg yolk

Calcineurin

e. Lipoprotein:

They have lipid as prosthetic group.

Eg. Lipovitelline, chylomicrons

Derived protein:

•These protein are the derivatives of either simple or complex protein resulting from the action of heat, enzymes and chemicals.

•Some artificially produced protein are included in this group.

•They are classified as primary derived protein and secondary derived protein.

i. Primary derived protein:

•The derived protein in which the size of protein molecules are not altered materially but only the arrangement is changed.

•Some examples are;

a. Proteans:

•Obtained as a first product after the action of acid or enzymes or water on protein.

•They are insoluble in water.

•Eg. Edestan, **myosin**

b. Metaprotein:

They are produced by further action of acid or alkali on protein at 30-60°C.

They are water insoluble but soluble in dil acid or alkali.

Also known as Infraprotein.

Eg. Curd

c. Coagulated protein:

- They are produced by the action of heat or alcohol on protein.
- They are insoluble in water.

Eg. Coagulated egg

ii. Secondary derived protein:

- The derived protein in which size of original protein are altered.
- Hydrolysis has occurred due to which size of protein molecule are smaller than original one.

Examples; **a) Proteoses:**

- They are produced by the action of dilute acid or digestive enzymes when the hydrolysis proceeds beyond the level of metaprotein.
- They are soluble in water
- They are not coagulated by heat. • Eg. Albumose, Globulose etc.

Classification of protein on the basis of biological functions:

1.Catalytic protein:

They catalyze biochemical reaction in cells. Eg. Enzymes and co-enzymes

2. Structural protein;

They make various structural component of living beings.

Eg. Collagen make bone, Elastin make ligamnets and keratin make hair and nails

3. Nutrient protein:

They have nutritional value and provide nutrition when consumed.

Eg. Casein in milk

4. Regulatory protein:

They regulate metabolic and cellular activities in cell and tissue.

Eg. Hormones

5.Defense protein:

They provide defensive mechanism against pathogens.

Eg. **Antibodies**, complement proteins

6. Transport protein:

They transport nutrients and other molecules from one organ to other.

Eg. Haemoglobin

7. Storage protein:

They stores various molecules and ions in cells.

Eg. Ferritin store Iron

8. Contractile or mobile protein:

They help in movement and locomotion of various body parts.

Eg. Actin, myosin, tubulin etc

THANK YOU