Proteins

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(2019-2020)

Proteins:

- Proteins are polymers of amino acids that are covelently linked through peptide bonds.
- Proteins composed of 20 different amino acids.
- The term protein is used to describe molecules with greater than 50 amino acids.
- Each protein consist of one or more polypeptide chains.

- Dalton: is the measuring unit of proteins molecular weight , it is equal to the mass of one hydrogen atom = 1.67×10^{-24}

Functions of proteins:

1-catalysis enzymes: are proteins that accelerate thousands of biochemical reactions.

2-structural proteins : such as collagen.

3- some proteins help in the movement of cells such as actin.

4-Defence: such as immunoglobulins(antibodies).

5-Regulation : such as hormones.

6-Transport: such as hemoglobin that carries O_2.

7-Storage proteins such as ferritin which stores iron.

8-contractile proteins: these proteins help in contraction and relaxation of muscles such as myosin.

9-maintenance proteins: these help in maintenance of osmotic pressure and pH.

10- toxins: there are some toxic proteins such as snake toxins and anaerobic bacteria toxins.

Proteins properties:

1-molecular size: most proteins are macromolecules having high molecular weight.

2-differential solubility: solubility of proteins affect by many factors like pH and temperature.

3-less solubility of proteins is at the isoelectric point.

Iso electric point: is the pH at which the negative charge neutralized with the positive charge.

4-some proteins are less soluble in water, but the solubility can increasing if we add a salt such as 0.02 N NaCl this process called salting in , while proteins precipitate from aqueous solutions by adding concentrated salt solution ,this process called salting out.

5-Heavy metals: salts of heavy metal(like pb,Hg) can precipitate proteins.

6-proteins hydrolysis by boiling them with acids or by proteolytic enzymes.

7-proteins have different bonds which are:

- Peptide bond
- Disulphide bond
- Hydrogen bond
- hydrophobic bond

8-proteins have optical mutarotation

Mutarotation is the change in the rotation of the compound to the equilibrium value.

9- proteins in general are not crystalline except few types .

Proteins classification:

Proteins are classified according to :

↙ ↘

shape

↓

- fibrous like collagene
- Globular like albumin

composition

↓

- simple proteins like globulins
- conjucated proteins like metaloproteins are consistof simple proteins combined with nonprotein component called prosthetic group.

Structure of proteins:

1-primary

2-secondary:either α-helix or β-sheet

3-tertiary

4-quaternary

Some important definitions:

- Bohr effect: is a mechanism where by O_2 is delivered to cells in proportion to their needs in addition the binding of oxygen to hemoglobin is affected by the concentration of hydrogen ion (H+) and CO2 in the surrounding tissue.
- Albumin: is the most abundant protein in serum (more than 50% of blood serum proteins) , albumin synthesized in liver and its half life is (18-20) days.

Denaturation of proteins:

Denaturation means disruption of protein structure or irreversible precipitation of proteins.

Denaturation of proteins causes partial or complete loss of their biological activity.

Many factors can denature proteins such as:

1-freezing

2-UV.

3-alcohol and alkaline compound

4-urea

5-detergents

6-stirring

7-salting

8-heavy metals

9-temperature change

THANK YOU

Lipids
part(1)

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- Lipids: are defined as those substances from living organisms that dissolve in nonpolar solvents such as ether , chloroform and aceton but not in water.
- Functions of lipids :

1- in cell membrane.

2-stored energy

3-plasma lipoprotein

4-protective

5-serving as hormones

Classification of lipids:

1-simple lipids:

A- fat , oil

B- wax and triglyceride

2- compound lipids

A- phospholipids:are structural components of cell membrane

(consist of glycerol+fatty acids+phosphoric acid)

B-sphingolipids: occure chiefly in the cell membrane of the brain and nervous system.

C-glycolipids

D-lipoproteins:consist of (protein +lipid group)

Lipoproteins are classified according to their density to:

A-chylomicron

B-very low density lipoproteins(VLDL)

C-low density lipoproteins(LDL)

D-high density lipoproteins(HDL)

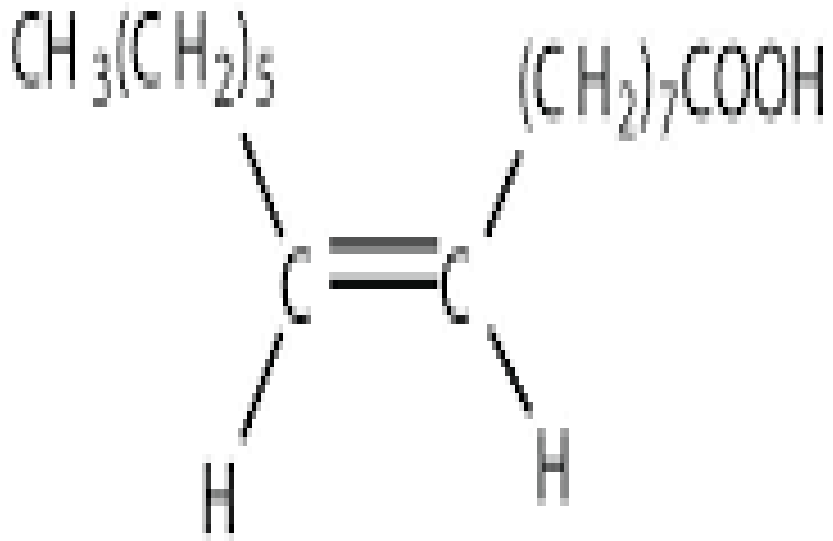
3-derived lipids: produced from the hydrolysis of simple lipids and compound lipids

Fatty acids (FA):

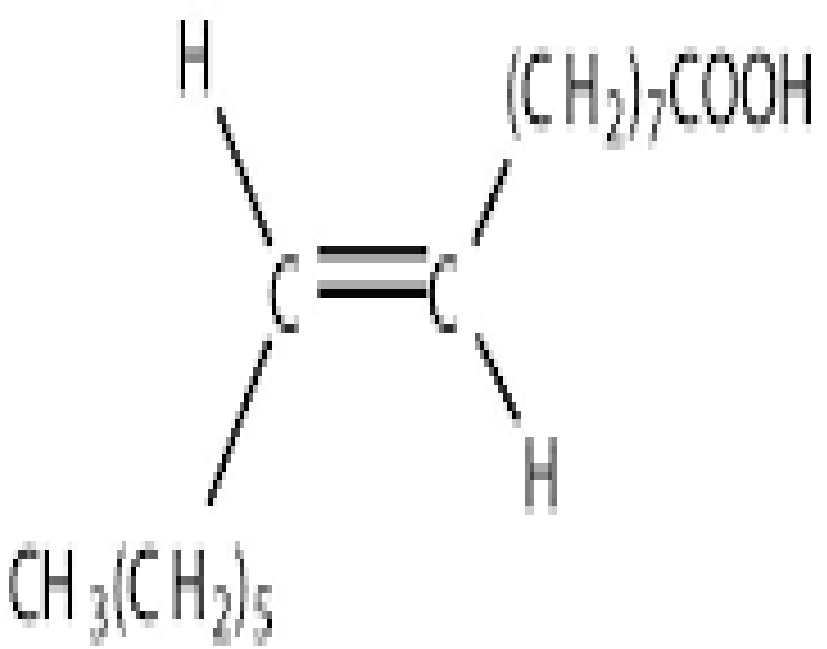
They are monocarboxylic acids contain hydrocarbon chains of variable lengths.

Fatty acids that contain only {c – c} single bonds are called saturated fatty acids.

while Fatty acids that contain one or more double bonds {c = c } are called unsaturated fatty acids and they can occure in two isomeric forms : cis and trans.



cis fatty acid



trans fatty acid

- Nonessential fatty acids: are fatty acids that can be synthesized

- Essential fatty acids: they must be obtained from the diet because mammals do not possess enzymes required to synthesize them.

- Free fatty acids that produced from ingestion of triglyceride by the intestine are absorbed into the blood where they bound to albumin and transpoted to the tissues that need fuel, these free fatty acids level elevated in diabetes mellitus.

Lipids
part(2)

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Triglyceride or triacylglycerol(TG):

- They are synthesized in liver or adipose tissue.
- They are ester of glycerol with three fatty acid molecules.
- glycerol is carried in the blood to the liver that having glycerol kinase enzyme which converts glycerol to glycerol-3-phosphate.
- In the liver cells glycerol-3-phosphate can be used in the synthesis of triacylglycerol,phospholipids or glucose.
- When energy reserves are high , triacylglycerols are synthesized in a process called lipogenesis.
- When energy reserves are low, triacylglycerols are degraded in a prossess called lipolysis by hormone sensitive lipase(HSL) to form fatty acid and glycerol.
- Fatty acid degredation : is the process in which fatty acids are broken down resulting in release of energy.

Cholesterol:

Cholesterol: is a waxy steroid metabolite found in the cell membranes and transported in the blood plasma of all animals .

it is an essential structural component of mammalian cell membranes where it is required to establish proper membrane permeability and fluidity.

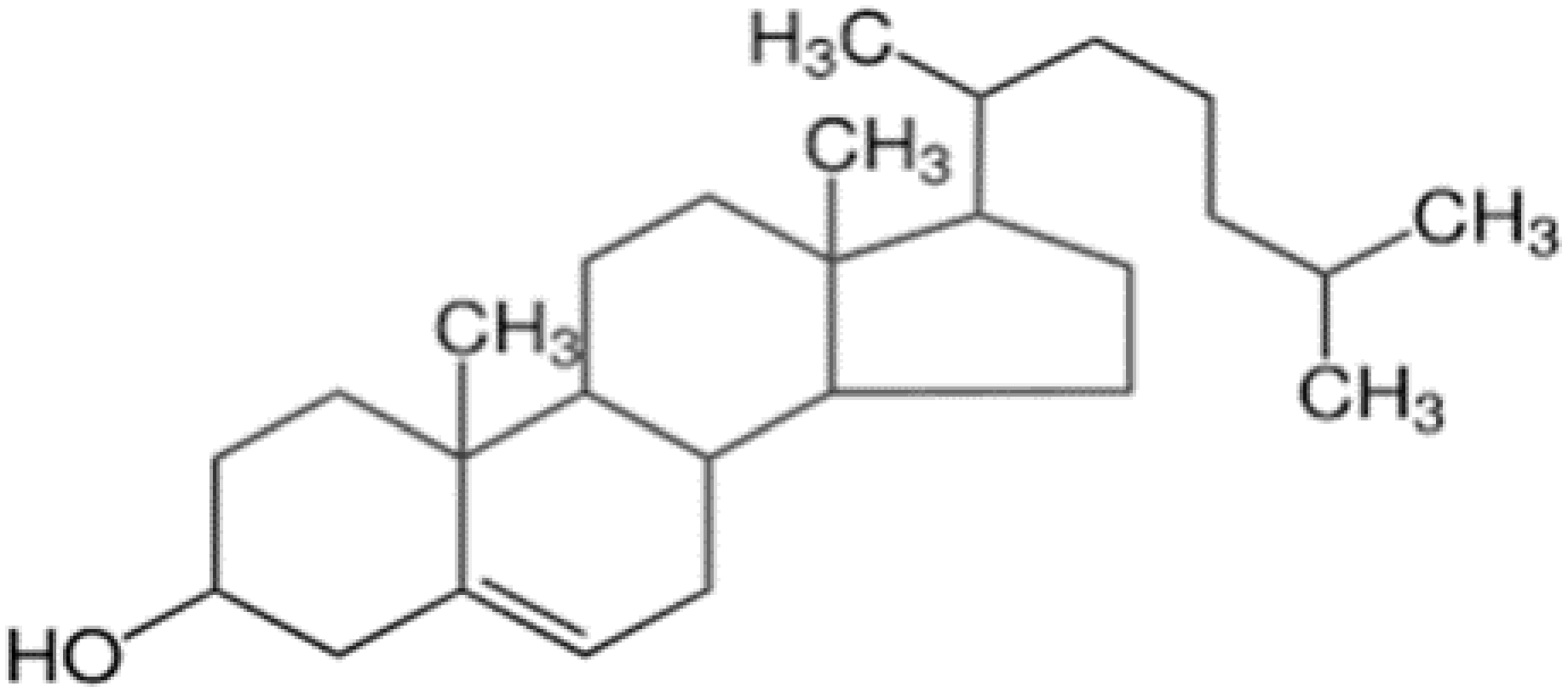
Cholesterol is asolid alcohol containing 27 carbon atoms and one hydroxyl group.

Sourses of cholesterol:

1-dietary sourses.

2-about 20-25% of daily cholesterol synthesized in liver.

3-Other sites of cholesterol production include adrenal gland ,intestine and reproductive organ.


H3C
CH3
CH3
CH3
CH3
HO

Cholesterol metabolism:

Cholesterol produced by the liver is converted to bile which then stored in gallbladder.

Bile contains bile salts that can solubilize fats in the digestive tract and help in the intestinal absorption of fat molecules and vitamins that are soluble in fat(E,D,A,K).

Dislipidemia:

Hypercholesterolemia : means higher levels of LDL in blood and low levels of HDL , this condition is strongly associated with cardiovascular disease (like atherosclerosis).

ENZYMOLOGY part(1)

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- Clinical enzymology: is the application of the science of enzymes in the diagnosis and treatment of disease.
- Catalysis: is defined as the process of acceleration of a chemical reaction by some changes.
- Enzymes: are proteinic compounds(usually globular) , they are of high molecular weight (13000-500000) Dalton or more, made up principally of chains of amino acids(about 62) linked together by peptide bonds, they catalyze biochemical reactions.
- In enzymatic reactions, the molecules at the beginning of the process are called SUBSTRATES, and they are converted to different molecules called PRODUCTS.
- Enzymes are produced or synthesized by cell to do function either in or out that cell.
- Plasma or serum enzyme levels are often useful in the diagnosis of particular diseases or physiological abnormalities.

Cofactors and coenzymes:

- Many enzymes require the presence of other compounds(non proteinic) known as cofactors before their catalytic activity can be exerted.

types of cofactors :

Inorganic like metal ions	Organic : there are two classes
	A- tightly bound to the enzyme which is called prosthetic group
	B-or released from the enzyme ,this is called Coenzyme(such as NADH) which is small organic molecule can transport chemical groups from one enzyme to another, coenzyme considered as second substrate.

- Apoenzyme: is the enzyme without cofactor,this is the inactive form of enzyme.
- Holoenzyme: is the enzyme with cofactor, this is the active form of enzyme.

- General principles of enzymes nomenclature:

1-enzyme names derived from substrate name + ase(like urease)

2-enzyme named according to the reaction it catalyzed (like lactic dehydrogenase)

3-enzymes named according to their function(like amino transferase)

Note: there is a nother systeme of nomenclature in this system each enzyme has a code number such as (1.1.1.1)this number called IUBMB number ,

I=International

U=Union

B=Biochemistry

M=Molecular

B=Biology

Major six classes of enzymes:

1-oxidoreductases

2-transferases

3-hydrolases

4-lyases

5-isomerases

6-ligases

ENZYMOLOGY
Part(2)

❑Models of enzyme-substrate binding:

A- Lock and key model

B- Induced –fit model

❑Active site of enzyme: is the region of binding with substrates , each enzyme contains an active site.

❑Common features of the active site:

1-it is three dimentional clefts.

2-it take up a small part of the total volume of the enzyme.

3-substrates bind to an enzyme at this site by multiple weak attractions.

4-the specifity of bounding depends on the precisely defined arrangements of atom in an active site.

- Active energy: is the threshould energy that must be overcome to produce a chemical reaction.
- Factors affecting enzyme activity or function:

1-enzyme concentration.

2-inhibitors of enzyme: there are three types:

A-competitive inhiobition.

B-noncompetitive inhibition.

C-substrate inhibition.

3- temperature effect.

4-PH effect.

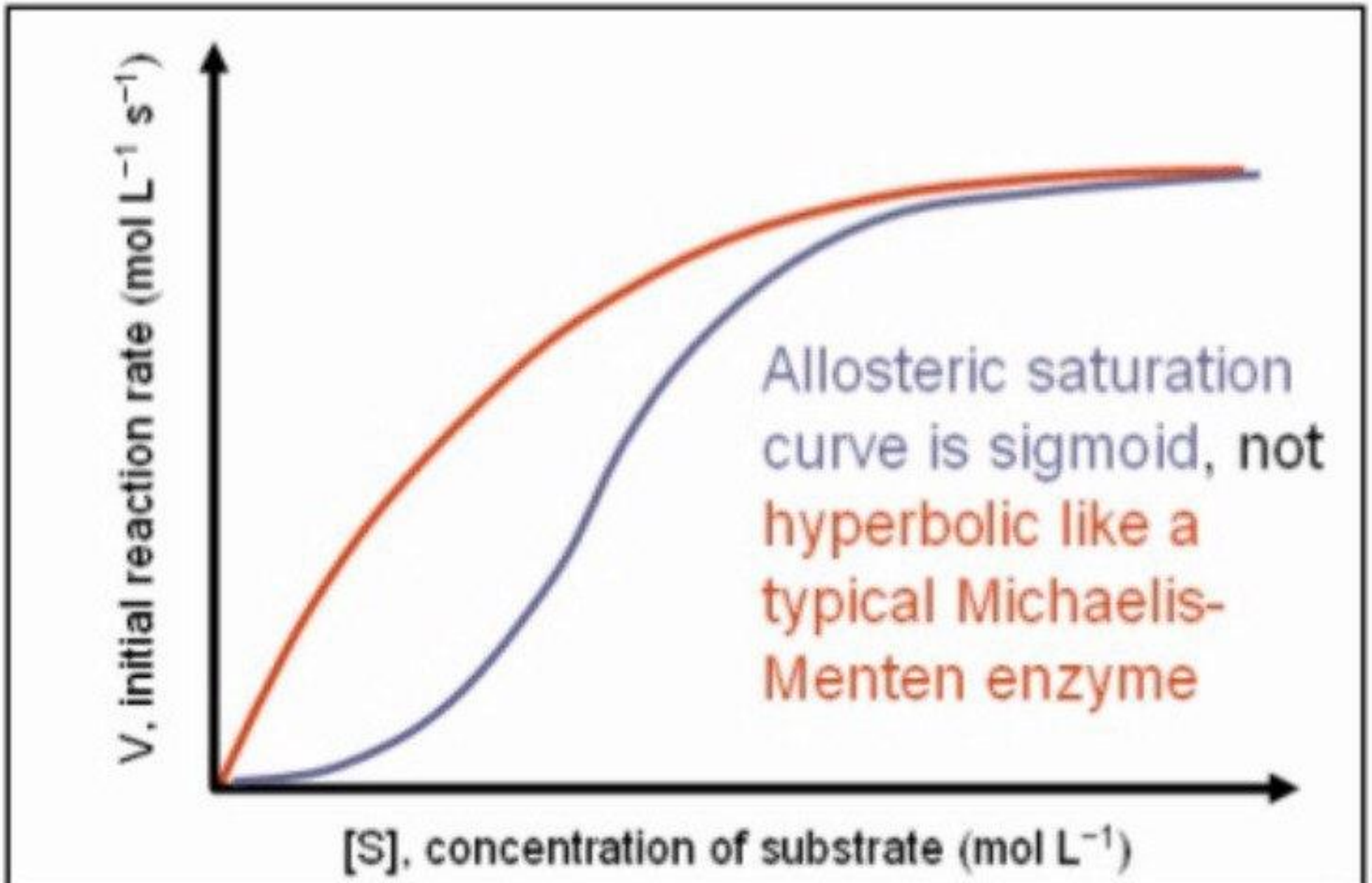
- Allosteric enzyme: (allosteric) means (other site) allosteric sites are sites on the enzyme that bind to molecules by weak noncovelant bonds causing a change in the conformation of the enzyme.

- Allosteric effects may be positive or negative.

- Enzymes can be regulated by inhibitors and activator.

- The binding curve for allosteric enzymes is sigmoidal.

teric Enzyme Kinetics: Sigmoid Curve instead of Hyperbola.



- The Michaelis – Menten kinetic model: explains several aspects of the behavior of many enzymes.

Each enzyme has a Km value that is characteristic of that enzyme under specified conditions.

Km= is a rate constant

- structural level of enzymes:

1-primary structure

2-secondary structure

3-tertiary structure

4-quaternary structure

- the interactions in an enzyme molecule are:

1-ionic bonds

2-hydrogen bonds

3-sulfide bonds

4-vander waals forces (electrostatic interactions)

➢Enzyme units :

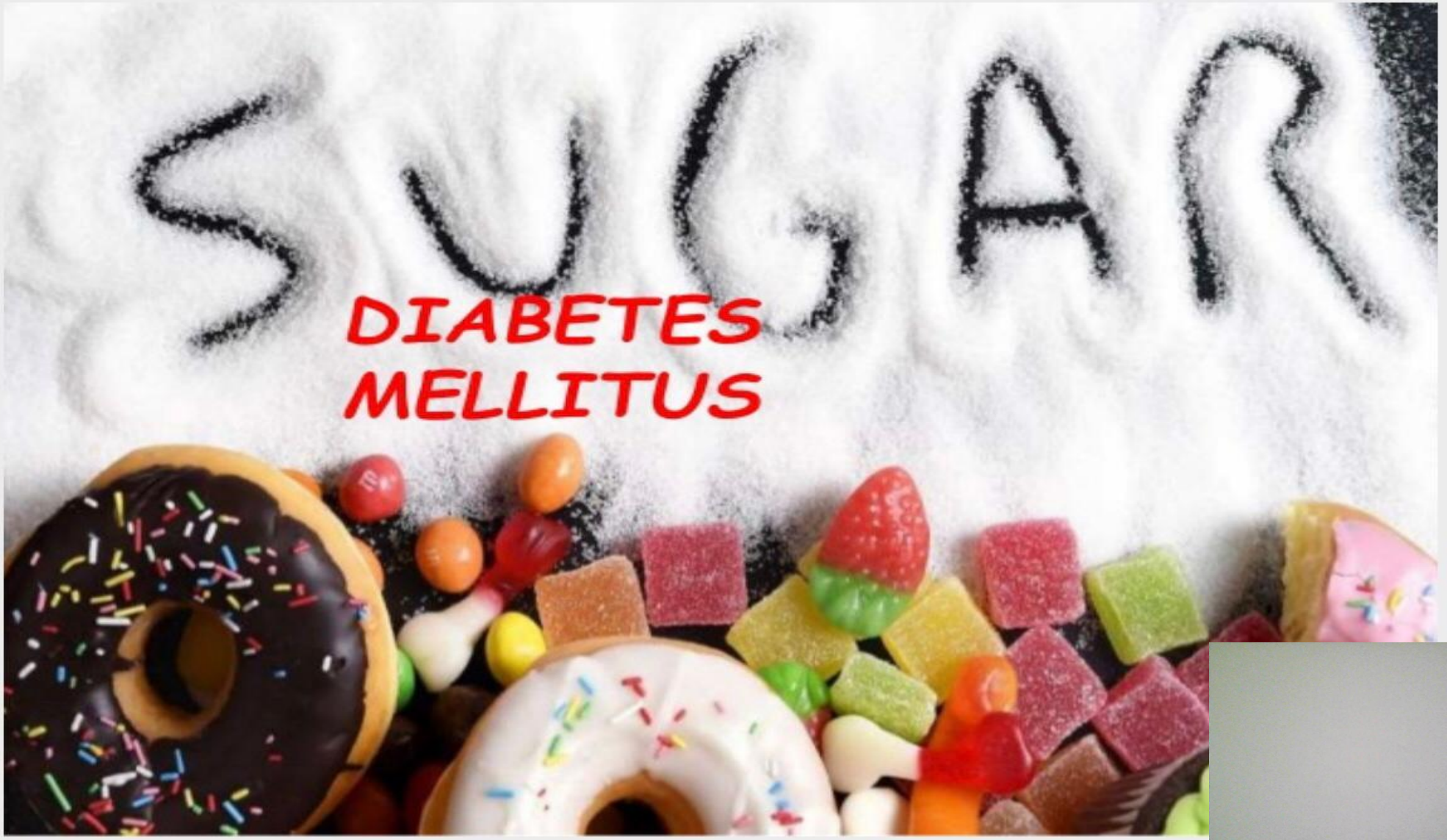
1-international unit(IU):the amount of enzyme that convert 1µmol of substrate per minute under defined condition

2-Katal unit: is the conversion rate of 1 mole of substrate per second .

3-specific activity: unit/ mg of enzyme.

➢ disorders of enzyme:

Any malfunction (like mutation, overproduction,underproduction or deletion) of a single enzyme can lead to a genetic disease such as phenylketonurea.


SUGAR
DIABETES
MELLITUS

INTRODUCTION

- **Diabetes mellitus** (**DM**), is a group of metabolic diseases in which there are high blood sugar levels over a prolonged period.

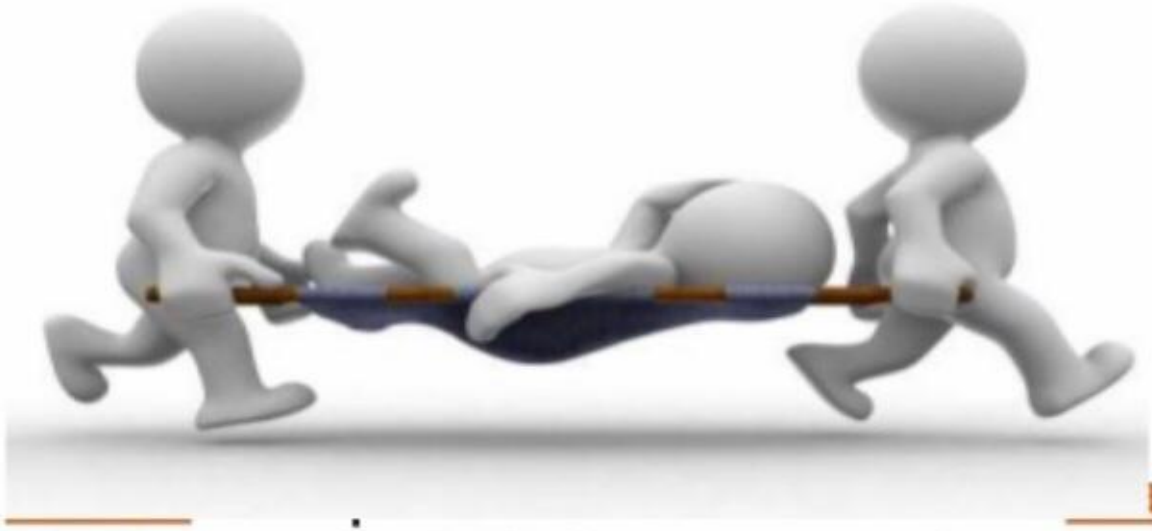
- Symptoms of high blood sugar include frequent uri
  increased thirst, and increased hunger.

SIGNS AND SYMPTOMS

- The classic symptoms of untreated diabetes are
  - weight loss
  - polyuria (increased urination)
  - polydipsia (increased thirst) and
  - polyphagia (increased hunger).

- Symptoms may develop rapidly (weeks or months) i
type 1 DM, while they usually develop much more slo
and may be subtle or absent in type 2 DM.

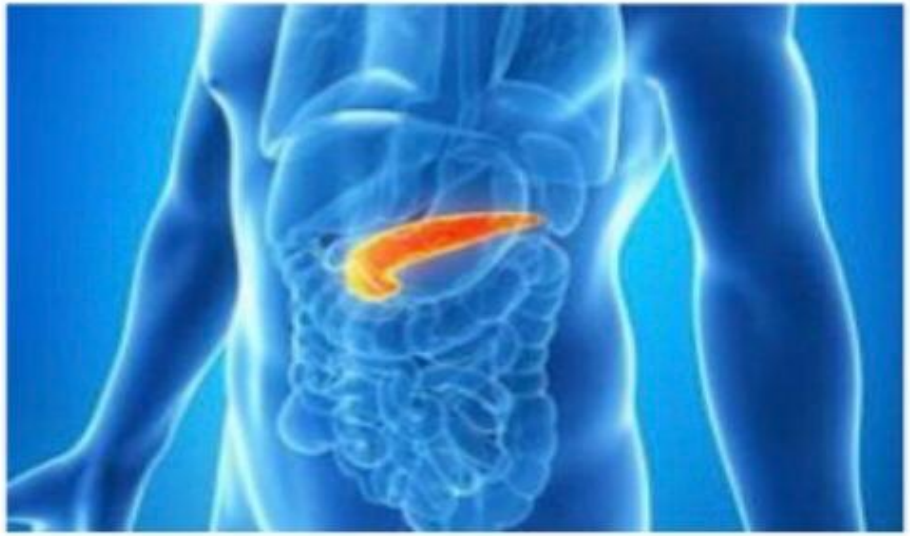
- If left untreated, diabetes can cause many complications.

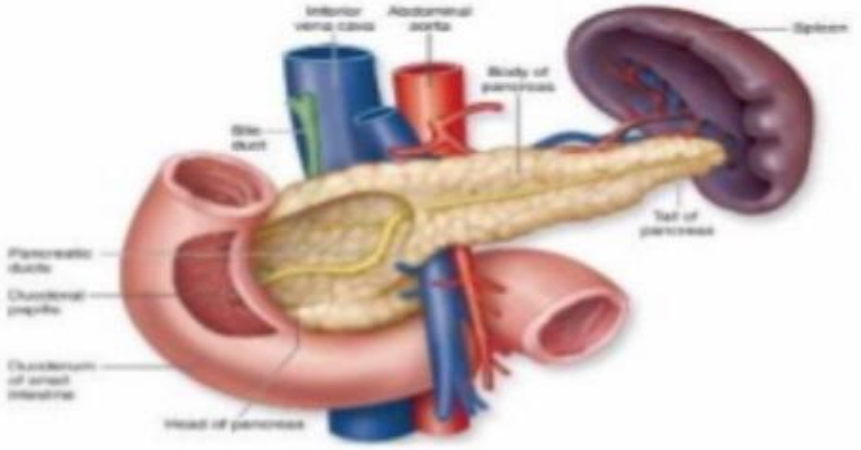


- _____ . ıbetic ketoacidosis, nonketotic hyperosmolar coma, or death.

- Serious long-term complications include heart disease, stroke, chronic kidney failure, foot ulcers and damage to the eyes.

- Diabetes is due to either the pancreas not producing enough insulin or the cells of the body not responding properly to the insulin produced.

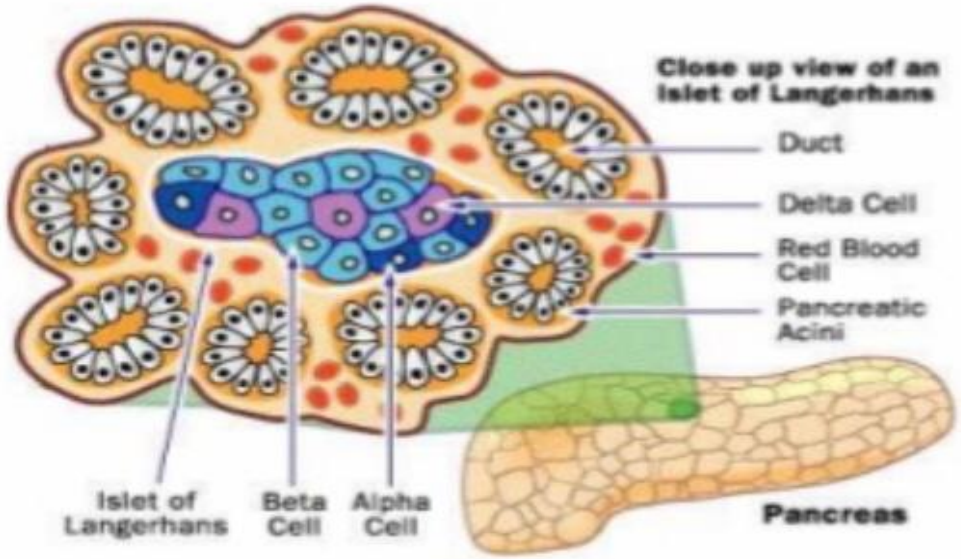


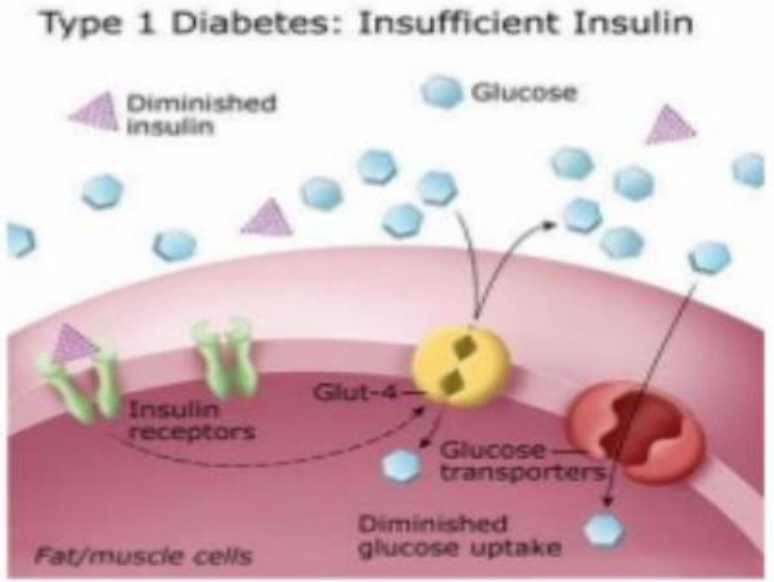


- There are three main types of diabetes mellitus:
  - Type 1 DM
  - Type 2 DM
  - Gestational Diabetes

Type 1 DM

- Results from the pancreas's failure to produce enough insulin.





- This form was previously referred to as "insulin-dependent diabetes mellitus" (IDDM) or "juvenile diabetes".

- The cause is unknown.

- Type 2 DM
  - Begins with insulin resistance, a condition in which cells fail to respond to insulin properly.

  - This form was previously referred to as "non insulin-dependent diabetes mellitus" (NIDDM) or "adult-onset diabetes".
  - The primary cause is excessive body weight and not enough exercise.

Gestational Diabetes

Is the third main form and occurs in pregnant women without a previous history of diabetes

NUCLEIC ACIDS
PART(1)

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- Nucleic acids : are biological molecules essential for life,they include DNA (deoxy ribonucleic acid) and RNA (ribonucleic acid).

They are existing in the nucleus of the cell (in the chromosomes inside the nucleus) and in the cytoplasm too.

- experimental studies of nucleic acids take the major part of modern biological and medical research ,also in genome and forensic science as well as the biotechnology and pharmaceutical industries.
- Nucleotides: are the building blocks of the nucleic acids , each nucleotide consists of three components :

1-nitrogenous heterocyclic base (either purine or pyrimidine)

2-pentose sugar

3-phosphate group

- Nucleic acids type differe in the structure of the sugar in their nucleotides

DNA contains deoxyribose

RNA contains ribose

⤢ types of nucleic acids:

1-Ribonucleic acid(RNA): is anucleic acid polymer consisting of nucleotide monomers which plays an important roles in the processes of transcription of genetic information from deoxyribonucleic acid (DNA) into proteins.

There are many types of RNA :

A-Ribosomal RNA(rRNA).

B- Transfere RNA(tRNA).

C-Messenger RNA (mRNA).

2-Deoxyribonucleic acid(DNA):is the nucleic acid that contains the genetic information.

DNA

deoxyribose

deoxyribonucleic acid

double stranded

bases: guanine, cytosine, adenine, thymine

A=T, C=G

long strands

nucleotides

- phosphate
- **sugar**
- **base**

RNA

ribose

ribonucleic acid

single stranded

bases: guanine, **cytosine,** **adenine, uracil**

A=U,C==G

short strands

Nucleic acid part (2)

Some important difinitions:

- Gene: a DNA sequence that codes for a polypeptide,rRNA or tRNA.
- Genome: a complete set of chromosomes which contain the genes.
- Genetic code:the set of nucleotide base triplet (codons) that code for the amino acids in proteins .
- Diploid genome: is that one which consists of two copies of each type of chromosome.
- Haploid genome: consists of one copy of each chromosome.
- Chromosome: composed of DNA that contains the genes of an organism.
- Replication: synthesis of DNA copy
- Transcription : synthesis of RNA using DNA as template.
- Transcription: prptein synthesis
- Mutation : any change in the nucleotide sequence of agene.
- DNA→RNA→PROTEIN

Important functions of nucleotide:

1-they are monomer of DNA and RNA.

2-form high energy molecule such as ATP.

3-some of them serve as a component of many coenzymes(like NAD+) and regulatory molecules (such as cAMP).

Disorder and diseases from defect in purine catabolic pathways:

Gout disease: refers to the deposition of sodium urate crystals in and around joints due to high levels of uric acid (hyperuricemia) in blood.

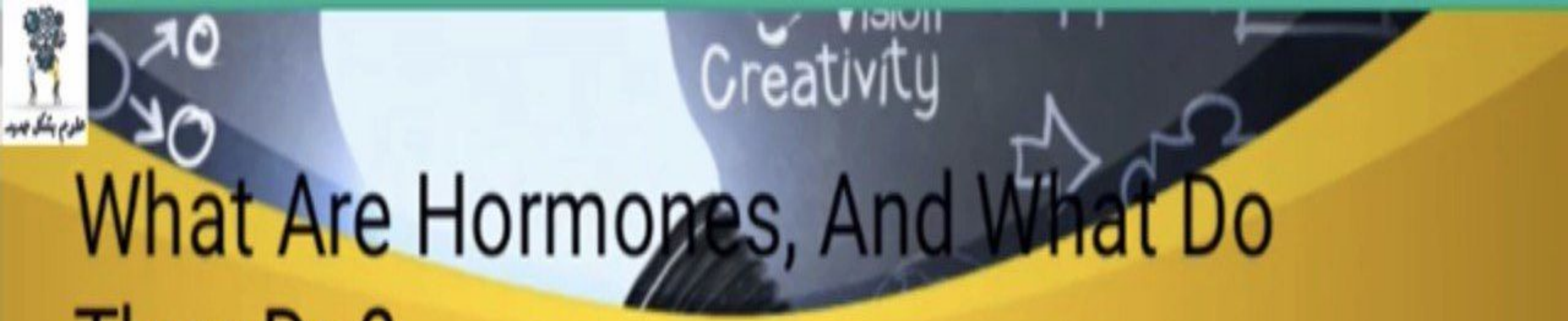
Note / uric acid is the final product of purine catabolism that is found in nucleic acids.

There are two types of gout:

1- primary gout: caused by genetic defect in purine metabolism that lead to overproduction of uric acid.

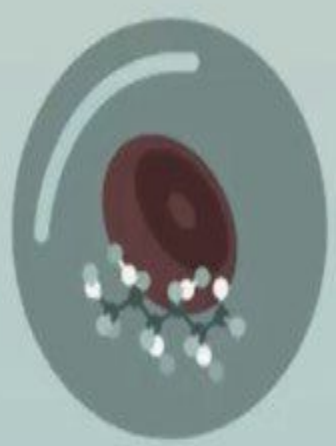
2-secondary gout: this type is occur as aresult of purine overproduction that lead to hyperuricemia or decreased secretion of uric acid by kidney.


HORMONES
HORMONE
REPRESENTATION
BIOLOGY
MEDICAL
ANATOMY
MEDICINE
HEALTH
SYSTEM
ORGANISM
MEMBRANE
SCIENCE
GLAND
FEMALE
BRAIN
RECEPTOR
NEURAL
CONCEPT
INSULIN
REPLACEMENT
SIGNAL
DEFINITION
BIOLOGICAL
HORMONAL
TRIGGERS
FEEDBACK
BIOSYNTHETIC
RESPOND
TARGET
SYNAPSE
HEAD
FLOW
TREATING
ESTROGEN
NEURON
HUMAN
MENOPAUSE
PROTEIN
ORGAN
THERAPY
FUNCTION
CARE
CELL
ENDOCRINE
CONCEPTUAL
BLOOD
MENSTRUATION
STEROID
PITUITARY
TREATMENT



What Are Hormones, And What Do They Do?

Hormones are special chemical messengers in the body that are created in the endocrine glands. These messengers control most major bodily functions, from simple basic needs like hunger to complex systems like reproduction, and even the emotions and mood.



Blood Glucose Levels

Water Content in blood

General Growth

Blood Pressure

Classification of hormones

According to Chemical Nature

- **Steroid Hormones**

  e.g. Testosterone, Estrogen, Progesterone

- **Amine Hormones**

  e.g. T_3, T_4, epinephrine, norepinephrine.

- **Peptide Hormones**

  e.g. Oxytocin and vasopressin

- **Protein Hormones**

  e.g. Insulin and glucagon

- **Glycoprotein Hormones**

  e.g. LH, FSH

- **Eicosanoids Hormones**

- Overproduction of a hormone
- Underproduction of a hormone
- Nonfunctional receptors that cause target cells to become insensitive to hormones

SPECTRPHOTOMETRY

- A method in which the absorption or transmission properties of a material is quantitatively measured as a function of wavelength.

- The basic principle behind this method is that :

"Each compound absorbs or transmits light over a certain range of wavelength"

BEER – LAMBERT LAW

It states that the absorbance of light by a material in a solution is directly proportional to its concentration in that solution.

$$A = \epsilon l c$$

Where,

A – absorbance

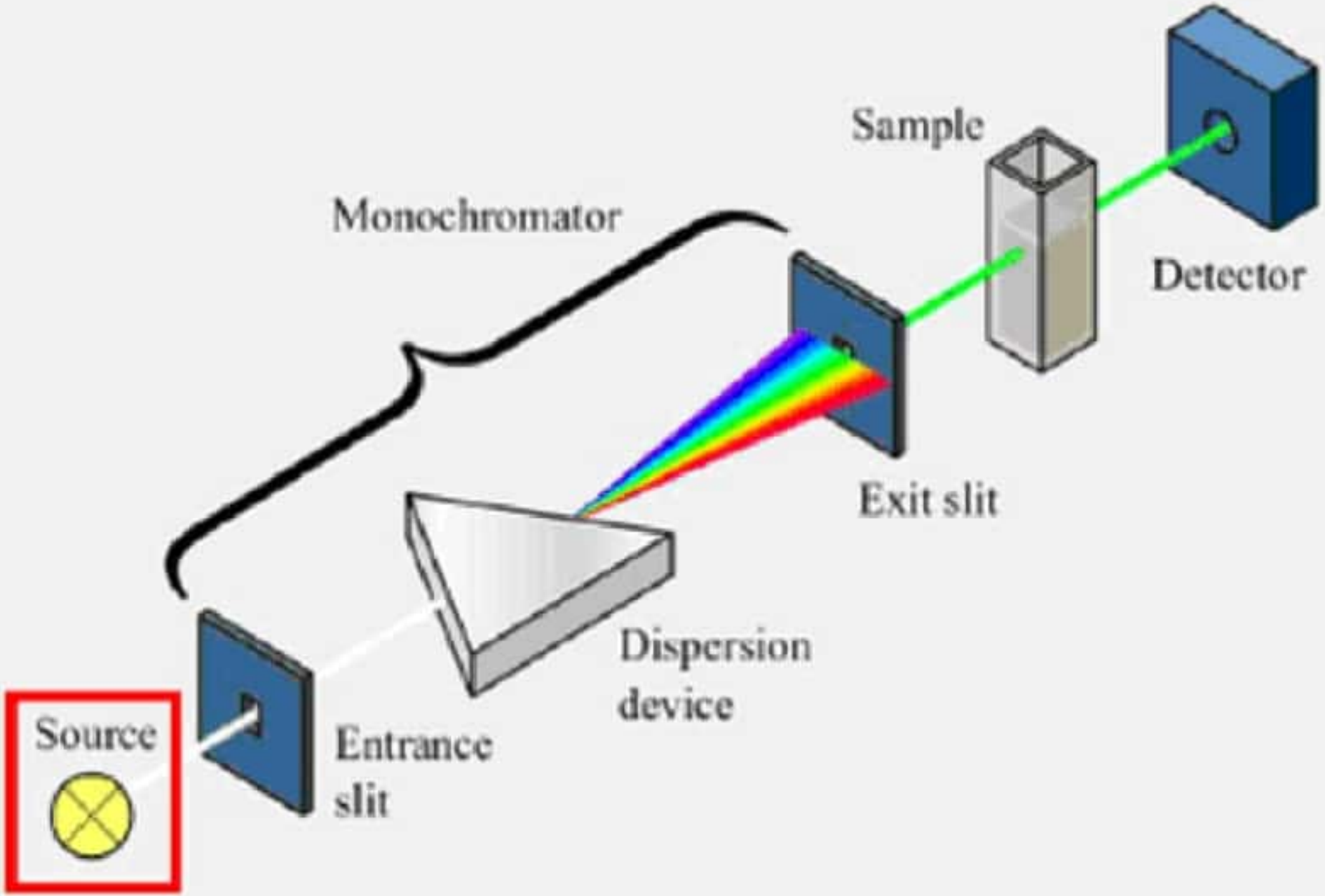
ϵ - molar absorptivity

l – length of solution

c – concentration

- A spectrophotometer is an instrument that measures the amount of photons absorbed by a sample after it is passed through its solution.

- With the spectrophotometer , the amount of a known chemical substance can be determined by measuring the absorbance.


Sample
Monochromator
Detector
Exit slit
Dispersion
device
Source
Entrance
slit

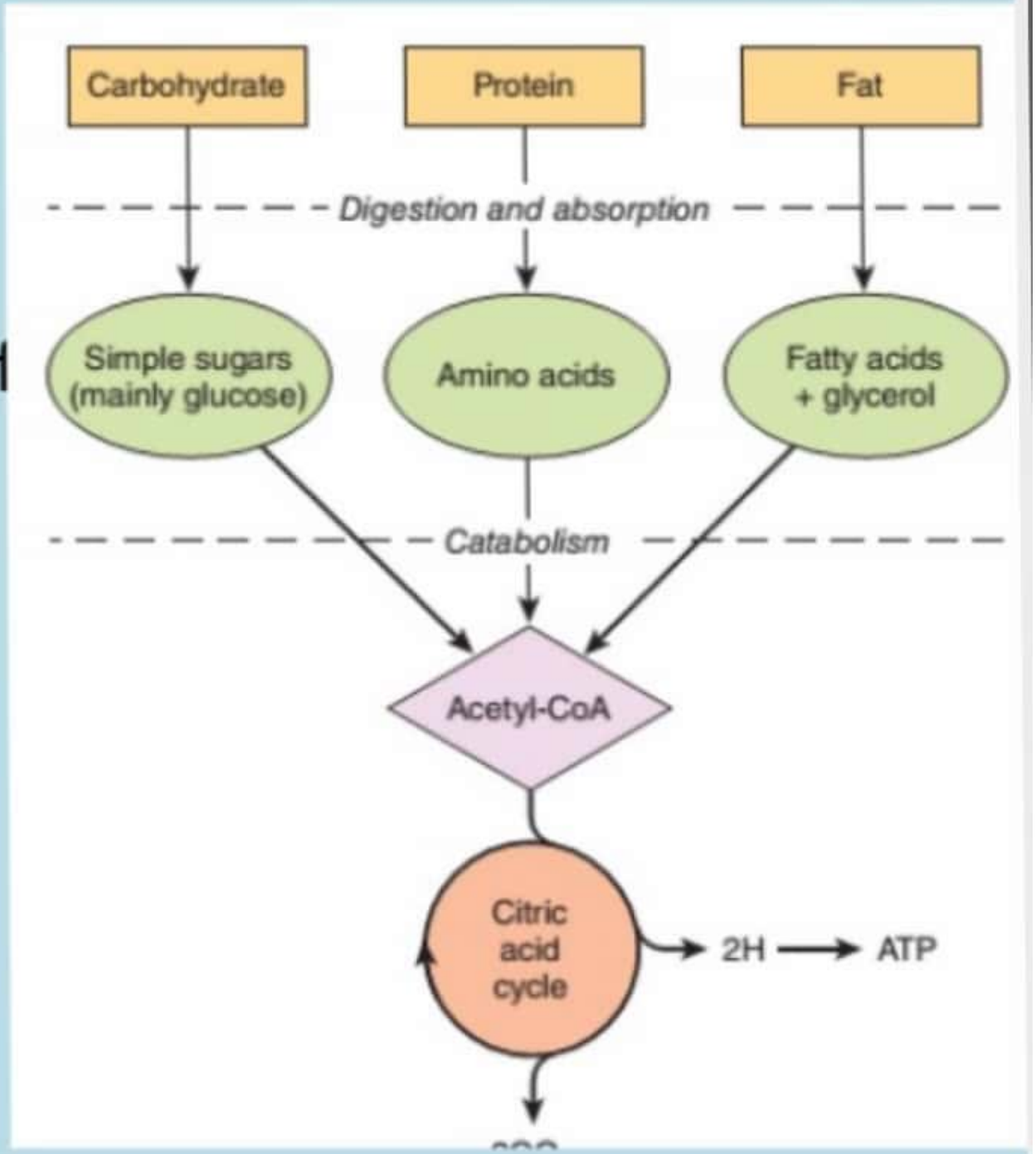
Introduction

- Metabolism is the term used to describe
  - The interconversion of chemical compounds in the body
  - The pathways taken by individual molecules,
  - Their interrelationships, and the mechanisms that regulate the flow of metabolites through the pathways
- It falls mainly in 3 categories: catabolism, anabolism and amphibolic pathways

- **TCA cycle supplies energy & also provides many intermediates required for the synthesis of amino acids, glucose, heme etc.**
- **TCA cycle is the most important central pathway connecting almost all the individual metabolic pathways.**

Metabolism

- All the products of digestion are metabolized to **acetyl-CoA -** oxidized by the **citric acid cycle**



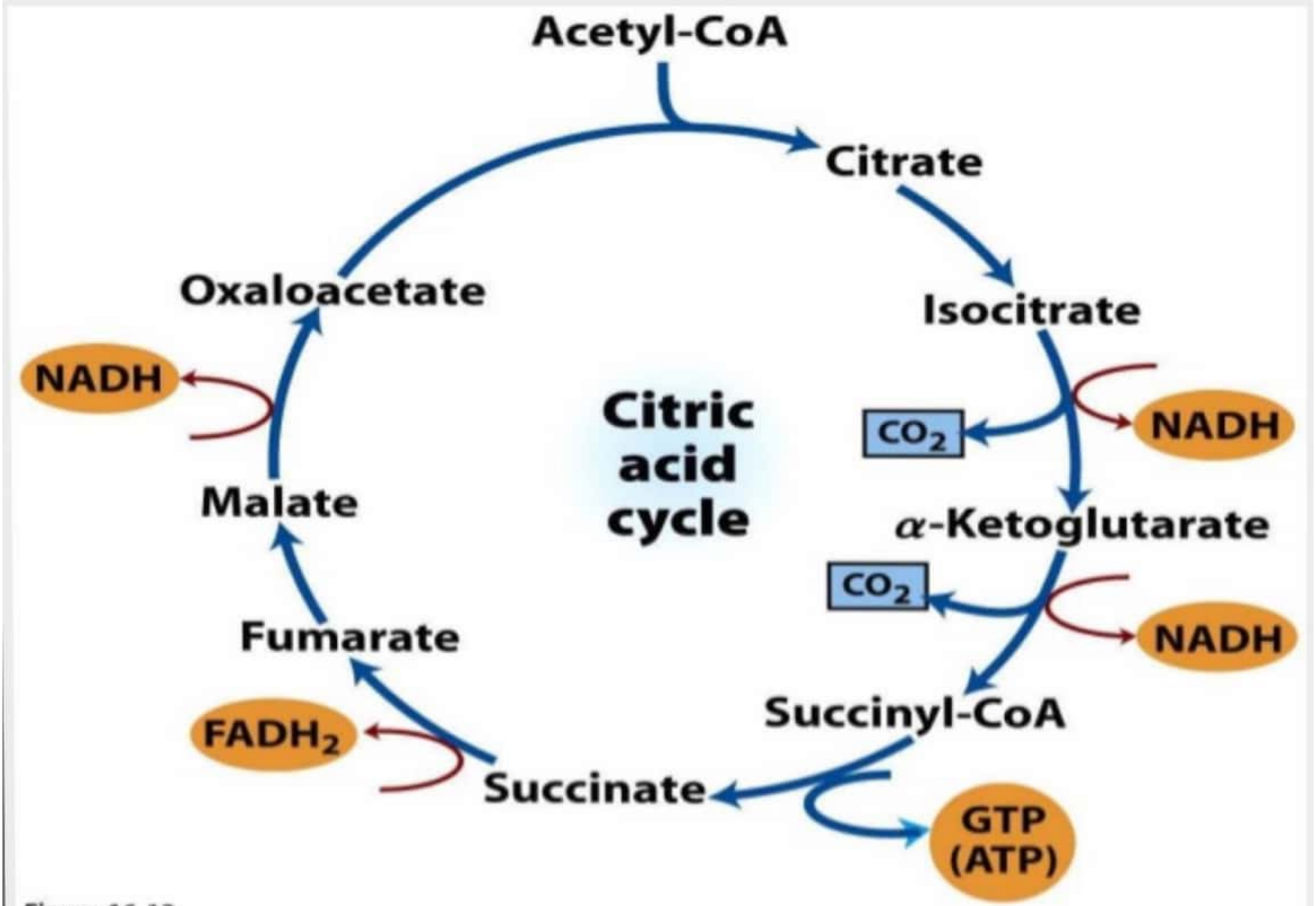


Figure 16-13
Lehninger Principles of Biochemistry, Fifth Edition

Regulation of TCA Cycle

- **Three regulatory enzymes**

  1. Citrate synthase

  2. Isocitrate dehydrogenase

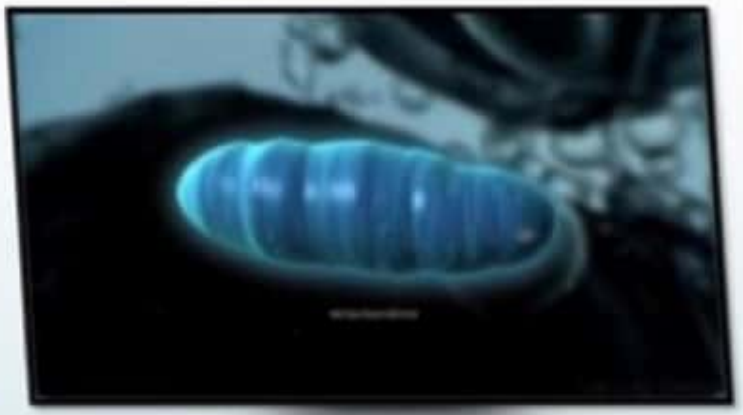
  3.α-ketoglutarate dehydrogenase

- **Definition**
- **Citric acid cycle or TCA cycle or tricarboxylic acid cycle essentially involves the oxidation of acetyl CoA to CO_2 & H_2O.**
- **Location of the TCA cycle**
- **Reactions of occur in mitochondrial matrix, in close proximity to the ETC.**

Definition

Oxidative Phosphorylation

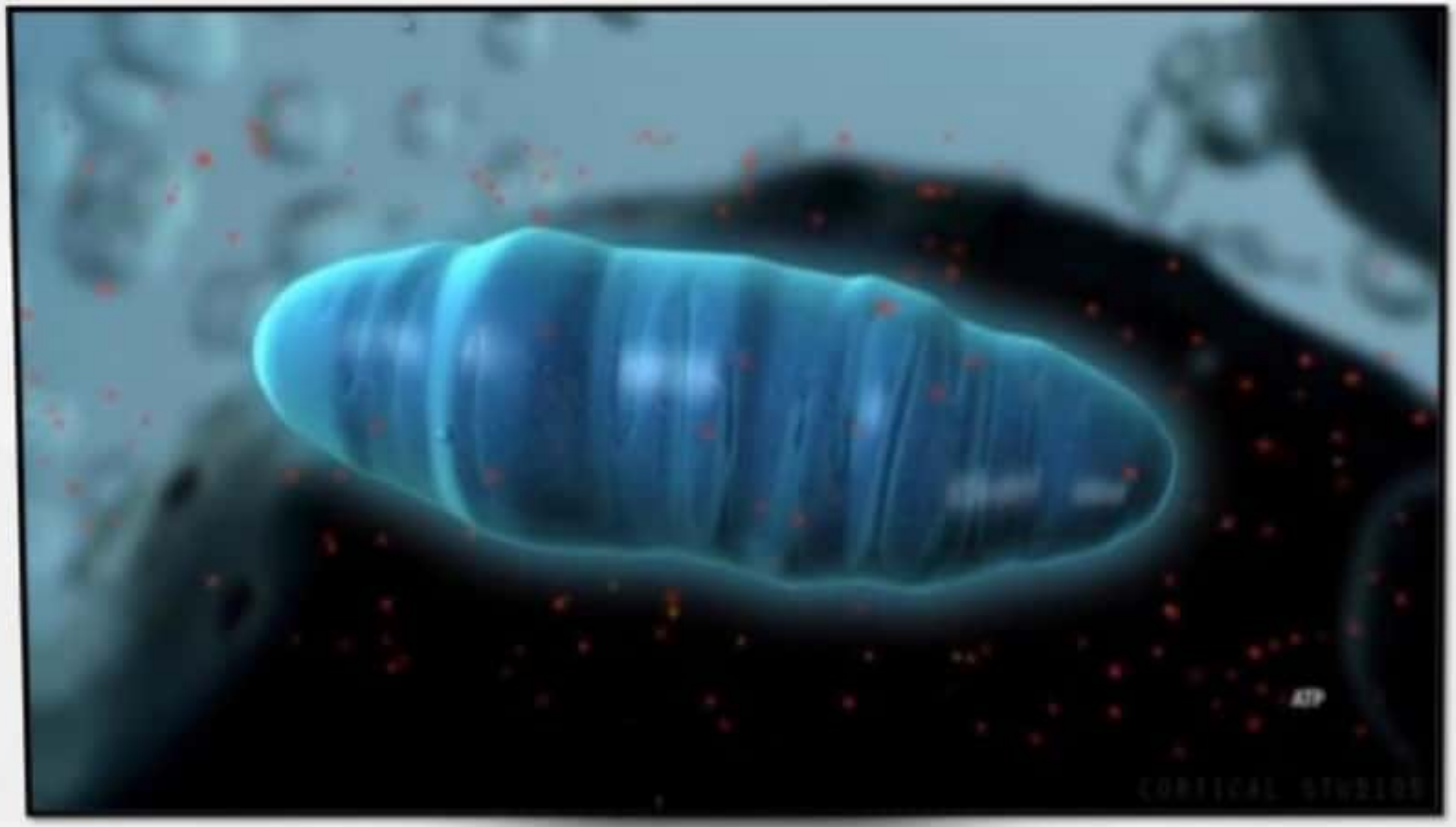
- The synthesis of ATP from ADP (phosphorylation), that occurs when NADH and $FADH_2$ are oxidized by through electron transport chain (respiratory chain)



- Oxidation coupled with phosphorylation is called Oxidative phosphorylation

- Mitochondria are the site of oxidative phosphorylation in eukaryotes

OXIDATIVE PHOSPHORYLATION



Metabolism

- **Anabolic pathways**
  - Involved in the synthesis of larger and more complex compounds from smaller precursors
  - Ex: Synthesis of protein from amino acids and the synthesis of reserves of tri-acylglycerol and glycogen.
  - Anabolic pathways are **endothermic.**
- **Catabolic pathways**
  - Involved in the breakdown of larger molecules, commonly involving oxidative reactions;
  - They are **exothermic**, producing reducing equivalents, and, mainly via the respiratory chain
- **Amphibolic pathways**
  - Occur at the "**crossroads**" of metabolism, acting as links between the anabolic and catabolic pathways
  - Ex: Citric acid cycle

TCA Cycle

- Also known as Krebs cycle
- TCA cycle essentially involves the oxidation of acetyl CoA to CO_2 and H_2O.
- TCA cycle –the central metabolic pathway
- The TCA cycle is the final common oxidative pathway for carbohydrates, fats, amino acids.

NUCLEIC ACIDS
PART(1)

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2-pentose sugar

3-phosphate group

- nucleic acids type differe in the structure of the sugar in their nucleotides

DNA contains deoxyribose

RNA contains ribose

types of nucleic acids:

1-Ribonucleic acid(RNA): is anucleic acid polymer consisting of nucleotide monomers which plays an important roles in the processes of transcription of genetic information from deoxyribonucleic acid (DNA) into proteins.

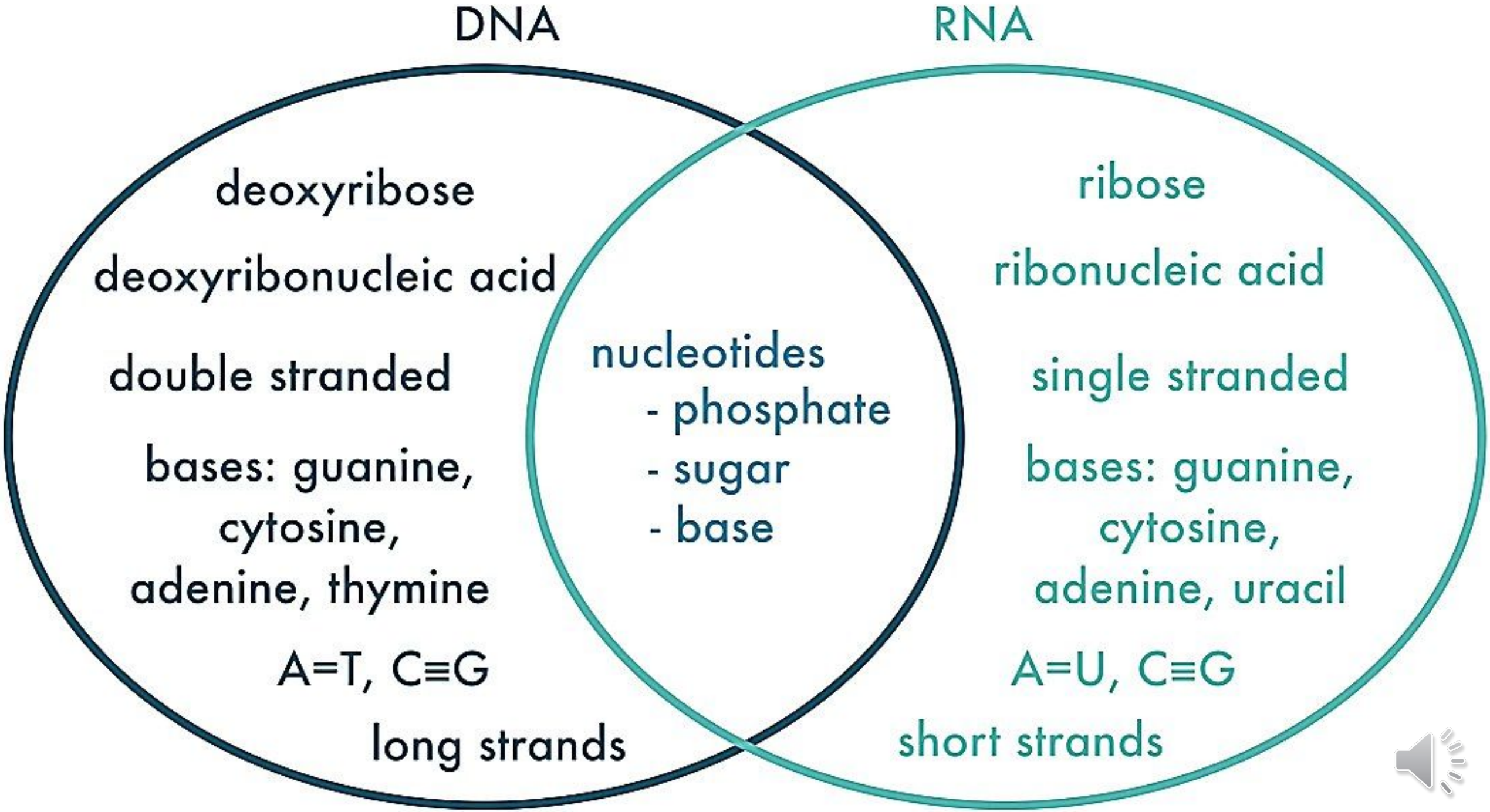
There are many types of RNA :

A-Ribosomal RNA(rRNA).

B- Transfere RNA(tRNA).

C-Messenger RNA (mRNA).

2-Deoxyribonucleic acid(DNA):is the nucleic acid that contains the genetic information.


DNA
RNA
deoxyribose
deoxyribonucleic acid
double stranded
bases: guanine,
cytosine,
adenine, thymine
A=T, C≡G
long strands
nucleotides
- phosphate
- sugar
- base
ribose
ribonucleic acid
single stranded
bases: guanine,
cytosine,
adenine, uracil
A=U, C≡G
short strands

Biochemistry Nutrition.

Nutrients are chemical substances required by the body to sustain basic functions and are optimally obtained by eating a balanced diet. There are six major classes of nutrients essential for human health: carbohydrates, lipids, proteins, vitamins, minerals, and water. Carbohydrates, lipids, and proteins are considered macronutrients and serve as a source of energy. Water is required in large amounts but does not yield energy. Vitamins and minerals are considered micronutrients and play essential roles in metabolism. Vitamins are organic micronutrients classified as either water-soluble or fat-soluble. The essential water-soluble vitamins include vitamins B1, B2, B3, B5, B6, B7, B9, B12, and C. The essential fat-soluble vitamins include vitamins A, E, D, and K. Minerals are inorganic micronutrients. Minerals can classify as macrominerals or microminerals. Macrominerals are required in amounts greater than 100 mg per day and include calcium, phosphorous, magnesium, sodium, potassium, and chloride. Sodium, potassium, and chloride are also electrolytes. Microminerals are those nutrients required in amounts less than 100 mg per day and include iron, copper, zinc, selenium, and iodine. This article will review the following biochemical aspects of the essential nutrients: fundamentals, cellular, molecular, function, testing, and clinical significance.

. **Glycosaminoglycans**[1] (**GAGs**) or **mucopolysaccharides**[2] are long, linear polysaccharides consisting of repeating disaccharide units (i.e. two-sugar units). The repeating two-sugar unit consists of a uronic sugar and an amino sugar, except in the case of the sulfated glycosaminoglycan keratan, where, in place of the uronic sugar there is a galactose unit.[3] GAGs are found in vertebrates, invertebrates and bacteria.[4] Because GAGs are highly polar molecules and attract water; the body uses them as lubricants or shock absorbers.

Mucopolysaccharidoses are a group of metabolic disorders in which abnormal accumulations of glycosaminoglycans occur due to enzyme deficiencies.

CLINICAL BIOCHEMISTRY PRACTICAL (2).

2023……. SECOND STAGE

LECTURER ……SUAD TURKEY ALI

Clinical biochemistry (2).

Second stage 2023

Lecturer…..Suad Turkey Ali

- نظري.....THEORETICAL

Disease

A **disease** is a particular abnormal condition that adversely affects the structure or function of all or part of an organism and is not immediately due to any external injury.[1][2] Diseases are often known to be **medical conditions** that are associated with specific signs and symptoms. A disease may be caused by external factors such as pathogens or by internal dysfunctions. For example, internal dysfunctions of the immune system can produce a variety of different diseases, including various forms of immunodeficiency, hypersensitivity, allergies, and autoimmune disorders.

In humans, *disease* is often used more broadly to refer to any condition that causes pain, dysfunction, distress, social problems, or death to the person affected, or similar problems for those in contact with the person. In this broader sense, it sometimes includes injuries, disabilities, disorders, syndromes, infections, isolated symptoms, deviant behaviors, and atypical variations of structure and function, while in other contexts and for other purposes these may be considered distinguishable categories. Diseases can affect people not only physically but also mentally, as contracting and living with a disease can alter the affected person's perspective on life.

Death due to disease is called death by natural causes. There are four main types of disease: infectious diseases, deficiency diseases, hereditary diseases (including both genetic and non-genetic hereditary diseases), and physiological diseases. Diseases can also be classified in other ways, such as communicable versus non-communicable diseases. The deadliest diseases in humans are coronary artery disease (blood flow obstruction), followed by cerebrovascular disease and lower respiratory infections.[3] In developed countries, the diseases that cause the most sickness overall are neuropsychiatric conditions, such as depression and anxiety.

The study of disease is called *pathology*, which includes the study of *etiology*, or cause.

Terminology[]

Concepts]

In many cases, terms such as *disease*, *disorder*, *morbidity*, *sickness* and *illness* are used interchangeably; however, there are situations when specific terms are considered preferable.[4]

Disease

The term *disease* broadly refers to any condition that impairs the normal functioning of the body. For this reason, diseases are associated with the dysfunction of the body's normal homeostatic processes.

Acquired disease

An acquired disease is one that began at some point during one's lifetime, as opposed to disease that was already present at birth. *Acquired* sounds like it could mean "caught via contagion".

Acute disease

An acute disease is one of a short-term nature (acute);

Chronic condition or chronic disease

A chronic disease is one that persists over time, often for at least six months, but may also include illnesses that are expected to last for the entirety of one's natural life.

Stress.

Stress can be defined as any type of change that causes physical, emotional, or psychological strain. Stress is your body's response to anything that

requires attention or action.

Everyone experiences stress to some degree. The way you respond to stress, however, makes a big difference to your overall well-being.

Sometimes, the best way to manage your stress involves changing your situation. At other times, the best strategy involves changing the way you respond to the situation.

Developing a clear understanding of how stress impacts your physical and mental health is important. It's also important to recognize how your mental and physical health affects your stress level.

Signs of Stress

Stress can be short-term or long-term. Both can lead to a variety of symptoms, but chronic stress can take a serious toll on the body over time and have long-lasting health effects.

Some common signs of stress include:[1]

- Changes in mood
- Clammy or sweaty palms
- Decreased sex drive
- Diarrhea
- Difficulty sleeping
- Digestive problems
- Dizziness
- Feeling anxious
- Frequent sickness
- Grinding teeth
- Headaches
- Low energy
- Muscle tension, especially in the neck and shoulders
- Physical aches and pains
- Racing heartbeat
- Trembling

Obesity

- **Overview**

Overweight and obesity are defined as abnormal or excessive fat accumulation that presents a risk to health. A body mass index (BMI) over 25 is considered overweight, and over 30 is obese. The issue has grown to epidemic proportions, with over 4 million people dying each year as a result of being overweight or obese in 2017 according to the global burden of disease.

Rates of overweight and obesity continue to grow in adults and children. From 1975 to 2016, the prevalence of overweight or obese children and adolescents aged 5–19 years increased more than four-fold from 4% to 18% globally.

Obesity is one side of the double burden of malnutrition, and today more people are obese than underweight in every region except sub-Saharan Africa and Asia. Once considered a problem only in high-income countries, overweight and obesity are now dramatically on the rise in low- and middle-income countries, particularly in urban settings. The vast majority of overweight or obese children live in developing countries, where the rate of increase has been more than 30% higher than that of developed countries.

ENZYMOLOGY
PART(1)
م. سعاد تركي علي

- Clinical enzymology: is the application of the science of enzymes in the diagnosis and treatment of disease.
- Catalysis: is defined as the process of acceleration of a chemical reaction by some changes.
- Enzymes: are proteinic compounds(usually globular) , they are of high molecular weight (13000-500000) Dalton or more, made up principally of chains of amino acids(about 62) linked together by peptide bonds, they catalyze biochemical reactions.
- In enzymatic reactions, the molecules at the beginning of the process are called SUBSTRATES, and they are converted to different molecules called PRODUCTS.
- Enzymes are produced or synthesized by cell to do function either in or out that cell.
- Plasma or serum enzyme levels are often useful in the diagnosis of particular diseases or physiological abnormalities.

Cofactors and coenzymes:

- Many enzymes require the presence of other compounds(non proteinic) known as cofactors before their catalytic activity can be exerted.

types of cofactors :

Inorganic like metal ions	Organic : there are two classes
	A- tightly bound to the enzyme which is called prosthetic group
	B-or released from the enzyme ,this is called Coenzyme(such as NADH) which is small organic molecule can transport chemical groups from one enzyme to another, coenzyme considered as second substrate.

Apoenzyme: is the enzyme without cofactor,this is the inactive form of enzyme.

Holoenzyme: is the enzyme with cofactor, this is the active form of enzyme.

General principles of enzymes nomenclature:

1-enzyme names derived from substrate name + ase(like urease)

2-enzyme named according to the reaction it catalyzed (like lactic dehydrogenase)

3-enzymes named according to their function(like amino transferase)

Note: there is a nother systeme of nomenclature in this system each enzyme has a code number such as (1.1.1.1)this number called IUBMB number ,

I=International

U=Union

B=Biochemistry

M=Molecular

B=Biology

Major six classes of enzymes:

1-oxidoreductases

2-transferases

3-hydrolases

4-lyases

5-isomerases

6-ligases

Introduction to Specimen Collection

Laboratory tests contribute vital information about a patient's health. Correct diagnostic and therapeutic decisions rely, in part, on the accuracy of test results. Adequate patient preparation, specimen collection, and specimen handling are essential prerequisites for accurate test results. The accuracy of test results is dependent on the integrity of specimens.

Safety and Disposal Considerations in Specimen Collection

In all settings in which specimens are collected and prepared for testing, laboratory and health care personnel should follow current recommended sterile techniques, including precautions regarding the use of needles and other sterile equipment. Treat all biological material as material that is potentially hazardous as well as contaminated specimen collection supplies. For all those who are involved in specimen collection and preparation, the responsibility to adhere to current recommendations designed to maintain the safety of both patients and health care workers does not end when the patient is dismissed.

There are four steps involved in obtaining a good quality specimen for testing: (1) preparation of the patient, (2) collection of the specimen, (3) processing the specimen, and (4) storing and/or transporting the specimen.

Preparation

Prior to each collection, review the appropriate test description, including the specimen type indicated, the volume, the procedure, the collection materials, patient preparation, and storage and handling instructions.

Preparing the Patient. Provide the patient, in advance, with appropriate collection instructions and information on fasting, diet, and medication restrictions when indicated for the specific test.

Preparing the Specimen. Verify the patient's identification. Proper identification of specimens is extremely important. All primary specimen containers must be labeled with at least two identifiers at the time of collection. Submitted slides may be labeled with a single identifier, but two identifiers are preferred. Examples of acceptable identifiers include (but are not limited to): patient's name (patient's first and last name exactly as they appear on the test request form), date of birth, hospital number, test request form number, accession number, or unique random number.

Avoiding Common Problems

Careful attention to routine procedures can eliminate most of the potential problems related to specimen collection. Materials provided by the laboratory for specimen collection can maintain the quality of the specimen only when they are used in strict accordance with the instructions provided. To collect a sufficient quantity of each type of specimen indicated for the procedures to be performed**.**

General Specimen Collection. Some of the common considerations affecting all types of specimens:

- Please examine specimen collection and transportation supplies to be sure they do not include expired containers.
- Label a specimen correctly and provide all pertinent information required on the test request form.
- Submit a quantity of specimen sufficient to perform the test and avoid a QNS (quantity not sufficient), as indicated in the test requirements. Use the container/tube indicated in the test requirements for appropriate specimen preservation.
- Follow patient instructions prior to specimen collection Including the proper order of blood draw when multiple tubes are required.)
- Carefully tighten specimen container lids to avoid leakage and/or potential contamination of specimens.
- Maintain and transport the specimen at the temperature indicated in the test requirements.
- Mix specimen with additive immediately after collection by inverting 5-10 times.

Serum Preparation. The most common serum preparation considerations:

- Separate serum from red cells within two hours of venipuncture.
- Mix by inverting specimen with additive immediately after collection.
- Avoid hemolysis: red blood cells broken down and components spilled into serum.
- .

Plasma Preparation. The most common considerations in the preparation of plasma:

- Collect specimen in additive indicated in the test requirements.
- Mix specimen with additive immediately after collection by inverting 5-10 times.

- Avoid hemolysis or red blood cell breakdown.
- Fill the tube completely, thereby avoiding a dilution factor excessive for total specimen volume (QNS).
- Separate plasma from cells within two hours of venipuncture or as indicated in the test requirements.
- Label transport tubes as “plasma”
- Indicate type of anticoagulant (eg, “EDTA,” “citrate,” etc)

Urine Collection. The most common urine collection considerations:

- Obtain a clean-catch, midstream specimen.
- Store unpreserved specimens refrigerated or in a cool place until ready for transport.
- Provide patients with instructions for 24-hour urine collection(s).
- Add the preservative (as specified in the test requirements) to the urine collection container prior to collection of the specimen if the preservative is not already in the container.
- Provide sufficient quantity of specimen to meet the minimum fill line on preservative transport container.
- Provide the proper mixing of specimen with urine preservative as specified in the test requirements.
- Use the collection container as specified in the test requirements, and refrigerate the specimen when bacteriological examination of the specimen is required.
- Carefully tighten specimen container lids to avoid leakage of specimen.
- Divide specimen into separate containers for tests with such requirements.
- Provide a 24-hour urine volume when an aliquot from the 24-hour collection is submitted.
- Preservatives vary for each test; refer to test information for the required preservative.

One of the most common problems in specimen collection is the submission of an insufficient volume of specimen for testing. The laboratory sends out a report marked QNS (quantity not sufficient), and the patient has to be called back for a repeat collection at an inconvenience to the patient and to the physician. To ensure an adequate specimen volume:

1. Always draw whole blood in an amount 2½ times the required volume of serum required for a particular test.

2. For example, if 2 mL serum are required, draw at least 5 mL whole blood. If there is difficulty in performing venipuncture, minimum volume may be submitted if it is indicated in the test description. For most profile testing, draw at least two 8.5-mL gel-barrier tubes.
3. If pediatric tubes are used, be sure to collect an adequate volume of specimen to perform the test.
4. Provide patients with adequate containers and instructions for 24-hour urine and stool collections.
5. It is critical, especially for any specimen collection tube containing an additive, to allow the tube to fill to the "fill line" marked on the tube. This requirement is important in order to achieve the proper blood-to-additive ratio; otherwise, the specimen may be found to be QNS.

Preparing the Patient

Patient Instructions

It is important to gain the patient's understanding and cooperation in obtaining an acceptable specimen.

Patient States

Basal State. In general, specimens for determining the concentration of body constituents should be collected when the patient is in a basal state (ie, in the early morning after awakening and about 12 to 14 hours after the last ingestion of food). Reference intervals are most frequently based on specimens from this collection period.
The composition of blood is altered after meals by nutrients being absorbed into the bloodstream. Consequently, postprandial blood (blood drawn after a meal) is not suitable for some chemistry tests. An overnight fast is preferable (from 6 PM of the evening previous to collection) to ensure that the patient is in the basal state. This minimizes the effects of ingested substances on the test results. Before you collect
the specimen, ask the patient when he/she last ate or drank anything. If the patient has eaten recently and the physician wants the test to be performed anyway, you should indicate “nonfasting” on the test request form. In the clinical information/comments section of the test request form, indicate the time the patient ate. Fasting does not include abstaining from coffee, tea, or sugar-free liquids.

- **Exercise.** Moderate exercise can cause an increase in blood glucose, lactic acid, serum proteins, and creatine kinase (CK).
- **Emotional or Physical Stress.** The clinical status of the patient can cause variations in test results.
- **Time of Day of Collection.** Diurnal variations and variations in circadian rhythm can also affect test results. For example, growth hormone peaks in the morning before waking and decreases throughout the day. Serum iron levels may change as much as 30% to 50%, depending on individual variation, from morning until evening.

Note: For chemistry profiles, 12- to 14-hour fasting specimens are recommended.

Timed Specimens

There are two types of timed blood specimens: One is for a single blood specimen ordered to be drawn at a specific time. The other is for a test that may require multiple blood specimens to be collected at several specific times.

Single Specimens. Here are some instances in which timed single specimens may be required.

- Fasting plasma glucose alone or in conjunction with a random glucose determination, as recommended by the American Diabetes Association, to diagnose diabetes. Fasting here is defined as no caloric intake for at least eight hours.
- Postprandial glucose may be performed two hours after a meal for a timed test that is helpful in diabetes detection.
- Blood glucose determinations may be ordered at a specific time to check the effect of insulin treatment.
- Blood cultures may be ordered for a specific time if a bloodstream bacterial infection is suspected.
- Therapeutic monitoring of patients on medication.

Multiple Specimens. Here are some instances in which timed multiple specimen tests may be ordered

- The most common timed procedure is a glucose tolerance test. First, a blood specimen is drawn from a fasting patient. Then, the patient is given glucose orally and blood specimens are drawn at fixed intervals. **Note**: The American Diabetes Association and the World Health

Organization (WHO) have specific recommendations for glucose tolerance testing.

- To test the effect of a certain medication, a physician may order the same test to be obtained on consecutive days, before, during, and after the patient has received a medication.

1. Only one test request form accompanies the serial samples, and it is completed with all patient information, including any medications administered and the number of samples sent.
2. The test request form and all specimens are sent in one container (box or plastic specimen transport bag).

Interference of Medications and Other Substances

medications can interfere with chemical determinations or alter levels of substances measured. Drug interference is complicated and often method-dependent such that only general recommendations can be stated here. Precautions to be observed must be determined by the physician, and the patient must then be told to avoid specified medications for the necessary periods of time prior to specimen collection.
If the patient cannot be taken off the medication in question, its presence should be noted on the test request form.

CARBOHYDRATES

Carbohydrates

- Most common nutrient on earth
- Supplies body with energy
- 3 Types of Carbohydrates:
  - Sugars, starches, fibers
- Major food sources: plants
  - Formed during photosynthesis

Carbohydrates

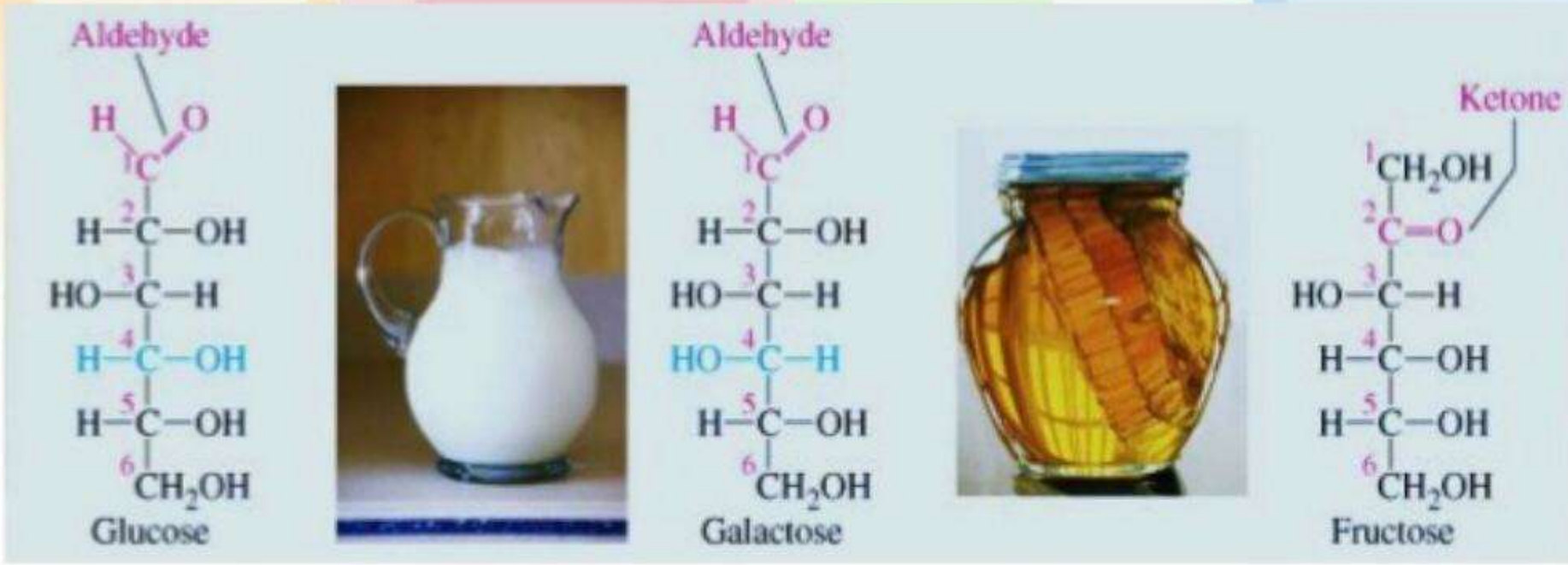
Carbohydrates are broadly defined as polyhydroxy aldehydes or ketones and their derivatives or as substances that yields one of these compounds

- Composed of carbon, hydrogen, and oxygen
- Functional groups present include hydroxyl groups
- -ose indicates sugar

Carbohydrates contained in foods such as pasta and bread provide energy for the body.

Function of Carbohydrates in Cells

- ✓ Major source of energy for the cell
- ✓ Major structural component of plant cell
- ✓ Immediate energy in the form of GLUCOSE
- ✓ Reserve or stored energy in the form of GLYCOGEN



CLASSIFICATION OF CARBOHYDRATES

- **Simple Sugars**
  - Monosaccharides
  - Disaccharides
- **Complex Carbohydrates**
  - Starch
  - Glycogen
  - Cellulose (a form of fiber)

- Another type of classification scheme is based on the hydrolysis of certain carbohydrates to simpler carbohydrates i.e. classifications based on number of sugar units in total chain.
- Monosaccharides: single sugar unit
- Disaccharides: two sugar units
- Oligosaccharides: 3 to 10 sugar units
- Polysaccharides: more than 10 units

Monosaccharides: The Single Sugars

- **Monosaccharides: single sugar units**
  - **Glucose**
    - Found in fruits, vegetables, honey
    - "blood sugar"—used for energy
  - **Fructose**
    - "Fruit sugar"
    - Found in fruits, honey, corn syrup
  - **Galactose**
    - Found as part of lactose in milk

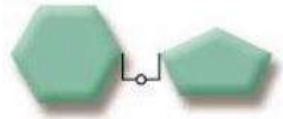
Glucose

Fructose

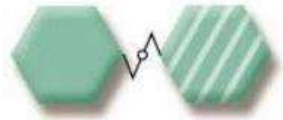
Galactose

Disaccharides: The Double Sugars

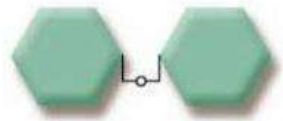
- **Disaccharides: two linked sugar units**
  - **Sucrose:** glucose + fructose
    - "Table sugar"
    - Made from sugar cane and sugar beets
  - **Lactose:** glucose + galactose
    - "Milk sugar"
    - Found in milk and dairy products
  - **Maltose:** glucose + glucose
    - Found in germinating cereal grains
    - Product of starch breakdown



Sucrose



Lactose



Maltose

The Biochemistry of Water

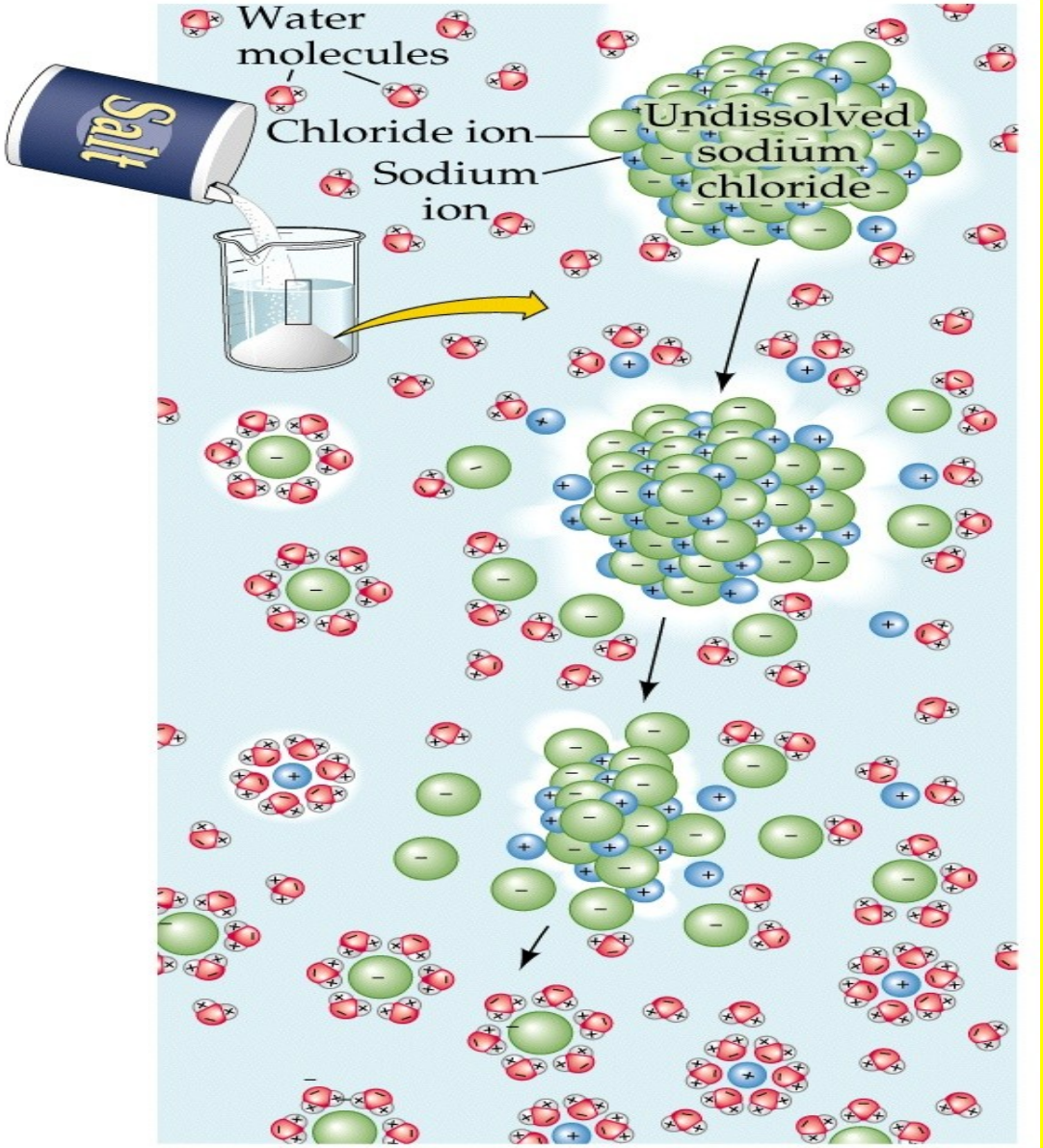
The Biochemistry of Water

- **2.3 Water, pH, and Buffers**
- Water is the solvent of life
- All organisms are composed primarily of water, such that most eukaryotic organisms are about 90 percent water while prokaryotes are about 70 percent water. No organism, not even the prokaryotes, can develop and grow without water.
- **All chemical reactions in organisms occur in liquid water**.
- Being polar, water has unique properties. These include its role as a solvent, as a chemical reactant, and as a factor to maintain a fairly constant temperature.

- **Water Has Several Unique Properties**
- **Liquid water is the medium in which all cellular chemical reactions occur.**
- **Being polar, water molecules are attracted to other polar molecules and act as the universal solvent in cells.**

- **Take for example what happens when you put a solute like salt in water.**
- **The solute dissolves into separate sodium and chloride ions because water molecules break the weak ionic bonds and surround each ion in a sphere of water molecules.**
- **An aqueous solution, which consists of solutes in water, is essential for chemical reactions to occur**

- **Water molecules also are reactants in many chemical reactions. The example of the hydrolysis reaction shown at the top of this page involved water in splitting maltose into separate molecules of glucose and glucose.**
- **As you have learned, the polar nature of water molecules leads to hydrogen bonding.**
- **By forming a large number of hydrogen bonds between water molecules, it takes a large amount of heat energy to increase the temper-ature of water.**
- **Likewise, a large amount of heat must be lost before water decreases tem-perature.**
- **So, by being 70 to 90 percent water, cells are bathed in a solvent that maintains a more consistent temperature change.**



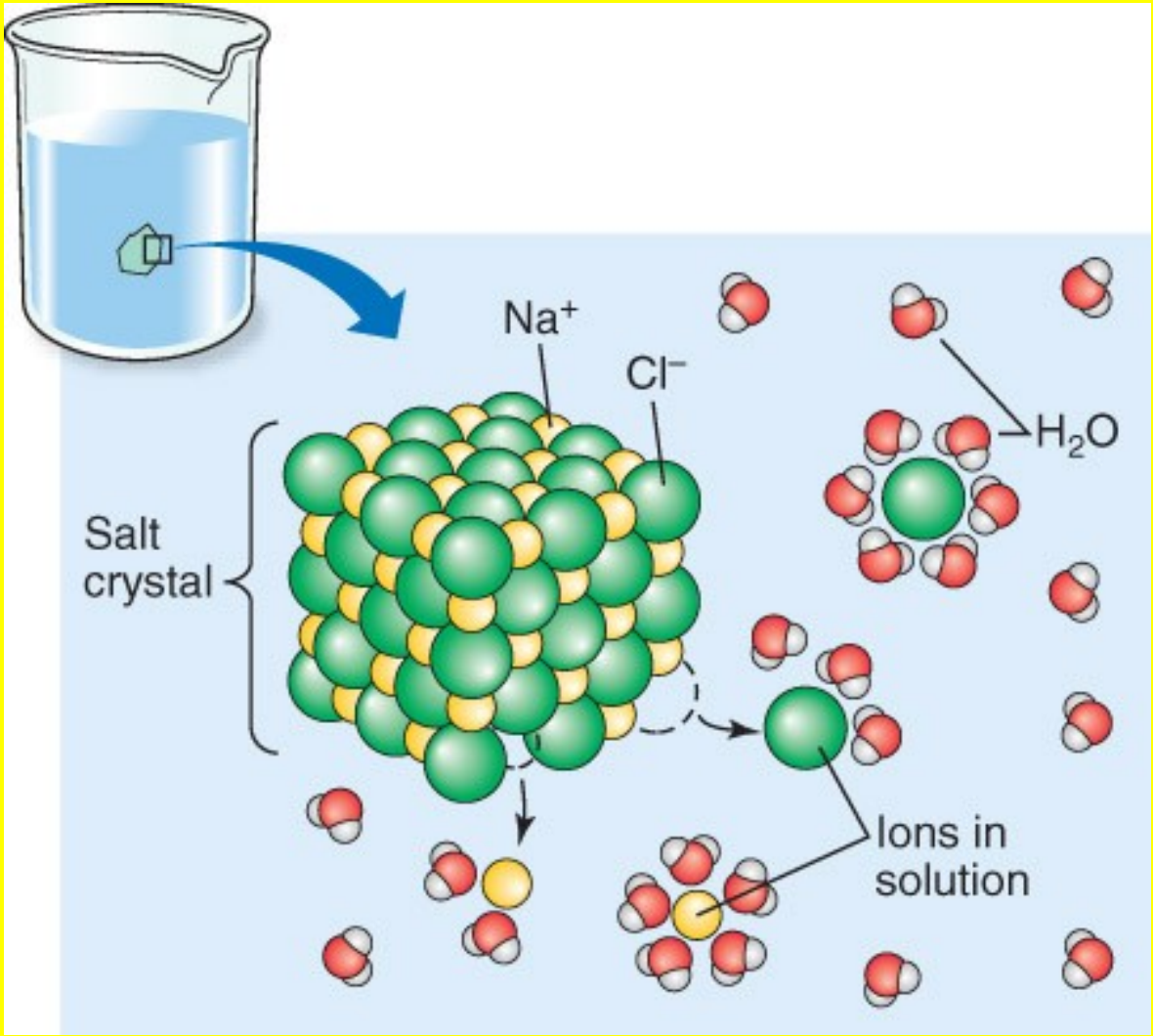
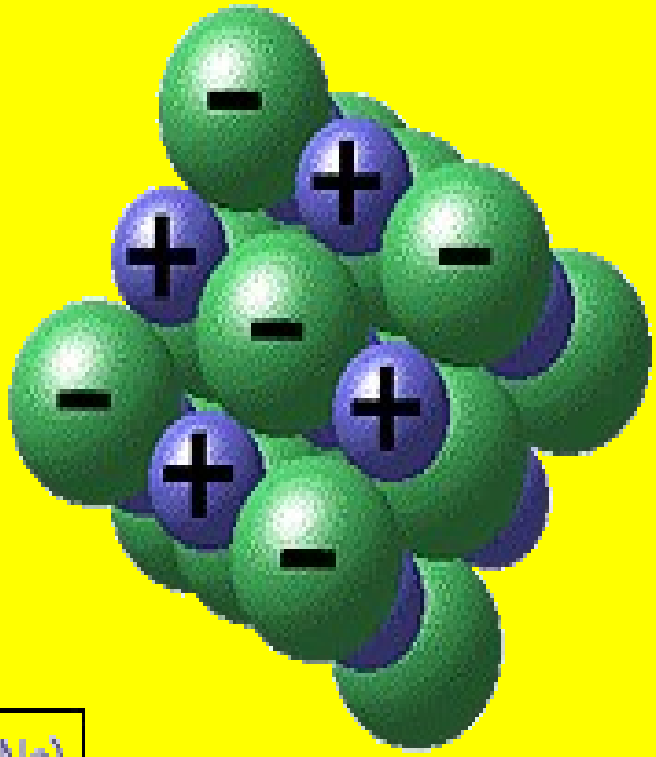


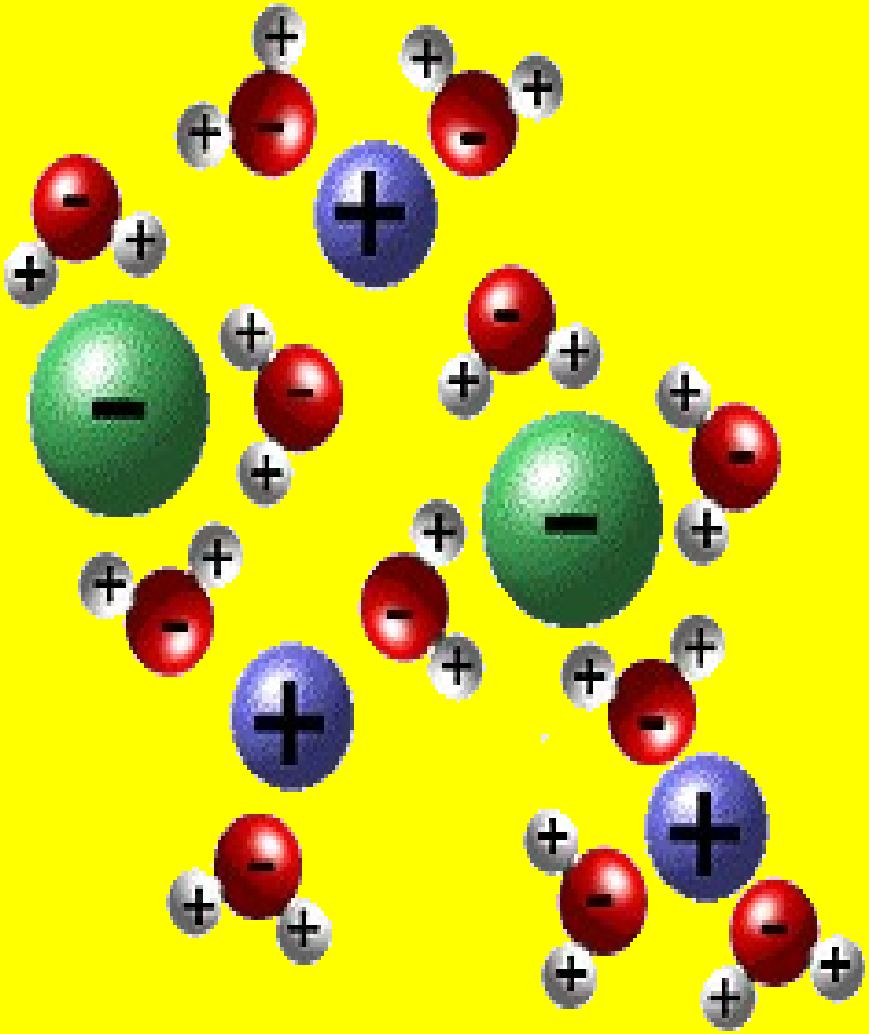
Figure 02.06: Solutes dissolve in water

Dissolution of NaCl in H_2O

NaCl crystal structure



NaCl in water

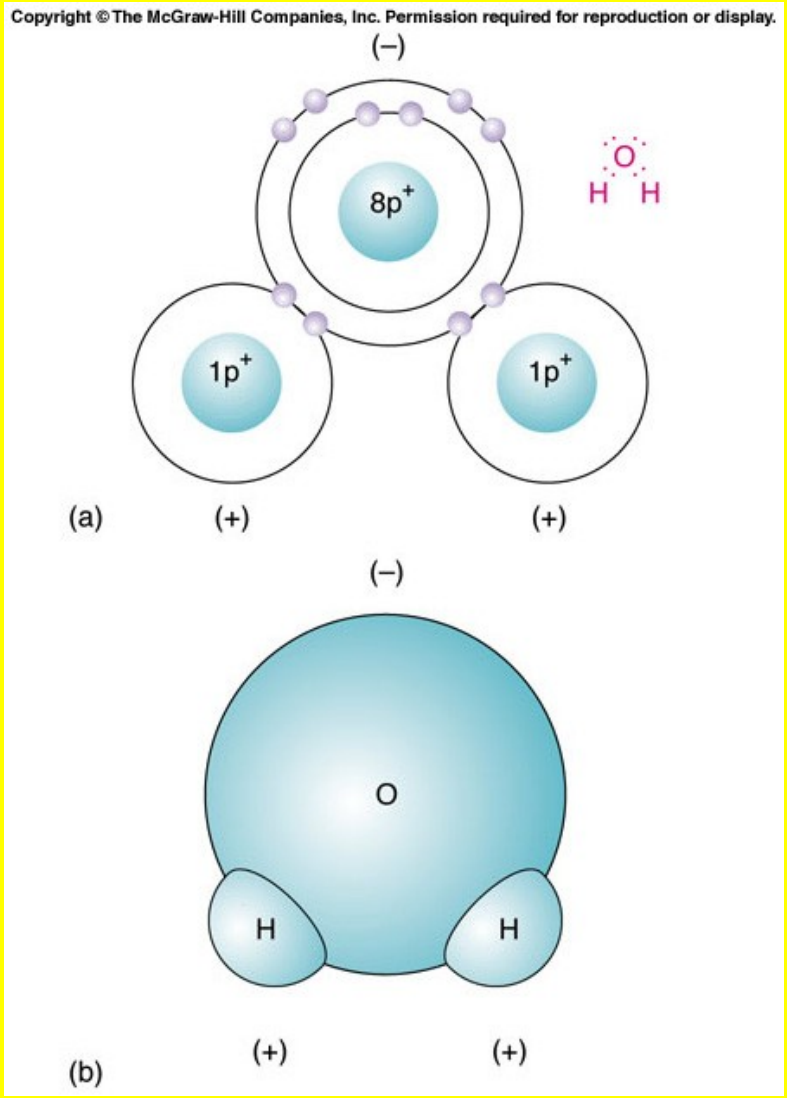


sodium (Na)
chlorine (Cl)

Water

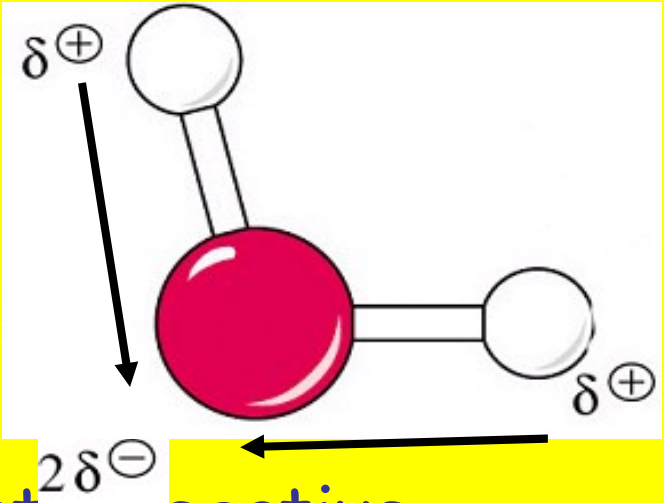
- Water **contains polar covalent bonds because oxygen and hydrogen do not share electrons equally**
- Oxygen exerts a greater pull on the electrons and gains a negative charge
- Hydrogen as a result has a positive charge
- As a result – the water molecule has a positive end (the hydrogen atoms)
- **The oxygen is slightly negative**
- **This forms a dipole – a polar covalent molecule**

H_2O – a polar molecule



Properties of water

- Very polar



- Oxygen is highly electronegative
- H-bond donor and acceptor
- High b.p., m.p., heat of vaporization, surface tension

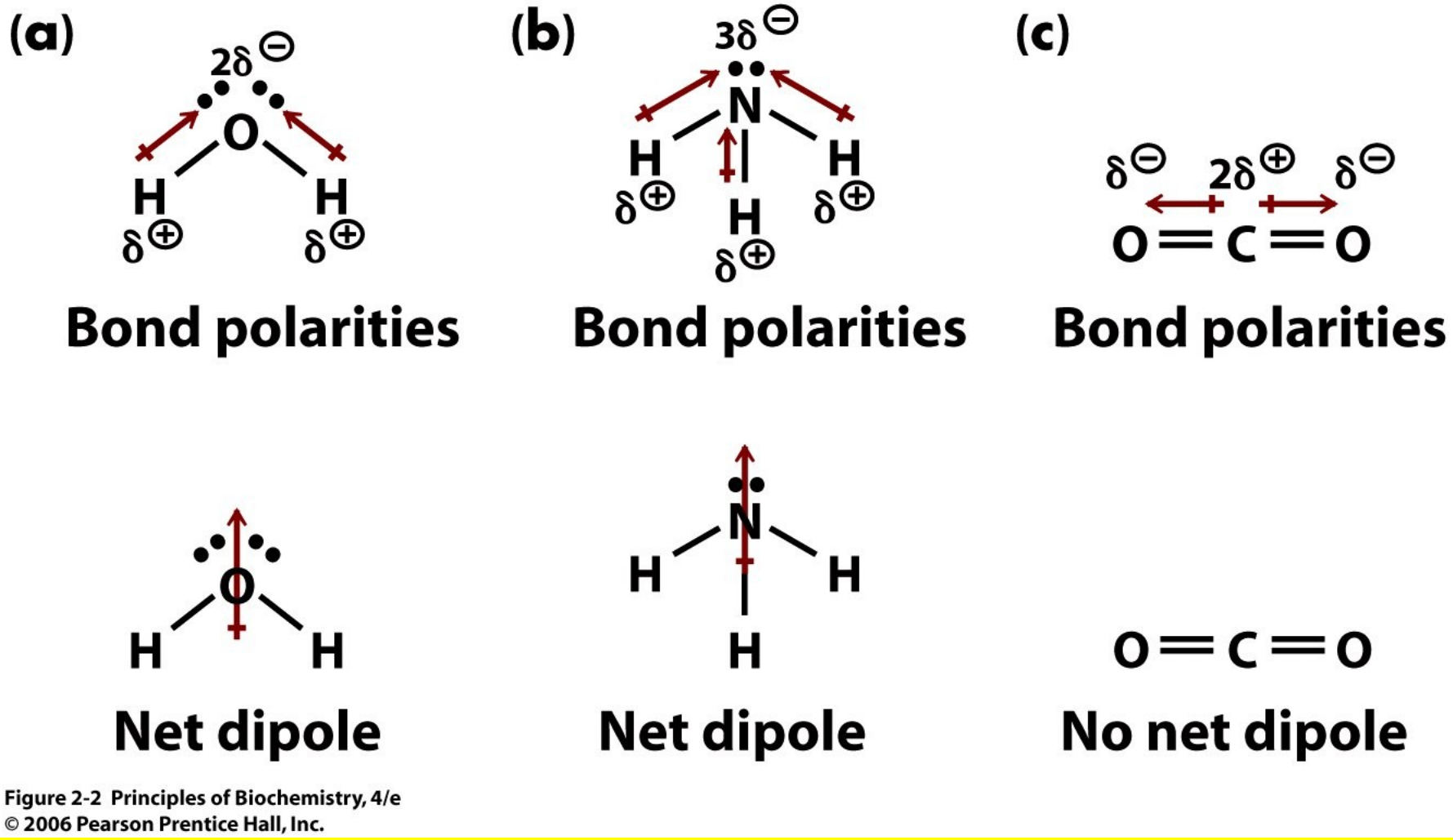


Figure 2-2 Principles of Biochemistry, 4/e

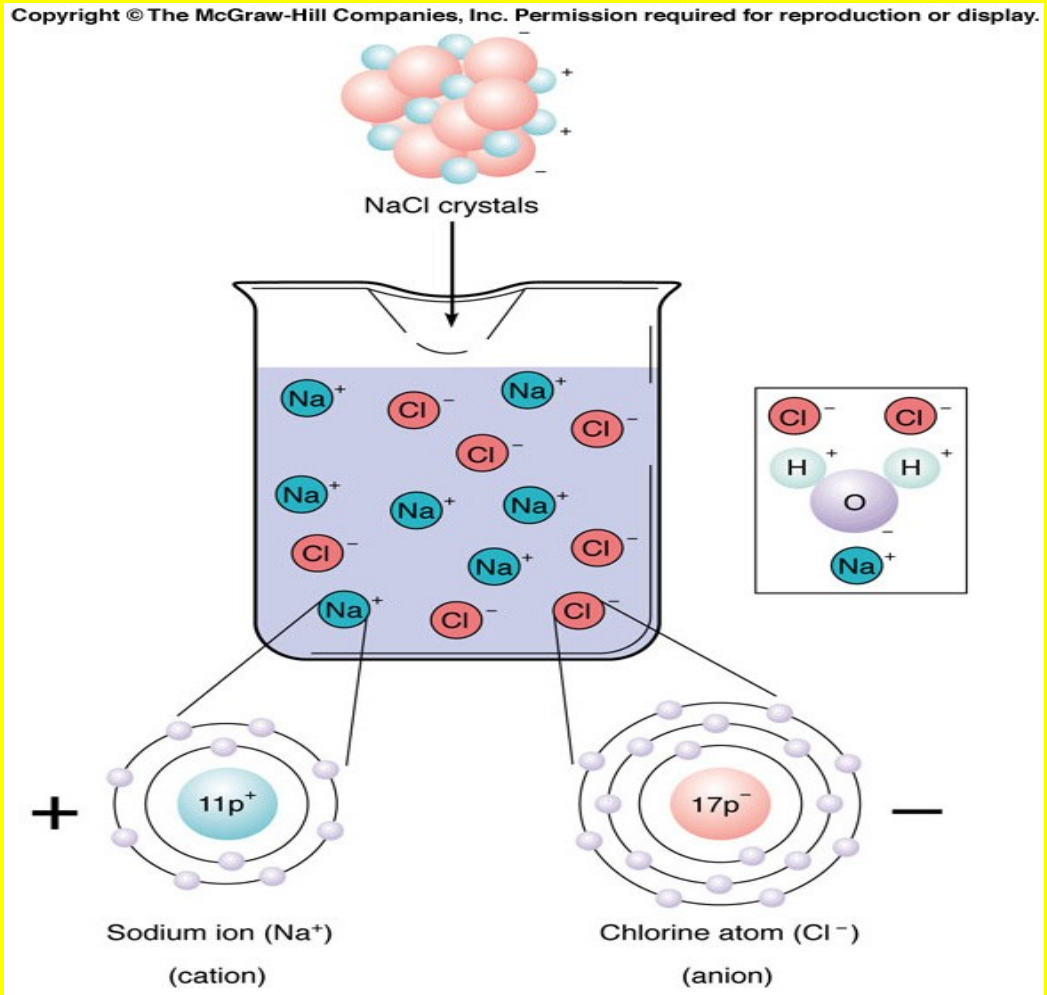
- **Properties of Water**
- Water Has Several Unique Properties
- **Water exists in three states (Liquid** – aquatic environment outside us and inside us), solid (ice) and gas (steam)
- **1. Surface Tension-** cell membranes moist, protection.
- Ex. Capillary action in plant roots, attraction to glass-meniscus.
- **2. Cohesion-** water molecules stick to each other held together by H-bonds.
- **3. Adhesion-** water molecules stick to unlike surfaces such as glass or plastic due to H-bonds between water and other polar compounds.
- **4. High Specific Heat-** water can absorb **or** release large amounts of heat energy with little temp change. E.g. Water stabilizes temp. in cells and ecosystems.

- **5. _High Heat of Vaporization-** many H-bonds must be broken before water can evaporate.
- **6. _Lower Density of Ice-** water molecules in an ice crystal are further apart because of H-bonding.
- **7 Water is Polar-** a good solvent; surrounds ions and other polar molecules. E.g.Transport of nutrients in organisms- plasma, cytoplasm, and xylem.
- **8 Medium for Chemical Reactions-** hydration/dehydration reactions.

Water as the universal solvent

- Most biological activities occur in **aqueous (water-based) solutions.**
- Water is able to dissolve small non polar covalent molecules, ionic compounds, and other polar covalent molecules
- **Water soluble molecules are described as hydrophilic (**water loving)**. Hydrophilic** molecules dissolve in water.
- **Those molecules that are not soluble in water are hydrophobic (**water hating or fearing)**. Hydrophobic** molecules – repel water.
- **Amphipathic** molecules -have both hydrophilic and hydrophobic properties

Solution – a mixture of one or more substances called **solutes**, dispersed in a dissolving medium called a **solvent**

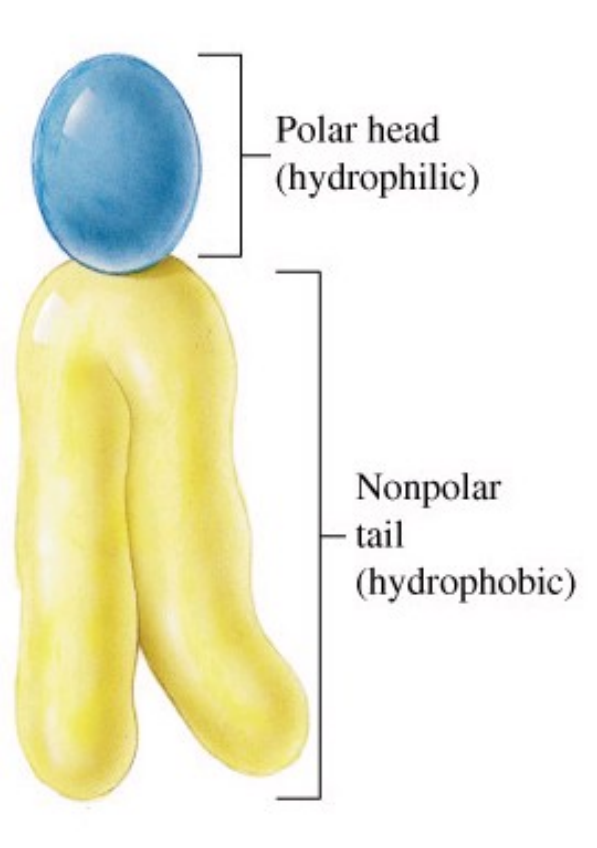


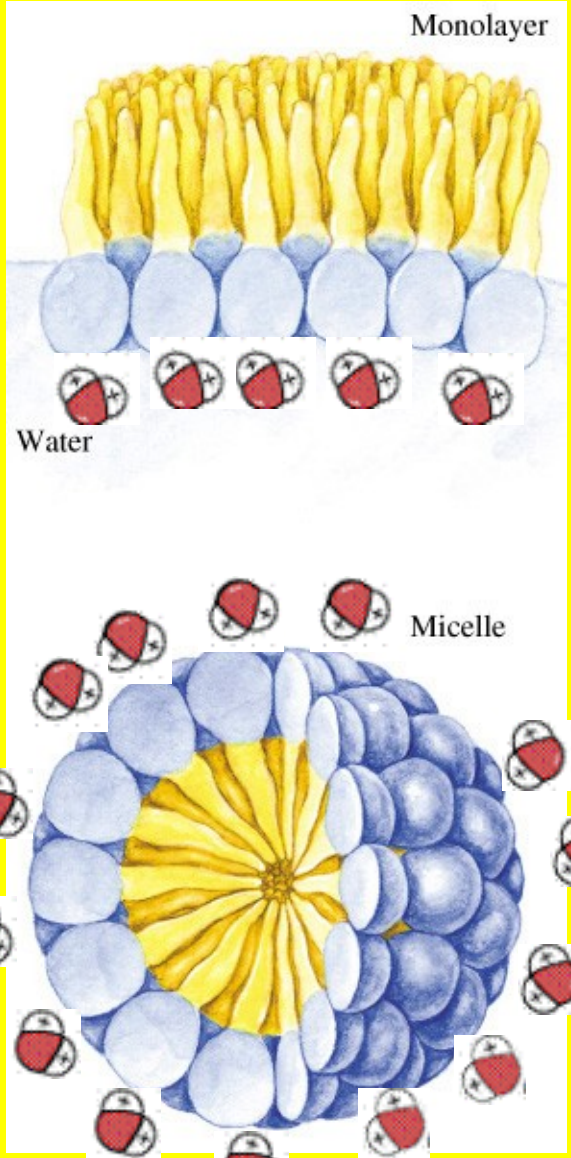
Solutes – Na^+ & Cl^-

Solvent – H_2O

Non-polar substances are insoluble in water

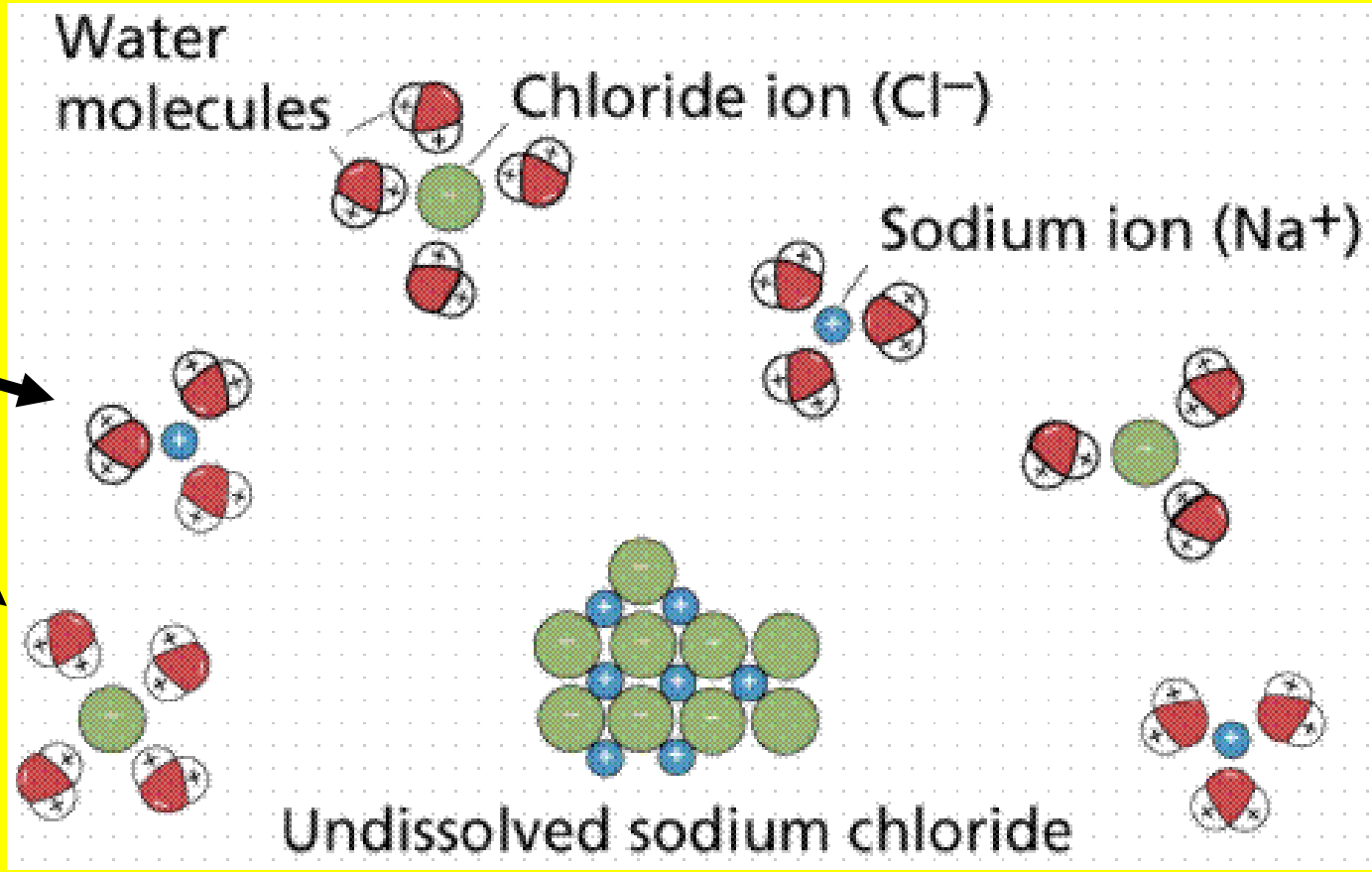
Many lipids are amphipathic

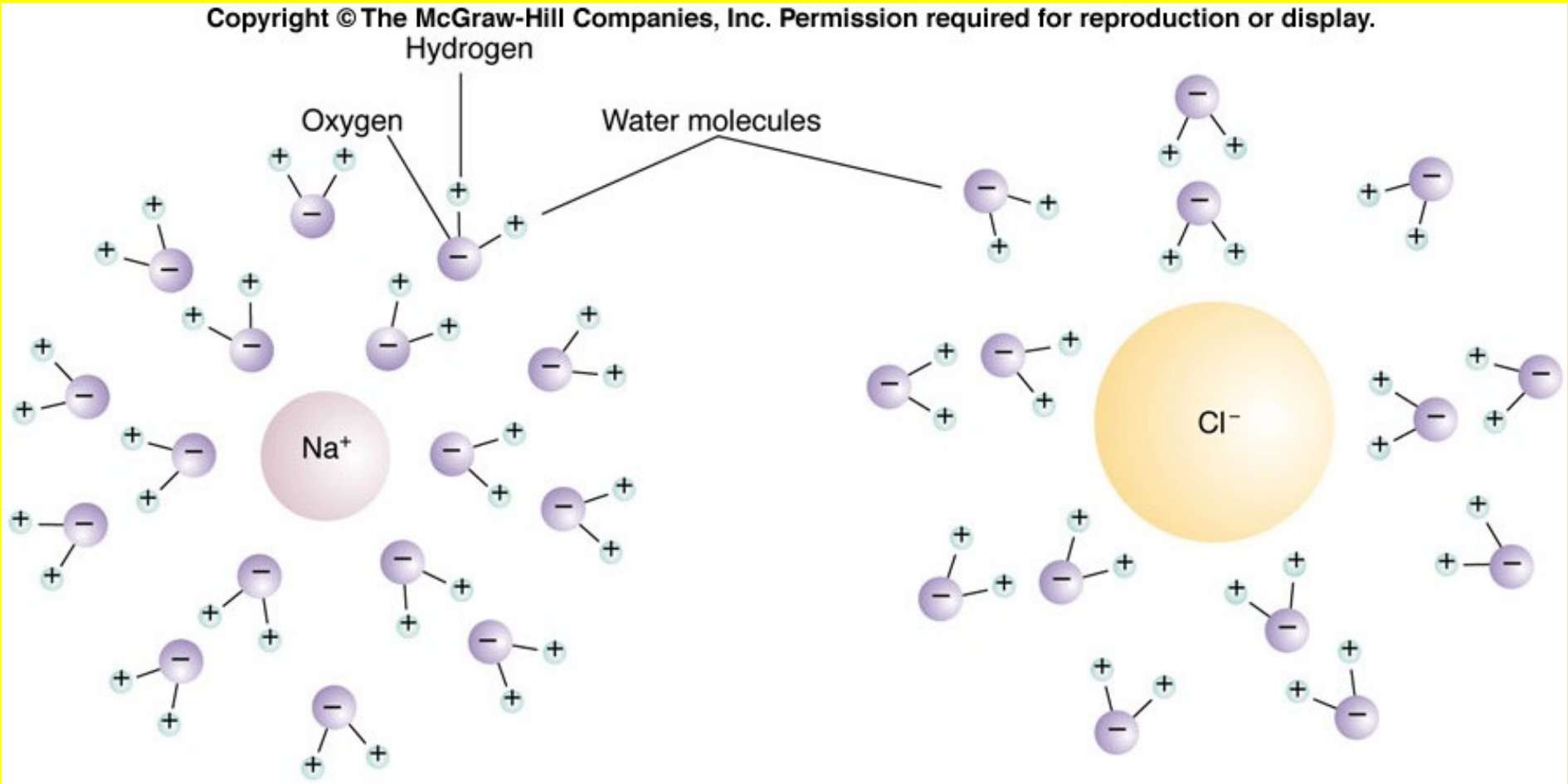




Water dissolves polar compounds

solvation shell
or
hydration shell





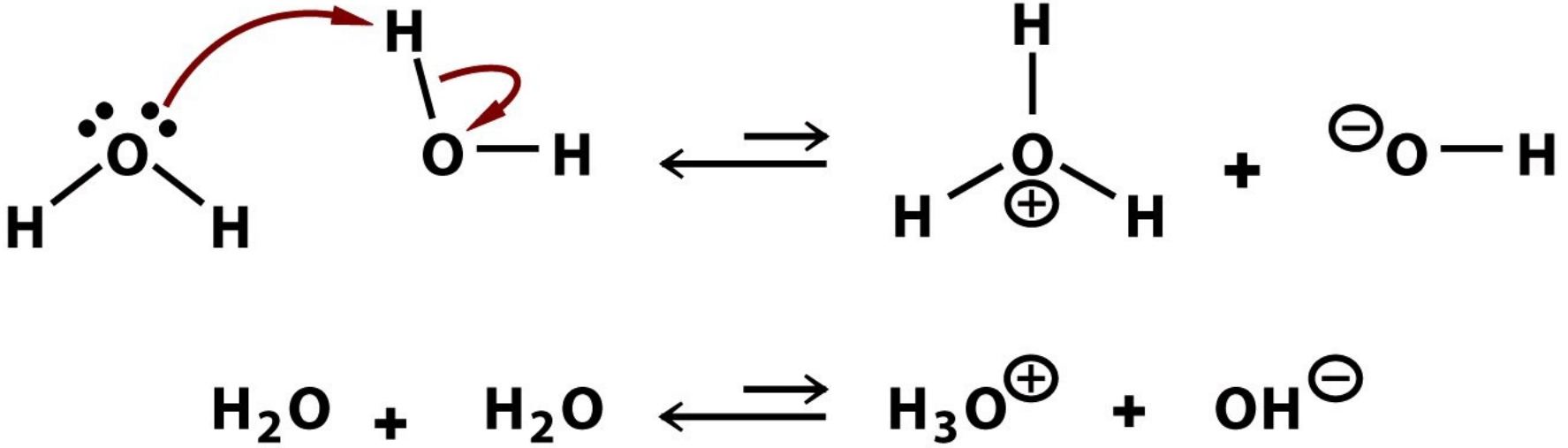
Solvation and Hydration shells

- Depending on the pH of a solution, macromolecules such as proteins which contain many charged groups, will carry substantial net charge, either positive or negative.
- Cells of the body and blood contain many polyelectrolytes (molecules that contain multiple same charges, e.g. DNA and RNA) and polyampholytes that are in close proximity.
- The close association allows these molecules to interact through opposing charged groups.

- The presence, in cells and blood, of numerous small charged ions (e.g. Na^{+}, Cl^{-}, Mg^{2+}, Mn^{2+}, K^{+}) leads to the interaction of many small ions with the larger macroions.
- This interaction can result in a shielding of the electrostatic charges of like-charged molecules.

- This electrostatic shielding allows macroions to become more closely associated than predicted based upon their expected charge repulsion from one another.
- The net effect of the presence of small ions is to maintain the solubility of macromolecules at pH ranges near their pI.
- This interaction between solute (e.g. proteins, DNA, RNA, etc.) and solvent (e.g. blood) is termed solvation or hydration.
- The opposite effect to solvation occurs when the salt (small ion) concentration increases to such a level as to interfere with the solvation of proteins by H_2O. This results from the H_2O forming hydration shells around the small ions.

Ionization of Water



$$H_2O + H_2O \rightleftharpoons H_3O^{\oplus} + OH^{\ominus}$$

Unnumbered figure pg 38 Principles of Biochemistry, 4/e

Ionization of Water

$$H_2O + H_2O \rightleftharpoons H_3O^+ + OH^-$$

$$H_2O \rightleftharpoons H^+ + OH^-$$

$$K_{eq} = \frac{[H^+][OH^-]}{[H_2O]}$$

$K_{eq} = 1.8 \times 10^{-16} M$

$[H_2O] = 55.5\ M$

$$[H_2O]\,K_{eq} = [H^+][OH^-]$$

$$(1.8 \times 10^{-16} M)(55.5\ M) = [H^+][OH^-]$$

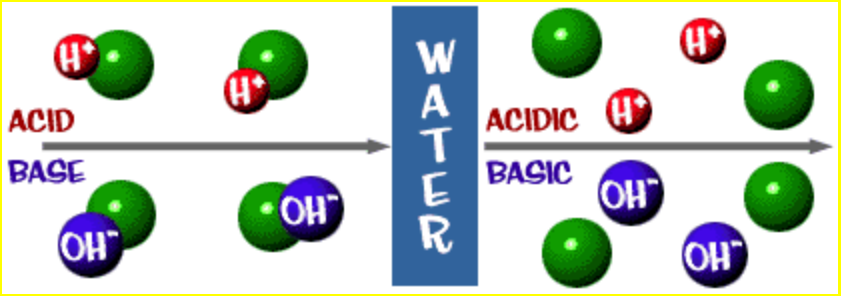
$$1.0 \times 10^{-14}\ M^2 = [H^+][OH^-] = K_w$$

If $[H^+]=[OH^-]$ then $[H^+] = 1.0 \times 10^{-7}$

- Ionization of H_2O releases hydrogen ions [H^+] & hydroxyl ions [OH^-]
- pH scale – ranges from 0 to 14, expresses the concentration of H^+ ions
  - pH is the negative logarithm of the concentration of H+ ions.
- pH 6 = 0.000001 moles H^+/ l
- pH 9 = 0.000000001 moles H^+/ l

Water and hydrogen ions

- http://www.biology.arizona.edu/biochemistry/p



- **Acids and Bases Must Be Balanced in Cells**
- **Cell chemistry is sensitive to pH changes**
- An acid is a chemical substance that donates a H+ to a solution; a base accepts the H+
- Acids donate hydrogen ions to a solution while bases remove hydrogen ions from a solution.
- The pH scale indicates the number of hydrogen ions in a solution and denotes the relative acidity of a solution.

- **Acids and Bases Must Be Balanced in Cells**
- **KEY CONCEPT Cell chemistry is sensitive to pH changes.**
- In an aqueous solution, **most of the water molecules remain intact, but some can dissociate into hydrogen ions (H+) and (OH-) only to rapidly recombine in a reversible reaction** represented thus:
- H2O <=> H+ + OH-
- For the chemical reactions in all cells to work properly, there must be a correct balance of H+ and OH-
- Besides water, other compounds in cells can release H+ or OH- and affect cell function

- For our purposes, an acid is a chemical that donates H+ to water or another solution.
- By contrast, a base (or alkali) is a substance that accepts hydrogen ions in solution, often by combining them with the hydroxyls of the base.

- Acids are distinguished by their sour taste. Some common examples are acetic acid in vinegar, citric acid in citrus fruits, and lactic acid in sour milk products.
- **Strong acids can donate large numbers of hydrogen ions to a solution.** Hydrochloric acid (HC1), sulfuric acid (H2SO4), and nitric acid (HNO3) are examples.
- Weak acids, typified by carbonic acid (HaCO3), donate a smaller number of hydrogen ions.
- Bases have a bitter taste. Strong bases take up numerous hydrogen ions from a solution leaving the solution with an excess of hydroxyl ions. Potassium hydroxide (KOH), a material used to make soap, is among them.
- Acids and bases frequently react with each other because of their opposing chemical characteristics. An exchange reaction involving hydrochloric acid (HCl) and sodium hydroxide (NaOH) is one example:
- HCl + NaOH -» NaCl + H2O

- To indicate the degree to which a solution is acidic, the Danish chemist Soren P. L. Sorensen introduced the symbol pH (potential hydrogen) and the pH scale.
- The scale extends from 0 (extremely acidic; high H+) to 14 (extremely basic; low H+) and is based on actual calculations of the number of hydrogen ions present when a substance mixes with water.
- Realize that **every time the pH changes by one unit, the hydrogen ion concentration changes 10 times**.
- A substance with a pH of 7,such as pure water, is said to be neutral; it is
- neither acidic nor basic because it has equal numbers of H+ and OH-.
- Figure 2”7 summarizes the pH values of several common substances.
- The greatest diversity of microorganisms occurs in environments where the pH is near neutral, although there are some spectacular exceptions
- In fact, the acidic soils of the Amazon rain forest contain less than half as many bacterial species as do the neutral soils of the deserts in the American Southwest.

- Acids and Bases Must Be Balanced in Cells
  - An acid is a chemical substance that donates a H+ to a solution; a base accepts the H+
  - The pH scale indicates the acidity or alkalinity of a solution
  - Cell chemistry is very sensitive to changes in pH

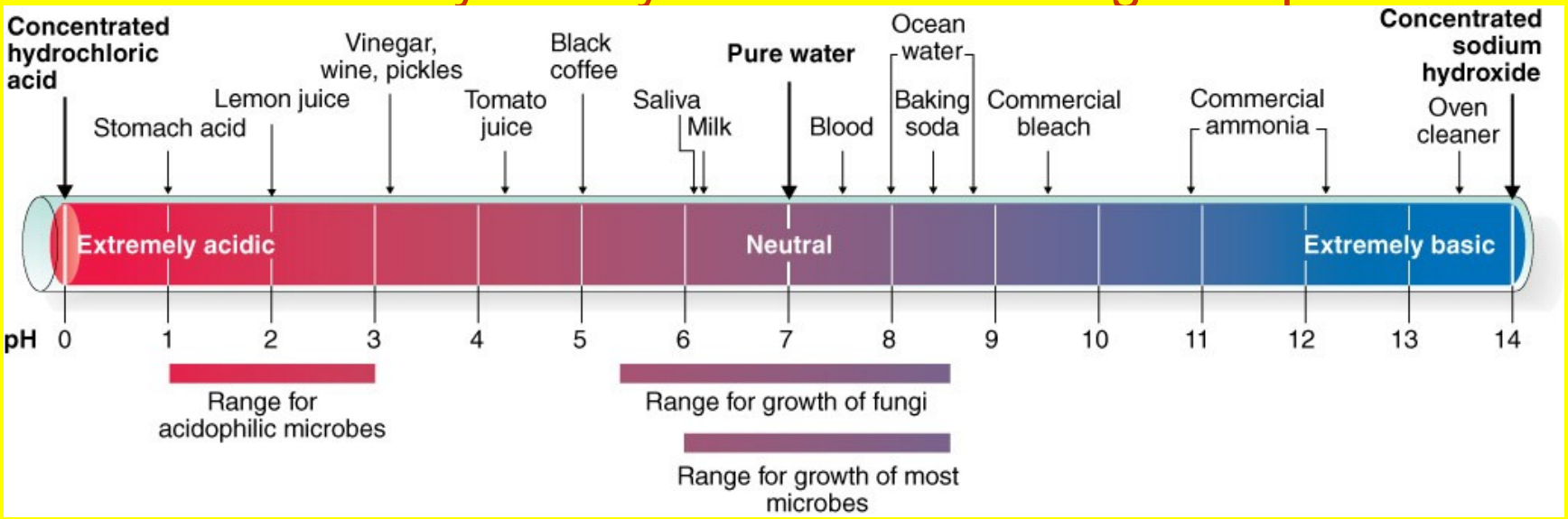


Figure 2.7, page 51

Acid and Base

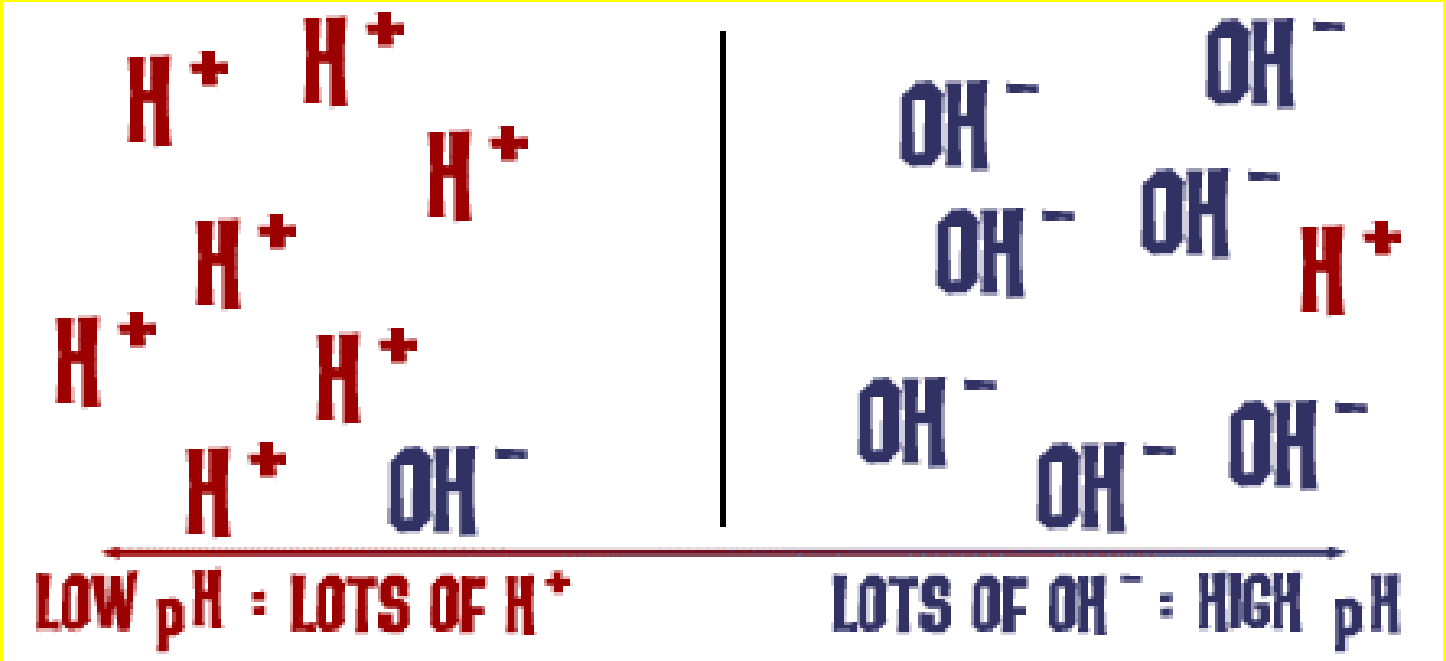
- Acids are hydrogen donors or proton donors

COOH $\rightarrow$ COO- + H+

- Bases are ~~hydro~~gen acceptors or proton acceptors

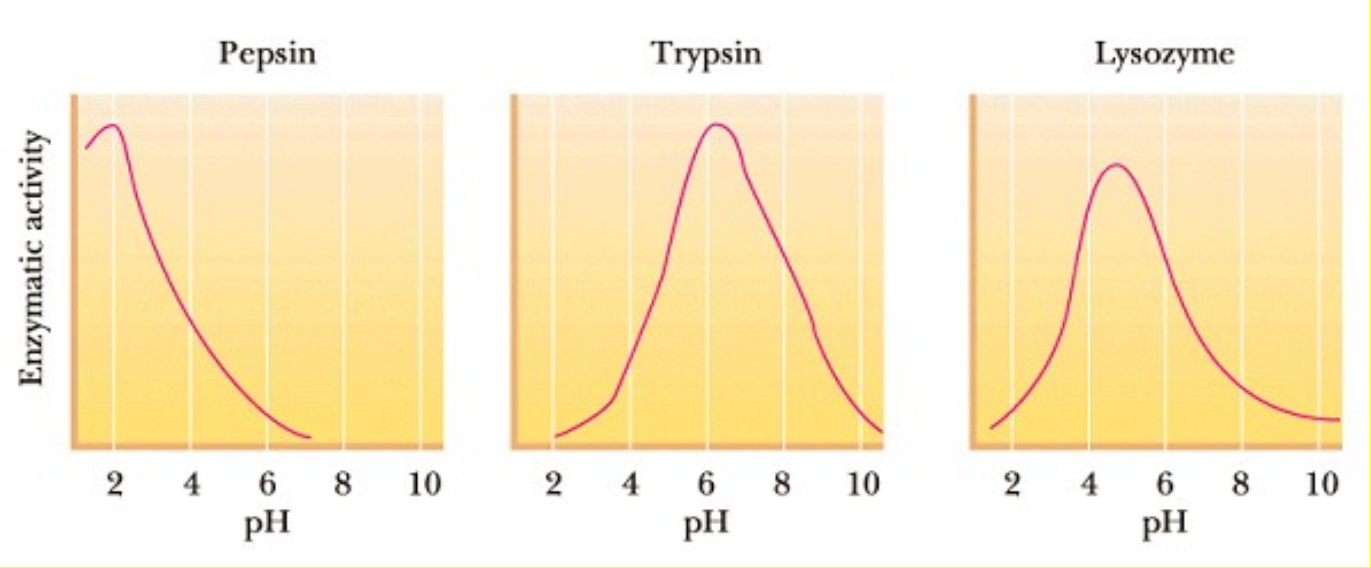
NH2 $\rightarrow$ NH3+

Acids and Bases



Weak Acids and Bases Equilibria

- **Strong acids / bases** – disassociate completely
- **Weak acids / bases** – disassociate only partially
- Enzyme activity sensitive to pH
- weak acid/bases play important role in protein structure/function



Acid/conjugate base pairs

$$HA + H_2O \rightleftharpoons A^- + H_3O^+$$

$$HA \rightleftharpoons A^- + H^+$$

HA = acid (donates H^+)(Bronstad Acid)

A^- = Conjugate base (accepts H^+)(Bronstad Base)

$$K_a = \frac{[H^+][A^-]}{[HA]}$$

K_a & pK_a value describe tendency to loose H^+

large K_a = stronger acid

small K_a = weaker acid

$$pK_a = - \log K_a$$

Carboxylic acids
(Organic acids)

- The acidic functional group in organic acids is the carboxl group
- The carboxyl group is a proton donor
- COOH ⟶ COO- in water solution

Organic bases

- Proton acceptors – gain a hydrogen and become positively charged in water solution
- The amino group - NH_2 becomes NH_3^+

pH

- The pH scale **indicates the acidity or alkalinity of a solution.**
- **Cell chemistry is very sensitive to changes in pH**

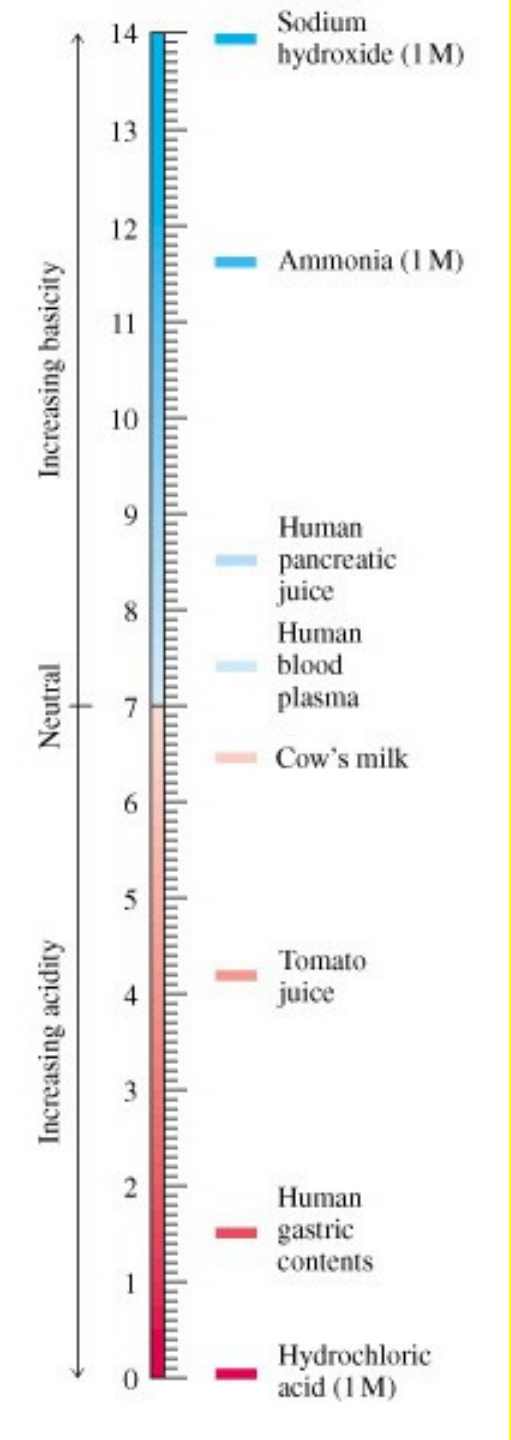
pH

- pH = **The concentration of H+ ions**
- **The negative logarithm of the hydrogen ion concentration in an aqueous solution**.

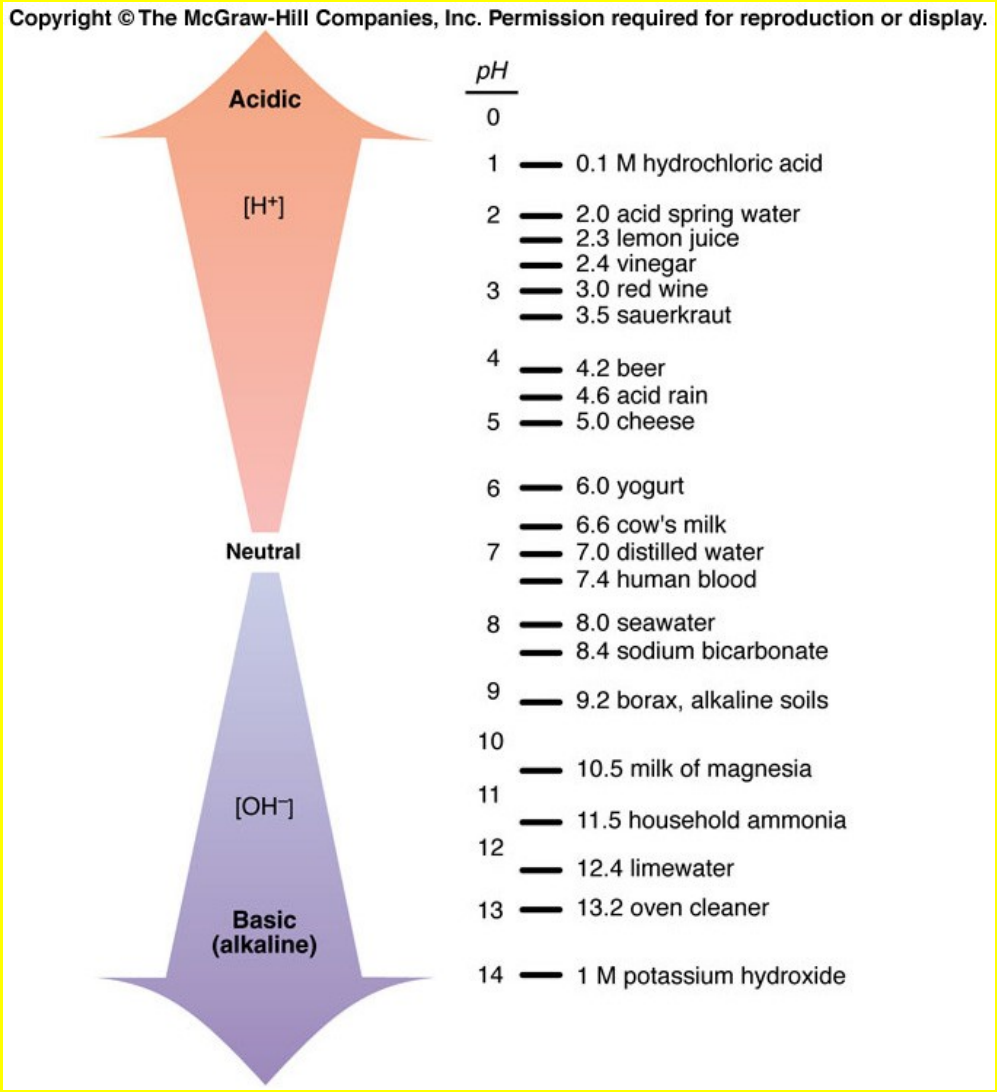
- pH = - log[H_30^+]

pH Scale

- Devised by Sorenson (1902)
- [H+] can range from 1M and 1×10^{-14}M
- using a log scale simplifies notation
- pH = -log [H^+]
- Neutral pH = 7.0



pH scale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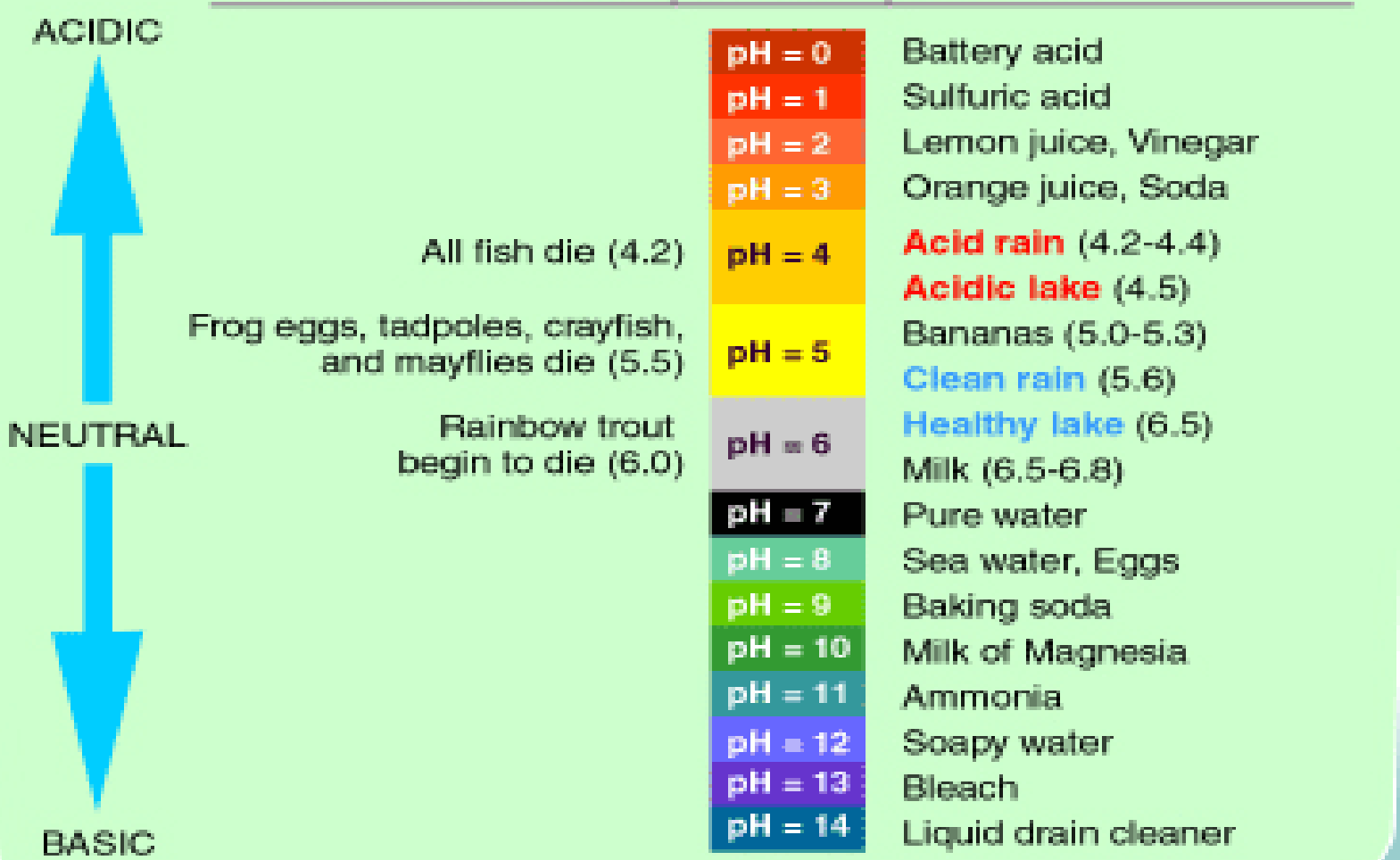
Acidic
[H+]
Neutral
[OH−]
Basic (alkaline)
pH
0
1 — 0.1 M hydrochloric acid
2 — 2.0 acid spring water
2.3 lemon juice
2.4 vinegar
3 — 3.0 red wine
3.5 sauerkraut
4 — 4.2 beer
4.6 acid rain
5 — 5.0 cheese
6 — 6.0 yogurt
6.6 cow's milk
7 — 7.0 distilled water
7.4 human blood
8 — 8.0 seawater
8.4 sodium bicarbonate
9 — 9.2 borax, alkaline soils
10
10.5 milk of magnesia
11
11.5 household ammonia
12
12.4 limewater
13 — 13.2 oven cleaner
14 — 1 M potassium hydroxide


Environmental Effects
pH Value
Examples
ACIDIC
NEUTRAL
BASIC
All fish die (4.2)
Frog eggs, tadpoles, crayfish, and mayflies die (5.5)
Rainbow trout begin to die (6.0)
pH = 0
pH = 1
pH = 2
pH = 3
pH = 4
pH = 5
pH = 6
pH = 7
pH = 8
pH = 9
pH = 10
pH = 11
pH = 12
pH = 13
pH = 14
Battery acid
Sulfuric acid
Lemon juice, Vinegar
Orange juice, Soda
Acid rain (4.2-4.4)
Acidic lake (4.5)
Bananas (5.0-5.3)
Clean rain (5.6)
Healthy lake (6.5)
Milk (6.5-6.8)
Pure water
Sea water, Eggs
Baking soda
Milk of Magnesia
Ammonia
Soapy water
Bleach
Liquid drain cleaner

- pH and measurement- pHydrion paper

- pH measurement – pH meter

Buffers

- **Buffers Are a Combination of a Weak Acid and Base**
- Buffers prevent pH shifts
- **Buffers are aqueous systems that resist changes in pH when small amounts of a strong acid or base are added.**
- **A buffered system consist of a weak acid and its conjugate base.**
- **The most effective buffering occurs at the region of minimum slope on a titration curve**

  (i.e. around the pKa).
- **Buffers are effective at pHs that are within +/-1 pH unit of the pKa**

- Buffers are a mixture of a weak acid and a weak base that maintain acid/base balance in cells. Excess hydrogen ions can be absorbed by the base and too few hydrogen ions can be provided by the acid.

- As microorganisms—and all organisms—take up or ingest nutrients and undergo metabolism, chemical reactions occur that use up or produce H+.
- It is important for all organisms to balance the acids and bases in their cells because chemical reactions and organic compounds are very sensitive to pH shifts.
- Proteins are especially vulnerable. If the internal cellular pH is not maintained, these proteins may be destroyed.
- Likewise, when most microbes grow in a microbiological nutrient medium, the waste products produced may lower the pH of the medium, which could kill the organisms.
- To prevent pH shifts, cells and the growth media contain **buffers,** which are compounds that maintain a specific pH. The buffer does not necessarily maintain a neutral pH, but rather whatever pH is required for that environment.
- Most biological buffers consist of a weak acid and a weak base
- If an excessive number of H+ are produced (potential pH drop), the base can absorb them. Alternatively, if there is a decrease in the hydrogen ion concentration (potential pH increase), the weak acid can dissociate, replacing the lost hydrogen ions.

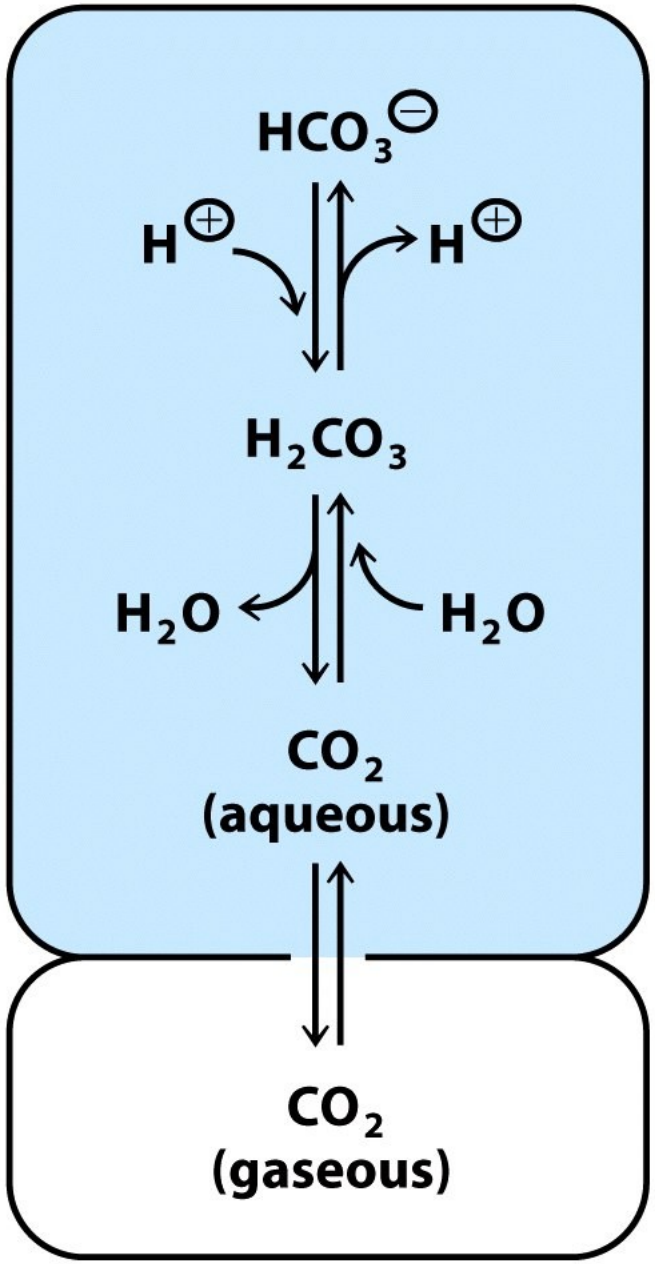
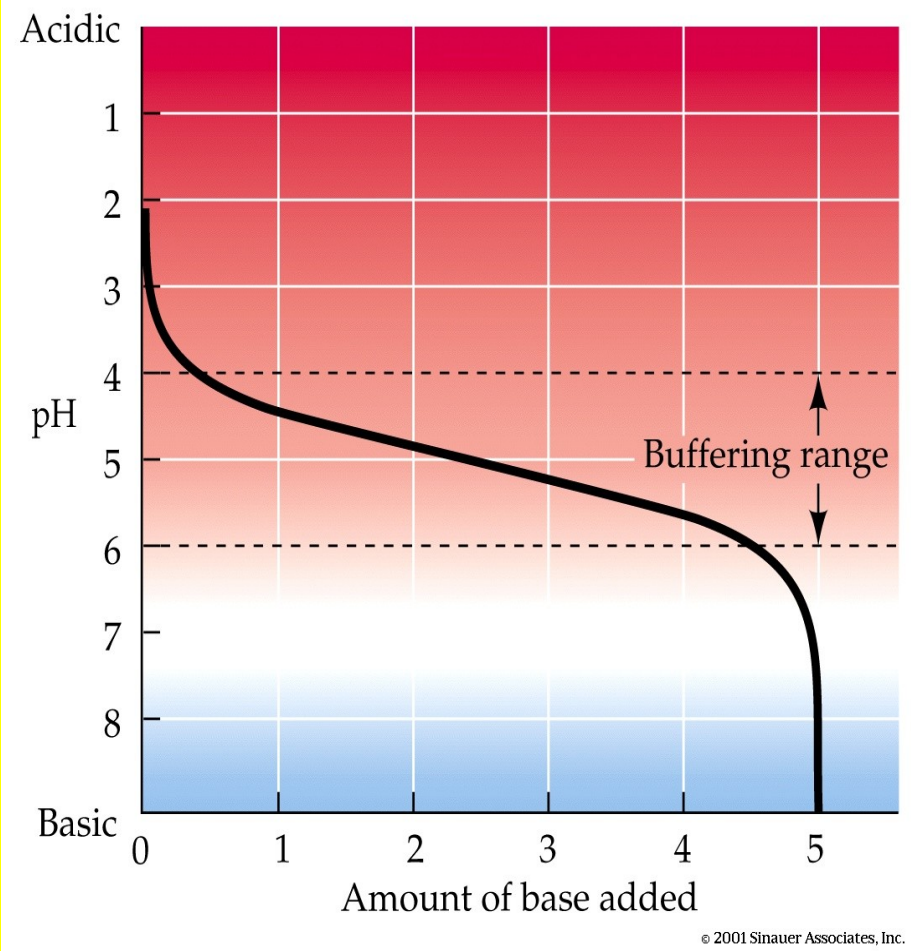


Figure 2-20 Principles of Biochemistry, 4/e

Buffering capacity



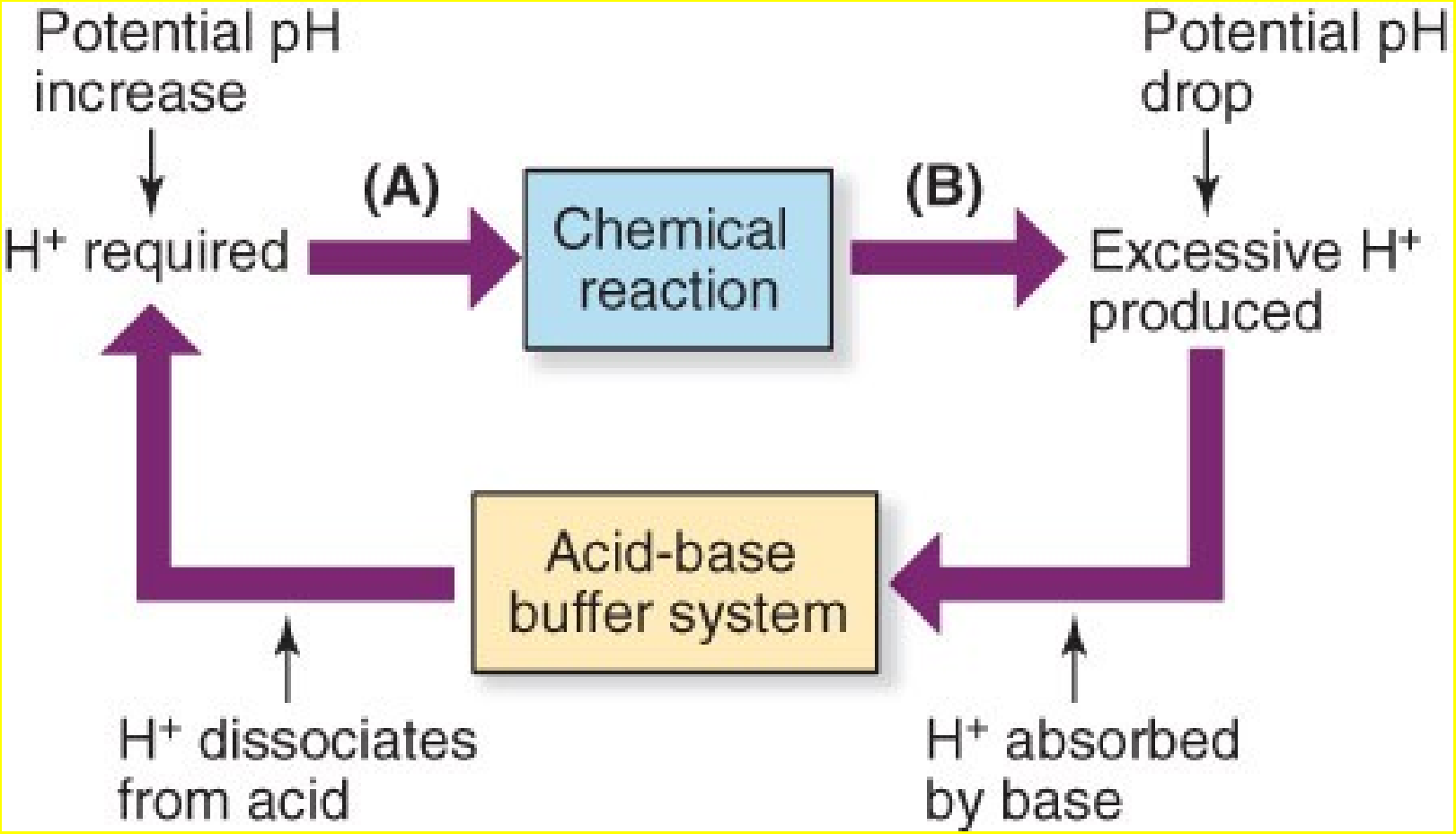


Figure 2.8, page 52

- Buffers Are a Combination of a Weak Acid and Base
  - Buffers prevent pH shifts

Where Are Proteoglycans Found?

Proteoglycans are one of the most important and critical polysaccharide components of the extracellular matrix. This remarkably diversified group of polysaccharides is found in the extracellular matrices, connective tissue, and cell surfaces.

The extracellular matrix of a cell is primarily made up of proteoglycans (which are GAG chains attached to proteins) and fibrous matrix proteins, such as collagen. Almost all living mammalian cells form proteoglycans that either become a part of the extracellular matrix or plasma membrane or secretory granules.

Since proteoglycans are an essential part of the extracellular matrix, they are part of the most abundant tissue in the body.

Proteoglycans and Glycoproteins

We know that proteoglycans are glycoproteins but let us understand how proteoglycans differ from glycoproteins. See Table 1.

Table 1: Glycoprotein vs proteoglycan

Glycoprotein	**Proteoglycan**
Define Glycoprotein: Any protein that is attached to a carbohydrate group or chain is referred to as a glycoprotein.	**Define Proteoglycan:** A core protein attached to glycosaminoglycan chains is referred to as a proteoglycan.
Chains attached to the protein core are short, branched with any charge	Long, linear, and negatively charged GAG chains are attached to the protein core
Primarily found on the cell membrane as transmembrane proteins	Primarily found in the extracellular matrix or plasma membranes of the cell
Involved in the cell recognition and cell signaling	Provides the structure to the cell and is involved in hydration and lubrication of the cell
Two types exist based upon protein interactions, i.e., *N-linked glycoproteins* and O-linked glycoproteins	Classified based upon the present GAG chains

Examples: collagen, mucin, etc	*Examples: heparin sulfate, chondroitin sulfate, etc.*

Data Source: Dr. Amita Joshi of Biology Online

Note it!

The size of proteoglycan may vary from 10 to 400 kDa.

Characteristics of Proteoglycans

A distinguishing characteristic of the proteoglycan from other glycoproteins is the attachment of the protein core through O-glycosidic bonds to GAG chains.

Proteoglycans are highly glycosylated large protein structures that are either found in the extracellular matrix or attached to the cellular surface.

Structure of Proteoglycans

Proteoglycans are highly glycosylated proteins. The basic chemical structure of the proteoglycans is a core protein unit attached to GAG chains (polysaccharides).

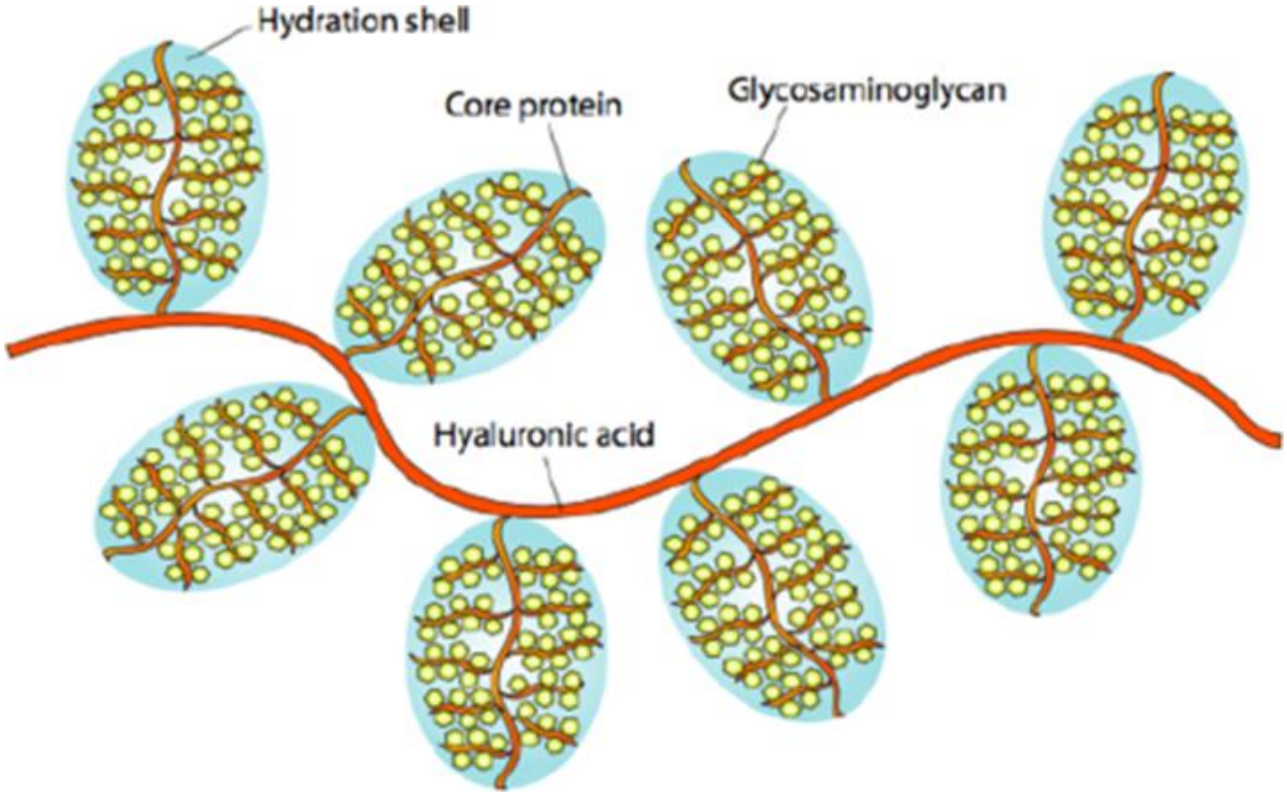


Figure 1: Basic proteoglycan structure. Image source: E. V. Wong.

Anticoagulants, commonly known as **blood thinners**, are chemical substances that prevent or reduce coagulation of blood, prolonging the clotting time. whereas anticoagulants inhibit specific pathways of the coagulation cascade.Common anticoagulants include warfarin and heparin.

Medical uses

The use of anticoagulants is a decision based upon the risks and benefits of anticoagulation.[14] The biggest risk of anticoagulation therapy is the increased risk of bleeding.

anticoagulation therapy can prevent formation of dangerous clots or prevent growth of clots.[30]

.

A number of anticoagulants are available. Warfarin, other coumarins, and heparins have long been used.[74] Since the 2000s

Coumarins (vitamin K antagonists

Further information: Vitamin K antagonist

These oral anticoagulants are derived from coumarin, which is found in many plants

Heparin

Heparin is the most widely used intravenous clinical anticoagulant worldwide.[82] Heparin is a naturally occurring glycosaminoglycan.

Laboratory use

Laboratory instruments, blood transfusion bags, and medical and surgical equipment will get clogged up and become non-operational if blood is allowed to clot. In addition, test tubes used for laboratory blood tests will have chemicals added to stop blood clotting. Apart from heparin, most of these chemicals work by binding calcium ions, preventing the coagulation proteins from using them.

- Ethylenediaminetetraacetic acid (EDTA) strongly and irreversibly chelates (binds) calcium ions, preventing blood from clotting.
- Citrate is in liquid form in the tube and is used for coagulation tests, as well as in blood transfusion bags. It binds the calcium, but not as strongly as EDTA.
- Oxalate has a mechanism similar to that of citrate. It is the anticoagulant used in fluoride/oxalate tubes used to determine glucose and lactate levels. The fluoride serves to inhibit glycolysis, which can throw off blood sugar measurements. In fact, citrate/fluoride/EDTA tubes work better in this regard.

Lipid Profile

Lipid profile is useful test used to detect heart disease this test contains the fallowing parameters:

1- S.HDL (Serum **high**-density lipoprotein)
2- S.LDL (Serum **low**-density lipoprotein)
3- S.VLDL (Serum **Very low**-density lipoprotein)
4- S.Cholesterol
5- TG (Triglyceride)

1- S.HDL: it transports cholesterol **from** tissue therefore:
↑ **Increase** level, are **useful**
↓ **Decrease** level, are **harmful**
} Good Cholesterol

2- S.LDL: it transports cholesterol **to** tissue therefore:
↑ **Increase** level, are **harmful**
↓ **Decrease** level, are **useful**
} Bad Cholesterol
*the **accumulation of LDL** inside the layer of artery **cause**: **Atherosclerosis** disease.

3- S.VLDL: it transports Triglyceride **from liver to tissues**.

4- S.Cholesterol: it is a lepidic waxy alcohol found in the cell membranes and transport in the blood plasma.
*** Normal Value:**
<200 mg/dL --> Normal
200 – 239 mg/dL --> Border line (high)
>240 mg/dL --> High

5- Triglyceride: it's the main constituent of vegetable oil and animal fats
Glycerol + 3 Fatty Acids ---> Triglyceride
*** Triglyceride Assay**: the method based on enzymatic hydrolysis of serum or plasma (TG) to glycerol and free fatty acid by **{Lipoprotein Lipase (LPL) (the Reagent)}**

*Normal Value:
<150 mg/dL

*Procedure of TG:
R1: Buffer solution
R2: Peroxidase, Cholesterol Esterase, Cholesterol Oxidase
R3: Standard solution
Absorbance: 500nm

Lipid Characteristic:

1- Insoluble in water
2- Soluble in organic compound
3- Classification:
   A- Simple Lipid: Fat
   B- Compound Lipid: Phospholipid
   C- Derived Lipid: Fatty Acid

Analysis Result:

1- Cholesterol
2- TG
3- HDL
} By Kit
4- VLDL = TG\5
5- LDL = Cholesterol – (HDL) + (VLDL)

*Method Name: Enzymatic colored

Bilirubin

Bilirubin: is one of bile component, it is **formed** in the liver, spleen, and bone marrow. It **also formed** as a result of hemoglobin breakdown as in the destruction of red blood cells.

*there are 3 types of bilirubin:

1- **Total** Bilirubin
2- **Direct** Bilirubin (**Conjugated**)
3- **Indirect** Bilirubin (**Unconjugated**)

1- **Total bilirubin:** increases with any type of jaundice.
Total bilirubin = **Direct** bilirubin + **Indirect** bilirubin
Diuretics and methyldopa --> **increase Total** bilirubin
Penicillin, Caffeine and Ethanol --> **Decrease Total** Bilirubin

2- **Direct bilirubin:** in normal condition excreted by Gastrointestinal tract (GIT) with only minimal amounts entering the blood stream.
* it called (**Direct**) because it is **water soluble** and **reacts directly with the reagents**.
* **Direct** Bilirubin is only type that can found in urine.
Direct Bilirubin arise in blood when **obstructive jaundice** (**occur** as from gallstones) or **hepatic jaundice occurs** because bilirubin cannot reach the intestines for excretion and instead enter the blood stream for excretion by kidney.

3- **Indirect bilirubin:** is normally found in blood stream, it increases in hemolytic jaundice (in which hemoglobin breakdown arises) and also increase because of hepatitis.
* it called (**Indirect**) because it is **non-water soluble** and **doesn't reacts directly with the reagent until alcohol should be added.**

*Patient must be fasting 4 – 8h before testing bilirubin
*Protect the specimen from bright light by wrapping the sample tube

in foil or placing in a refrigerator

*Normal Value:

Total Bilirubin: up to 1 mg/dL

Direct Bilirubin: up to 0.2 mg/dL

*Absorbance:

Total Bilirubin: 578 (560 – 600nm)

Direct Bilirubin: 546 (530 – 560nm)

Creatinine

Serum Creatinine levels and urinary Creatinine excretion of function of muscle mass in normal person and show little or no response to dietary changes.

Creatinine is derived from the non-enzymatic dehydration of Creatine in skeletal muscle. The amount of Creatine per unit of muscle mass is constant, and thus the rate of spontaneous breakdown of Creatine is also constant. **As a result, the plasma Creatinine concentration is very stable**.
Creatinine is freely **filtered at glomerulus** and is not **reabsorbed by tubules**. A small amount of the Creatinine in the final urine is derived from tubular secretion. **Because** of these properties of Creatinine, the Creatinine Clearance can be used to estimate the {Glomerular Filtration Rate (GFR)}.

***Normal Value**:

Serum:	Male: 0.7 – 1.4 mg/dL	Female: 0.5 – 0.9 mg/dL
Urine:	Male: 14 – 26 mg/kg/24-h	Female: 11 – 20 mg/kg/24-h
Clearance:	Male: 97 – 137 mg/min	Female: 88 – 128 mg/min

***Method Name**: Kinetic Method

***Procedure**:
R1: Sodium Hydroxide
R2: Picric acid solution
R3: standard solution
Absorbance: 500nm

***Calculation of Creatinine:** $\frac{(A2-A1)\,T}{(A2-A1)ST} * C_{ST}$ = {Creatinine} mg/dl

***Calculation of Creatinine Clearance:**

$$\text{ml/min} = \frac{Urine\ Creatinine\ (\frac{mg}{dl}) * Volume\ of\ urine\ of\ 24hrs\ (ml)}{Serum\ Creatinine\ \left(\frac{mg}{dl}\right) * 1440\ min}$$

Sodium (Na^+) & Potassium (K^+)

Sodium (Na^+) & Potassium (K^+) are electrolytes present in the body water bath inside and outside cells they **help** in the regulation of body fluid compartment osmolarity and volume.

***Osmolarity mean**: Movement of water across cell membrane **from** a solution with **low** solute particle concentration **to** a solution with **high** solute particle concentration.

Sodium (Na^+) & Potassium (K^+) **measuring** help in diagnosis of many diseases like liver and key diseases.

Sodium (Na^+) & Potassium (K^+) Analysis:

Sodium (Na^+) & Potassium (K^+) are **measured by**:

- {**Flame Atomic Emission spectrophotometer** (**FAES**)}
- {**Ion selective potentiometry** (**ISE**)}

in (FAES) we used 1:100 or 1:200 dilution sample by a dilute containing lithium.

The heat vaporized the salt to form the ground state atoms Na^+ and K^+ these atoms are heated by flame which resulting in the formation of excited atoms Na^+ & K^+. these excited atoms returned to their ground state with emission of light, Na^+ emission light is at 589nm while K^+ at 766nm (and lithium at 671nm)

***Normal Value**:

Na^+ --> 135 – 145 mmol/L

K^+ --> 3.6 – 5 mmol/L

Iron

Iron is very important element because it is essential component involved in the synthesis of many protein like hemoglobin and enzyme like NADH dehydrogenase.

Pathological Condition

Iron **Deficiency**

1- Anemia
2- Blood Loss
3- Iron poor diet
4- Impaired absorption

Iron **Over lead**

1- High absorption
2- High iron storage
3- Organs damage

Iron – Iron Binding Capacity (I, IBC)

Procedure:

1- 0.5ml serum in centrifuge tube
2- 1ml of iron solution
3- Mix and Stand for 30 minutes
4- Add about (160 – 180)mg (light $MgCo_3$)
5- Mix thoroughly from time to time.
6- After 45 minutes – one-hour centrifuge at least 10 minutes
7- Prepare (3 test tube) previously wash with HCL and rewash with Distell Water.
8- To all tube add 1ml of buffer solution.
9- Then add for all 50µl reducing agent prepared by dissolving 100mg as ascorbic acid in 0.5ml D.W.
10- The tube labeled (iron) add (0.25ml) serum

11- The tube labeled (IBC) take (0.25ml) from the superadded
12- To the tube labeled (ST) add (0.25ml) ST solution.
13- Measure the absorbance of all tube at 595nm and record the Absorbance (A_1)
14- Add (50 µl of (chromagen solution) mix and stand for (5 min).
15- Read the absorbance again at the same wavelength (A_2).

Calculation:

I

$$\frac{A2-A1}{A2*ST} * 100 \text{ mg/dl}$$

IBC

$$\frac{A2-A1}{A2*ST} * 300 \text{ mg/dl}$$

Sat. $\frac{I}{IBC} * 100$

*Normal Value:
15 – 45 mg/dl

Urea

Urea is produced from the Amino Acid deamination. The development of toxic levels of ammonia in the blood prevent by the conversion of ammonia to urea, this reaction occurs in liver.

Urea production increased when more amino acid is metabolized in the liver because of high protein diet, tissue breakdown or decreased protein synthesis.

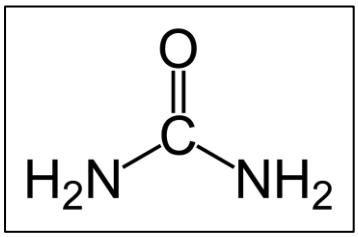
Principle:

$$Urea + H_2O \xrightarrow{Urase} Co_2 + 2NH_4^+$$

Function:

1- Urea is final product of metabolism of protein (A.A)
2- Urea synthesis in liver
3- Component (consist) = Aspartic Acid + Co_2 + $2NH_4^+$
4- NH4 = toxic --> Kidney --> Urea Cycle
5- $Urea + H_2O \xrightarrow{Urase} Co_2 + 2NH_4$
(Green Colored Complex)

***Procedure**:
R1: Phosphate buffer PH5
R2: Urease
R3: Sodium hydroxide
Absorbance: 578nm



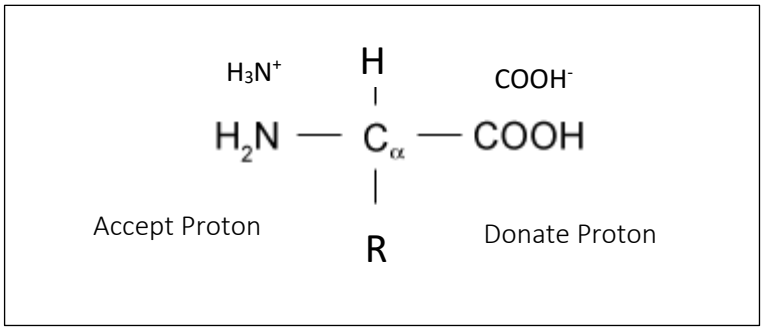
Urea Structure

***Normal Value:**
15 – 45 mg/dL

***Hyperammonemia:** is a condition of increasing of ammonia NH_4^+ in blood.

*Urea is 5 Reactions: 2 in Mitochondria and 3 in Cytosol

Amino Acid: Organic: C, O, H, N / Protein Hydrolyzing by Acids Alkaline Enzyme to form α-Amino Acids.



- **Dipeptide:** are 2 amino acid links together by peptide bond.
- **Tripeptide:** are 3 amino acid links together by peptide bond.
- **Tetrapeptide:** are 4 amino acid links together by peptide bond.
- **Residue:** it means any amino acid with in polypeptide chain.
- **Complete Protein:** Protein Contain essential & non-essential amino acid (Ex: Animal Protein).
- **Non-complete protein:** protein missing one or more essential Amino Acid (Ex: Plant, Vegetables).
- **Essential Amino Acid (Dispensable):** the body can't synthesize, get them from diet.
- **Non-Essential Amino Acid (Indispensable):** the body can synthesize from NH_3+C.

*Urea NH_3 --> Glutamine --> Urea (Soluble).
*Urea is not toxic liver, it's excreted by kidney.

Hepatic Coma:(الغيبوبة الكبدية)
اذا كان هناك قصور او تلف في الكبد Liver Damage سوف تزداد قيمة الـ NH_3 في الدم وتسبب التسمم مما يؤدي الى:

Hyperammonemia: an excessive concentration Of NH_4^+ In blood circulation.

Nitrogen Balance: (Basal Metabolism) (الرصيد الاوزوني)

N_2 in take = N_2 output

(in form of **protein**) = (in form **urea, uric acid and creatinine**)

Anabolism ⟷ **Catabolism**

+Ve N_2 Anabolism > Catabolism
Occur in growing children, Pregnancy from illness

-Ve N_2 Anabolism < Catabolism
Occur in deficiency protein diet, malabsorption, protein catabolism, protein lost through Burn, bleeding, fatigue and apatite.

Uric Acid

Uric Acid is the major product of catabolism of purine nucleosides (Adenosine and Guanosine). An abnormal increase in the level of uric acid in the blood circulation referred to as **hyperuricemia**, which is being the major cause of **gout** ailment resulting in the deposition of urates in the soft tissue especially in the joint areas. The increase levels of uric acid in circulation found associated with severe renal impairment.

***Normal Value**:
Male: 3.5 – 7.2 mg/dL
Female: 2.6 – 6 mg/dL

*Uric acid above 7 mg/dL --> **Hyperuricemia** --> Cause **Gout Disease**

***Method Name:** Enzymatic Method

***Procedure:**
R1: Buffer solvent \ uricase \ Antipyrine
R2: standard solution
Absorbance: 520nm

Calcium

Calcium is important element involved in bone structure contain: (19% Calcium, 85% Phosphate and 66% Magnesium).
Also it is useful in the regulation of parathyroid hormone decreasing.
Ca^{+} excretion is done by kidney therefore patient with renal impairment have elevated serum Ca^{+} concentration.

***Normal Value**:
Serum: 8.5 – 10.5 mg/dL
Urine: 50 – 450

***Absorbance**: 572nm

***Procedure:**

Crezolphthalyin Complexon (CPC)
+
Diethylamine
↓
Strong alkaline agent (مركب ذو معقد بنفسجي)

1- تغسل التيوبات جيداً بالماء المقطر
2- Deionized Water بـ Quvate تغسل الـ
3- 0.5 Diethylamine + 0.5 CPC
4- Add 10 µl serum
5- Read on 572nm

$$\{Ca^{+}\}\frac{T}{ST} * 9 \text{ or } 10$$

Enzymes
Serum GOT & Serum GPT

Transaminases GOT & GPT are the most useful test for detecting hepatic cell damage.

*the GOT is present in nearly external level in the heart, Skeletal Muscle and liver.

*the highest GPT Level are found in the liver.

Also these enzymes called: {Alanine amino transaminase (ALT) = GPT} {Aspartate amino transaminase (AST) = GOT}. They called aminotransaminase because they catalyzed the transaminase reaction by converting amino groups of excess amino acid to ammonia or urea for excretion.

L- Aspartate + 2-oxoglutarate $\xrightarrow[PH=7.4]{GOT}$ L- Glutamate + oxaloacetate

L- ALanine + 2-oxoglutarate $\xrightarrow[PH=7.4]{GPT}$ L- Glutamate + Pyruvate

*Normal Value:

GOT (AST): 8 – 40 WU/L

GPT (ALT): 5 – 30 WU/L

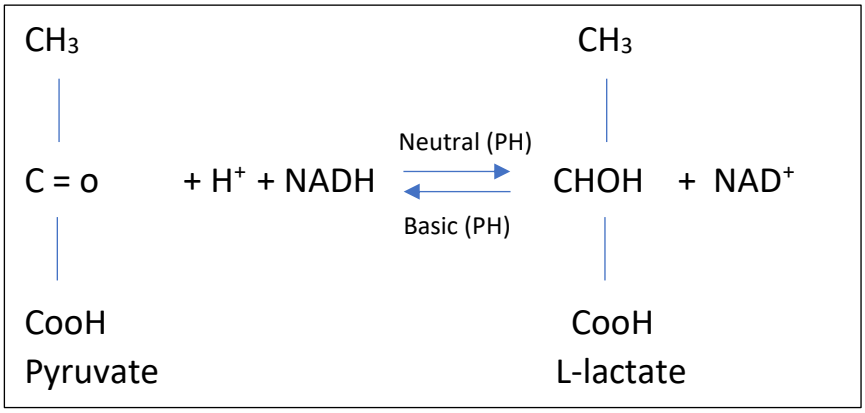
Alkaline Phosphate

This enzyme has been identical in most body tissues and is general catalyzed in the membrane of cells. The optimal PH of these enzymes about (10) and the highest activity of (AP) is in the liver, bone intestine, kidney and placenta.

Intrahepatic biliary obstruction is accompanied by an increased serum (AP) activity, also it increased because of bone disease like rickets (AP) elevates during rapid bone growth and in third trimester of pregnancy because it releases from placenta.

*Normal Value:
Children: 71 – 142 u/L
Adults: 21 – 92 u/L

Lactate Dehydrogenase (LDH)



LD is enzyme present in all cells of body, it catalyzing the reaction shown, the equilibrium of the reaction is PH depend with alkaline PH favoring the conversion of lactate to pyruvate and neutral PH favoring the reverse reaction.

LD composed of four subunits of MW=35,000 D, these subunits include two types:

1- **Heart (H):** this type present in heart and its half-life is 100 hours.
2- **Muscle (M):** this type present in muscle and its half-life is 10 hours.

*the half-life helped in diagnosis of isoform releasing though myocardial infarction.

Renal Function Test (RFT – KFT)	Liver Function Test (LFT)
Creatinine Test	ALT – AST Test
Urea Test	Alkaline Phosphatase (ALP – AP)
Uric Acid Test	Gamma-glutamyl transferase (GGT)
Albumin Test	Bilirubin Test
Total Protein Test	Prothrombin Time (PT)

Glucose Test

Glucose is a major energy source for the human body. Derived from the breakdown of carbohydrate obtained from daily diet and regulate through the process of glycogenolysis (breakdown of body stored glycogen) and gluconeogenesis (endogenous synthesis from amino acids and other substance).

The glucose level in the blood is maintained by diet uptake and regulate hormones such as insulin, glucagon or epinephrine.

An abnormal increase in blood glucose level referred to as hyperglycemia can be associated with diabetes mellitus and hyperactivity of thyroid, pituitary gland or adrenal gland.

An abnormal decrease beyond the fasting level referred to as hypoglycemia is observed in case of insulin overdose or conditions interfering with glucose absorption.

*Method Name: Enzymatic Method

*Principle:

The glucose is oxidized to D-gluconate by the glucose oxidase (GOD) with the formation of hydrogen peroxide in the presence of peroxidase (POD) a mixture of phenol and 4-aminoantipyrine (4-AA) is oxidized by hydrogen peroxide, to form a red quinonimine dye proportional to the concentration of glucose in the sample.

$$\text{Glucose} + H_2O + O_2 \xrightarrow{\text{GOD}} \text{Gluconate} + H_2O_2$$

$$2H_2O + \text{Phenol} + 4\ \text{Amino-Antipyrine} \xrightarrow{\text{Peroxidase}} \text{Quinonimine} + 4H_2O_2$$

*Specimen: serum, blood or Plasma is used for glucose measurement. It is important when whole blood is used to all stabilizer (usually sodium fluoride) to prevent glycolysis and loss of glucose.

*the patient must be fast of at least 10 hours.

*the glucose content of erythrocyte is lower than that in plasma glucose value in venous plasma or serum thus are (10 – 15%) higher than those in venous whole blood.

*in venous blood at room temperature decrease of 6mg/dL (0.33 mmol/L) per hour may occur, at 4C° there is only as light decrease during the first 2 hour and approximately 20% after 24 hours.

*blood glucose determination in neonates should be performed as rapidly as possible after sample collection since the glycolysis rate in neonatal erythrocytes is significantly higher than fetus in adults.

*ascorbic acid and methyldopa can cause decrease of glucose oxidase method is used.

*day to day variation of blood glucose determination may amount to 5%.

*Interferences:

1- Lipidemia / hyperlipidemia: is disorder of lipid metabolism (accumulation of lipid)
2- Bilirubin
3- Hemoglobin
4- Other drugs and substances may interfere.

*Symptoms of Diabetes Miletus:

1- Polyuria (frequent urination)
2- Polydipsia (increase thirst)
3- Polyphagia (increase hunger)

Introduction to specimen collection

1.Adequate preparation of patient.

2.using of sterile equipment.

3.treat all biological material as material that is potentially hazardous.

4.Preparation of the patient.

5.collection of the specimen.

6.processing the specimen.

7.storing and transporting the specimen.

8.take care of the volume of the specimen.

9.information about the patient (fasting, diet, and medication) for specific test.

10.All primary specimen containers must be labeled (name, date of birth, test request form number).

11.collect sufficient quantity of each type of specimen according to the procedure.

12.expired containers not use.

13.Avoid a (QNS) (QUANTITY NOT SUFFICIENT) for example for multiple tubes are required.

14.carefully tighten specimen container lids.

15.maintain and transport the specimen at the temperature indicated in the test requirements.

16.Avoid hemolysis or red blood cells breakdown when serum or plasma preparation.

17.patiant states (basal state) ……. the patient is in a basal state …….in the early morning after awaking and about 12 to 14 hours after the last ingesting of food.

18.for patient state indicate if he or she fasting or not fasting……., fasting does not include abstaining from coffee,tea,or sugar –free liquids.

19. Moderate exercise can cause an increase in blood glucose, lactic acid, serum patients, and creatine kinase.(CK).

20.INTERFERENCE of medications and other substances, patient must be told to avoid specified medications for the necessary periods of time prior to specimen collection, if the patient cannot be taken off the medication in question, its presences should be noted on the test request form.

……..

Serum, is the fluid and solute component of blood which does not play a role in clotting. It may be defined as blood plasma without the clotting factors, or as blood with all cells and clotting factors removed.

blood plasma, also known as blood plasma, appears light-yellowish or straw-colored. It serves as the liquid base for whole blood. Whole blood minus erythrocytes (RBCs), leukocytes (WBCs), and thrombocytes (platelets) make up the plasma.

serum and plasma both come from the liquid portion of the blood that remains once the cells are removed. Serum is the liquid that remains after the blood has clotted. Plasma is the liquid that remains when

clotting is prevented with the addition of an anticoagulant.

السيرم لايحتوي على clotting factors ولايحتوي على fibrinogen وبالتالي يسهل استخدامه في الفحوصات.

اما البلازما فهي احد العناصر الحيويه في جسم الانسان وتتمثل في السائل الشفاف بعد فصل كرات الدم الحمراء والبيضاء والصفائح الدمويه وتمثل البلازما نسبة 52% من حجم الدم في جسم الانسان وتقوم بوظائف هامه للإنسان منها تعزيز المناعه ومنع النزيف.

14.