

Protein-Calorie Malnutrition (PCM)

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Kwashiorkor

It is a disease that affects children between one and four years who are weaned.

The word kwashiorkor means red boy, due to the unnatural red-orange color of the hair.

The causes of this disease are protein deficiency, especially breast milk protein. Resulting from the early weaning of the child and the replacement of another child in his place. Because of the mother's ignorance in matters of nutrition, she feeds her child after weaning with adult foods, which are mainly made of starchy and sugary materials, in which there is no good protein after the child relied on milk for his diet.

Symptoms of the disease

The most important symptoms of kwashiorkor disease are growth stunting in the child, muscle atrophy, and fat deposition in different parts of the body, especially the liver.

Swellings appear in the abdomen and legs with the appearance of edema, and therefore cases of weight loss do not appear on children with kwashiorkor.

The cause of this disease is the obstruction and cessation of hemoglobin production due to the lack of protein and the accompanying malnutrition of other nutrients, namely vitamin B12 and folic acid, and this is accompanied by a deficiency in the production of hormones and enzymes.

Diarrhea also appears and is accompanied by a loss of body fluids, electrolytes and nutrients due to a deficiency in the cells lining the intestines.

The lack of protein causes the child's immune susceptibility to be weakened, so he cannot produce antibodies.

The skin of the child changes, the complexion changes, and spots appear in certain places on the body, especially the face, accompanied by peeling and flaking of the skin. The hair color also changes, becoming red-orange with spots in the form of dark and light areas due to the heterogeneity of growth and nutrition, and hair wrinkles change.

Usually, a child with a kwashiorkor shows signs of misery and indifference, as he sits for long periods of time without movement and reactions.



Marasmus (universal starvation) &
Kwashiorkor (protein deficiency)



Wrinkled face (lack of skin proteins)

Hepatomegaly with fatty liver
Deficient haemoglobin
Impaired immune defence system

Ascites: Fluid in the abdominal cavity

Growth failure
Muscle wasting
Thin limbs
(lack of muscle proteins)

Hunger oedema
(lack of plasma protein)

Marasmas disease (light),

A disease that affects infants between six and eighteen months of age, and the word maramas means in Greek (withering).

The causes of this disease are the severe lack of protein accompanied by a lack of energy in addition to the severe deficiency in other nutrients as a result of early weaning and severe neglect of nutrition and child care at this age, which occurs in very poor families who suffer from hunger and lack of food resources and quality. Symptoms of the disease One of the most important symptoms of the disease is obstruction of growth, severe decrease in body weight, and atrophy of muscles and fatty tissues, accompanied by growth in the skeletal system and brain, which leads to the appearance of the child with a large head and limbs and a tall and thin stature. The skin will also wrinkle and become more relaxed, making the affected child look like adults and the eyes will become wide and sunken.

The child also suffers from persistent diarrhea and a constant feeling of hunger, as the affected child is characterized by alertness and a constant feeling of suffering.

Prevention and treatment

The treatment is carried out after the patient is admitted to the hospital and the condition is diagnosed. The patient is fed through intravenous feeding. The first step is to return water and fluids to the cells with great care. The balance of water and electrolytes should be corrected, the acidity and alkalinity adjusted, and treatment should be started quickly. Then take care of feeding the patient using good proteins like milk. The patient is given an amount of

Protein is estimated at 2-3 g/kg of body weight. Then the quantity increases to 3-5 g/kg. of body weight and should avoid giving the patient high amounts of protein to avoid

Imbalance in the representation of proteins due to poor tissue efficiency, especially the liver, and the accumulation of catabolic substances, including yaoi, in the blood.



Nature and mechanism of Atherosclerosis.

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The stages of development of a pillow or porridge consisting of accumulated materials can be divided into the following stages:

1. Fatty streaks

They are fatty lines that are in the form of small and short strips of yellow color extending horizontally on the inner surface of the blood vessels. They are made up of the fatty layer that accumulates between the smooth muscles and the cells that are affected by the intima (wall cells) and the cells that are affected by it may not develop into the second stage, which is the plaques.

2. Sheet Plaques

It is a layer or plate with a diameter of about (1 cm) composed of fatty substances and fibrous plaques. It increases the thickness of the vessel wall as it protrudes into the lumen of the arteries and over time it grows and its components coalesce.

3. The stage of spoilage.

A wound or crack occurs in the vessel wall where plaques develop and the following occur:

- a. The endothelium or epithelial cells may be lost, the ulcerated wall may become ulcerated, and the accumulated fats are exposed to the bloodstream.
- b. Fibrin may be deposited and thrombus formed on the surface of the plates due to the ulceration and roughness of the place. The thrombus may enter the inside of the plate and sometimes covered by endothelium cells.
- c. Blood may enter the affected area and around the intercellular plate, and it may be difficult to know and determine the source of the blood, whether it is from the lumen of the blood vessel or is it from the vessel wall itself.
- d. Finally, the components are calcified and the area hardens by the accumulation of calcium.

Risk factors

There is no single factor that has an effect on atherosclerosis on its own. Rather, there are a large number of influencing factors that overlap with each other to form the result of the overall effect that increases or decreases the chances of developing atherosclerosis and heart disease, but there are major risk factors that are of great importance to the emergence of these health problems: the concentration of fatty substances, including cholesterol, blood pressure, and smoking. As for the factors that increase the chances of infection, they are: 1. Age: Injuries are high in the elderly, especially after 45 years of age. As the incidence increases with the increase in the age of the person. This disease may start at a young age, as fatty streaks were found in the aorta of a child less than one year old.

2. Gender:

Men are more likely than women to suffer from atherosclerosis and heart disease in general. The reason may be due to the presence of the female hormone estrogen, which is believed to help lower the concentration of cholesterol in the blood. And when the ovaries are removed in a woman before menopause, the proportion of cholesterol increases, and the chances of contracting the disease increase. The chances of infection in postmenopausal women increase and the ratio is equal between men and women after the age of seventy.

3. Heredity:

It appeared that the infection rate increases in people from families who are known to: suffer from these diseases. There are many injuries in the family: first and second degree relatives, especially parents and brothers.

4. Smoking

A smoker is more likely to get heart disease than a non-smoker. It depends on the intensity of smoking.

When the rate exceeds twenty cigarettes per day, the infection rate is 3-5 times the rate found in the category of non-smokers.

There is more than one possibility that is believed to be the cause of smoking. It may be from the effect of nicotine on vasoconstriction, and it may be from inhaling carbon monoxide or from the effect of nicotine on blood clotting, and there is still more than one question on this subject.

5. Obesity

Obese people are more likely to have atherosclerosis and cardiovascular diseases, and this may be due to the high percentage of fat and cholesterol, which are deposited in the walls of blood vessels. .

6. Blood pressure

High blood pressure increases the chances of developing atherosclerosis and heart disease, as high diastolic pressure increases the incidence by 3-5 times in normal conditions. .

7. Diabetes mellitus

The incidence of atherosclerosis and vascular disease increases in people with diabetes, and the reason is that they are prone to developing high blood pressure, which in turn is a cause of atherosclerosis.

8. Emotional stress and tension

Injuries increase among people who are ambitious and motivated to work more than others, as well as among individuals who are overcome by nervousness and tension.

9. Gout

The incidence of atherosclerosis and heart disease is increasing among people with gout...

Atherosclerosis

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Atherosclerosis is a physiological disorder that affects the blood vessels, which is the degeneration or erosion of the arterial walls in general and the arteries of the heart in particular, which leads to what is known as heart disease.

It is a type of hardening that occurs in the walls of the arteries, causing them to lose their elasticity. This hardening or thickening is caused by:

1. The accumulation and accumulation of fatty substances that contain 70% of cholesterol in the cells lining the wall
2. This is also accompanied by calcium deposition and formation of calcification and complex carbohydrates, including complex carbohydrates, mucopolysaccharides.
3. The blood may clot around it, making it hard, and then these deposits form the protrusions in the lumen of the blood vessel called plaque. When the cells adjacent to it are damaged, it leads to the appearance of the lesion. This protrusion leads to a narrowing of the lumen of the blood vessels and when it becomes old.

Stenosis leads to blockage of these vessels.

4. Obstructing and slowing the flow of blood helps to form a blood clot or thrombus This complicates matters further.

Diseases caused by atherosclerosis

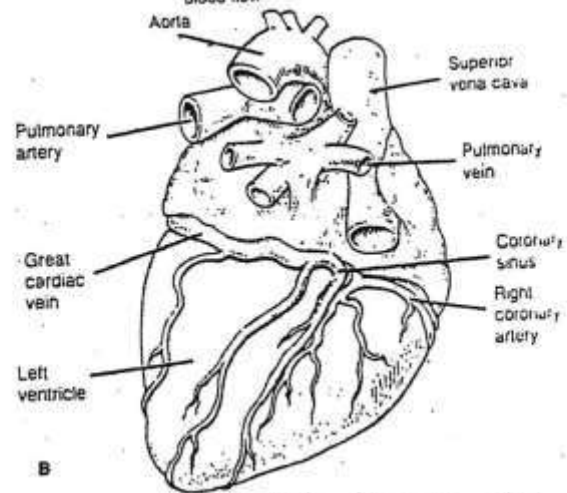
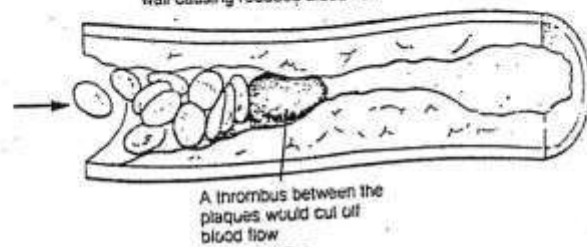
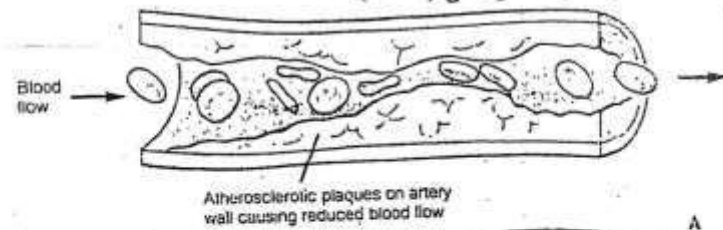
Atherosclerosis causes a number of diseases, especially heart diseases, including:

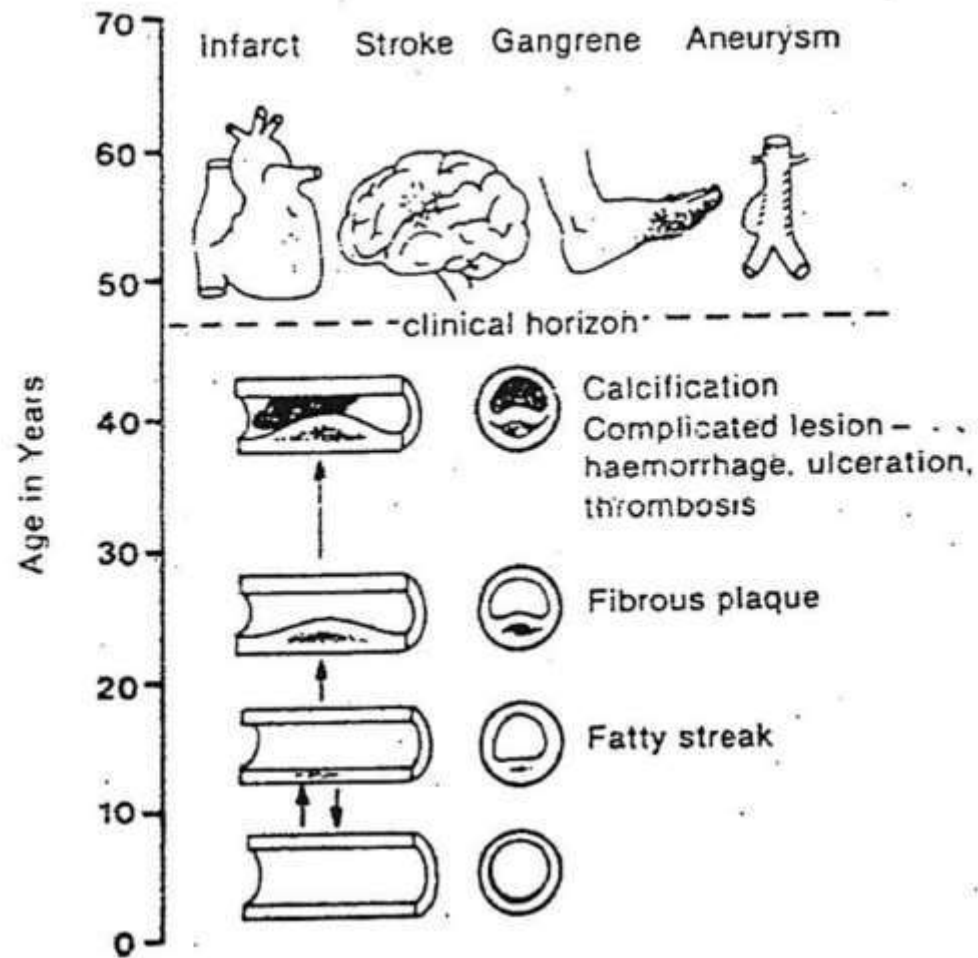
1. Coronary heart disease caused by hardening and blockage of the coronary artery that supplies the heart with blood, as it thickens and hardens due to the accumulation of fatty substances, including cholesterol...
2. It may result in ischemic heart disease, a disease caused when the heart muscle does not get enough blood to provide it with energy and nutrients as a result of the narrowing and stiffening of the coronary artery.
3. When the amount of oxygen and energy reaching the heart muscle decreases, severe pain occurs in the chest behind the sternum, and then a defect in the heartbeat, and this is termed as angina pectoris or angina pectoris, and the reason is that the amount of blood supplied is insufficient or less than usual due to tightness artery. There are other causes for this disease. .

4. When a complete blockage of the coronary artery, especially the left, occurs, the heart muscle dies, and the muscle loses its function of contraction and diastole, which results in what is called a myocardial infarction, and in this case, sudden heart attacks occur. Sometimes as a result of the passage of a piece of free, loose or insoluble clot in the blood, this loose piece called the embolus may reach narrow places that block the artery and prevent the blood from passing into the tissue, causing sudden heart attacks.

5. Atherosclerosis may cause other problems in the brain, called Cerebrovascular disease. As a blockage occurs in one of the brain's arteries due to the formation of an embolus or any clot and the rupture of the small arteries in it, where there is loss of consciousness, then paralysis, then hemorrhage, and this is what is termed (cerebral or stroke).

And when the artery that connects to any organ in the body or tissue is clogged, it may be part of the body, the fingers or the legs.





Diabetes Mellitus

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Causes of the disease. Etiology

There are many causes that lead to diabetes, including:

A. Genetic factors:

Heredity plays a major role in the emergence of symptoms of diabetes. A person may develop it when there is one or a number of family members, especially the parents, who have the disease. This personal predisposition may be genetic for the following physiological changes.

1. Formation of antibodies against the beta cells "B-cells" that secrete the hormone insulin in the pancreas, which leads to autoimmune destruction of cells
2. Beta cells may become infected with viruses when infected with any viral disease. . It affects the pancreas.
3. Degeneration of .8-cells due to any cause and may be mechanical.

B. Dietary factors.

Nutritional factors have an indirect effect, which may be through:

1. Obesity

Obesity has a great relationship with diabetes, as it is one of the most important reasons for the emergence of this disease. It is believed that the reason is the weakness of the ability to receive and bind insulin by the receptors in the cell wall, which are glycoproteins, which leads to the difficulty and lack of glucose entry into the cell, and for this the obese person needs his cells To three times the amount of insulin that the cells of a weak person need to function normally, and in such a case, losing weight to the natural limit of the person is better than following the method of insulin injections to treat the problem.

2. Eating a lot of sugar may be an indirect cause of diabetes symptoms.

3. It has been found that fiber is related to diabetes. It has been found that societies that consume large amounts of fiber have a lower incidence of diabetes.

Types of Diabetes Mellitus

Diabetes is divided into two types, depending on the age of the person who has it:

1. Youth or juvenile onset diabetes

This disease begins suddenly in childhood between (1-14) years of age, when the secretion of the hormone insulin from the pancreas gland stops, and this is why it is called “insulin-dependent diabetes mellitus”

This type of diabetes is characterized by fragility, which means that the level of glucose in the blood fluctuates between a high and a low level, which makes treatment more difficult.

2. Mature or adult onset Diabetes

This disease usually appears after the age of forty and appears slowly and is often without symptoms in the middle and late ages, which is why it is difficult to diagnose in the early stages of its appearance. It is called “non-insulin dependent” diabetes.

Diabetes Mellitus (NIDDM)

In this type, the reason is not due to a lack of insulin, but rather to the resistance of muscle and fat tissues and their cells to the action of insulin, including the weak connection of insulin to the receptors, which disrupts the work of insulin in introducing glucose into the cells. . In addition, the secretion of insulin may be slow, balanced by the accumulated and large amounts of glucose.

Symptoms

Symptoms of the disease may be many and complex, but the following symptoms can be inferred:

The patient suffers from extreme thirst, eating voraciously & polyipsis polyphagia, as well as polyuria, especially nocturia, in addition to feeling tiredness and weight loss, accompanied by poor vision and vision. Physiological changes may occur such as the accumulation of large amounts of glucose in the blood and the exit of quantities through Urine glucosuria. As a result of the demolition of fatty tissues, ketones accumulate, including:

Acetone, B-hydroxy butyric acid, Acetoacetic acid These are called 'ketone bodies' and the condition is called 'ketonuria'.

The accumulation of these substances in the blood leads to an increase in its acidosis, which is called acidosis, which leads to a feeling of dizziness, vomiting, loss of consciousness, and reaches the point of coma and fainting, when the pH drops from 7,4 to 7,0, and may lead to death if the patient is not helped quickly.

Treatment

One of the goals of treatment is to prevent the continuation of the increase in blood sugar when eating meals and to control it within the normal limits and to avoid its decrease to a minimum that causes adverse problems when the amount of insulin increases. .

The treatment should also take into account the natural weight of the person so as to prevent weight gain and loss and to ensure healthy normal growth in the case of children.

Treatment is either by using "insulin glaucoma" or by using oral hypoglycemic drugs, which in turn stimulate and activate insulin.

Use Of Insulin

There is more than one type of insulin in terms of the speed of absorption, the beginning of its action and the length of its effectiveness, which are divided into: fast-acting, medium-acting and long-acting.

Those with severe diabetes are given one dose of long-acting insulin each day, which increases and stimulates the metabolism of carbohydrates as a whole during the day. Then additional amounts of your usual fast-acting insulin are used at times when the blood sugar level rises to high levels, such as at mealtimes.

The initiation and effectiveness of the insulin were estimated as follows:

1. Rapid-acting insulin: its effectiveness begins between (100.0) hours, its maximum effectiveness is between (2-3) hours, and the duration of its effect is between (7-5) hours.
2. Intermediate-acting insulin: its effectiveness begins between (102) hours and reaches a maximum. Its effectiveness is between (12-8) hours, and its duration is between (24-18) hours.
3. Long-acting insulin: its effectiveness begins between (8) hours, its maximum effectiveness is between (18-19) hours, and its duration of action is between (30-39) hours.

Drugs Used

There are a number of drugs that can be used to treat diabetics who suffer from low or weak secretion of the hormone insulin. It is given orally.

These drugs stimulate and activate the beta cells in the pancreas to secrete the hormone insulin.

. Among these drugs:

Sulfonyl compounds. Sulphonylurea such as biguanides, orinase
Tolbutamide

Lipids

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Essential fatty acids

There are fatty acids (especially unsaturated essential and non-essential ones). What is meant by essential or essential fatty acids is the inability of the human body to synthesize or produce them from other fatty acids or any other substance inside the body, and thus must be eaten through food to meet the body's needs.

The lack of essential fatty acids leads to skin infections and the appearance of pimples, and skin tags as it leads to stunted growth.

Its deficiency may also lead to the appearance of eczema, in addition to cracking, peeling and falling of the skin.

Biological and physiological functions of basic fatty acids

1. It is one of the important compounds in the synthesis of the cell wall and mitochondria.
2. Strengthens the walls of blood vessels, making them more resistant and reducing their permeability.
3. It has been proven that a number of essential fatty acids, including arachidonic acid, prolong the period of blood clotting. Thus, it reduces the chances of developing clots, and thus reduces the chances of developing heart disease and atherosclerosis.

4. These acids are the raw material for the synthesis of hormones, for example, prostaglandins increase the secretion of the thyroid gland, inhibit the breakdown of fats, reduce gastric secretion and reduce blood pressure.

5. Unsaturated fatty acids lower blood cholesterol.

The deficiency of these acids, especially linoleic acid, leads to stunting of growth in children and leads to skin infections and the appearance of eczema in them.

In addition, it leads to high cholesterol in the liver and blood, and a decrease in the ability to bear children.

Lipoproteins

Biomolecules are a group of biomolecules resulting from the union of some lipids with proteins.

The most common protein fats are those found in the blood plasma, as they transport fats from the small intestine to the liver and then from the liver to adipose tissues and others.

Protein fats can be classified based on their density, which represents the fat content, which ranges between 75%-30%. The higher the fat content, the lower the protein fat density.

There are four types of protein fats:

1. High density Lipoprotein (HDL)

These fats transport cholesterol from the cells.

2. Low Density Lipoproteins (LDL)

It works to transport cholesterol into cells.

3. Very Low-density Protein

Lipoprotein (VLDL)

The triglycerides formed in the liver are transported endogenous from the liver to the cells.

4. Chylomicrons transport exogenous fats that originate from food from the intestine to the liver.

Lipids

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They are fatty and oily substances classified among the main nutrients, and they consist of carbon, hydrogen and oxygen elements, and some of them contain phosphorous and nitrogen.

Lipids are found in the human body either in the form of stored in special tissues where it is considered a potential energy, or Interfering with the structure of cells and body tissues.

Functions of lipids

1. Oils and fats are the main and major source of energy that the body needs, as one gram of fat gives 9 kilocalories when oxidized or burned, and this is double what a gram of carbohydrates or proteins gives it, as each gives 4 kilo calories.
2. Fat has an important physiological function, which is to form an insulating layer under the skin, which keeps the body temperature from changing rapidly. It prevents the loss of large amounts of energy or heat, especially when the body needs it in cold seasons. The skin sebaceous glands secrete fat in the form of fatty acids combined with cholesterol, giving the body smoothness and preventing dryness and cracking of the skin.

3. The internal organs of the body, such as the kidneys and the heart, are surrounded by a fatty layer, which is a cushion that protects these organs from external shocks.

4. Fats have important structural functions, as they are involved in the formation of cell walls and mitochondria, and in the composition of many bodily tissues, including the nervous system and the brain.

5. Fats act as carriers of fat-soluble vitamins such as vitamins A, D, E and K. 6.

6. Provides the body with essential fatty acids.

7. Fat has a relationship with sexual maturity, as it increases reproductive efficiency and increases the ability to reproduce.

8. Lipids and protein form an insulating outer layer for transmitting nerve signals in nerve cells and produce the so-called myelinated nerve.

9. Fats are activators of some enzymes in order to show their full activity.

10. Arachidonic acid is a specific generator for all prostaglandins, as it is converted by the enzyme cyclooxygenase to two prostaglandin compounds: Prostacyclin A2 and Thromboxane.

The first is formed in the walls of blood vessels and performs the function of vasodialator, and the second is formed in blood discs and performs the function of vasoconstrictor.

Fats and Oils

They are what are called neutral_fats, and they consist of esters of fatty acids with glycerol, and they are also called acylglycerols or (glycerides), and they are the main components of fats and oils in nature, including food.

These glycerides may be:

Monoglycerides, Diglycerides, and Triglycerides The ratio of the binding of fatty acids to the glycerol molecule.

When one molecule of fatty acids binds with glycerol, they are called monoglycerides, and when two molecules of fatty acids bind with glycerol, they are called diglycerols. Triacylglycerol is the main component of daily dietary fat.

It is one of the simple fats and the most abundant, and it is the form that is stored under the skin and within the adipose tissues.

The general structure of triacylglycerol, glycerol, with three molecules of electric acids, is therefore called neutral fat.

Triacylglycerol is either a solid or a liquid at room temperature. This depends on the nature of the fatty acids that make up the fat. If the fatty acids are saturated (that is, they do not contain double bonds), then they are solid or semi-solid at room temperature. This is what we notice with fats resulting from animal sources. If the fatty acids are unsaturated (that is, they contain **Binary** bonds) so they are liquid oils at room temperature, and this is what we notice with those extracted from plant sources.

Fatty acids

They are the basic units for the formation of oils and fats or derivatives of lipids when they are free. They are organic compounds consisting of a carbon chain of different lengths ending in a carboxylic group (COOH-) and usually consisting of an even number of carbon atoms between 4-30 carbon atoms.

The fatty acids circulating in nature are straight chains. There are short chain acids that contain 4-8 carbon atoms or long chain when the number of carbon atoms exceeds 10. Fatty acids are classified according to the presence of double bonds into:

* Saturated fatty acids when the carbon chain is free of double bonds.

Unsaturated fatty acids when the carbon chain contains one or more double bonds.

Usually, the proportion of saturated fatty acids is greater than the proportion of unsaturated fatty acids in fats and oils.

There are two important factors to determine the degree of hardness and fluidity of fat or oil and to determine the melting of fat and oil. These two factors are:

The length of the carbon chain of which the fatty acid is made.

And the degree of saturation. Saturated fatty acids increase the length of the carbon chain, the higher the melting point.

The presence of long-chain fatty acids (more than 10 carbon atoms) makes fat solid, thus it is called fat (solid at room temperature).

In the presence of short-chain fatty acids (less than 10 carbon atoms), they are usually volatile and liquid at room temperature.

The other important factor in determining the melting point is the degree of saturation.

The presence of the double bond makes the fat or oil liquid, and thus it is known as "oil", any liquid at room temperature. The greater the double bonds in the Ahma

The fatty acids present in the oil decreased the melting point and increased the fluidity of the oil.

Carbohydrates

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Oxidation of Carbohydrates

The most important compound in the process of carbohydrate metabolism is glucose, which is completely oxidized to carbon dioxide in water, as well as releasing energy.

At the beginning of the metabolism process, glucose turns into glucose-6-phosphate, which is the main compound in the processes and methods of metabolism, as this compound consists of glucose phosphorylation under the control of the hormone insulin.

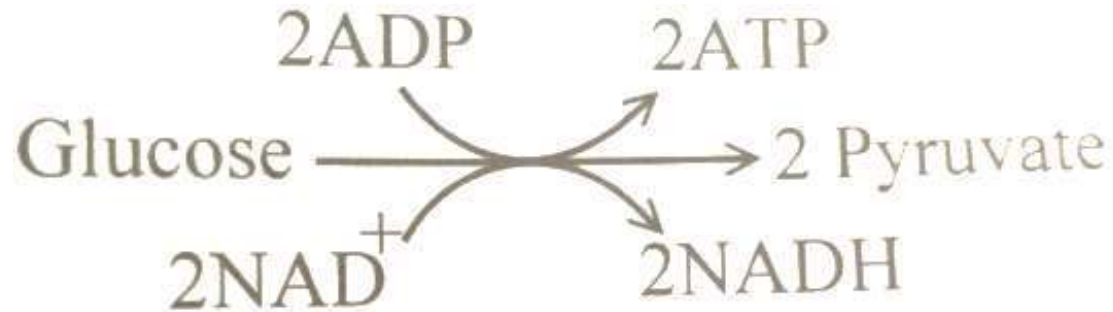
After its formation, it is either transformed into glycogen in the liver and muscles or into glucose, or it is oxidized by various methods, including the anaerobic route or glycolysis, followed by the aerobic pathway (Krebs cycle).

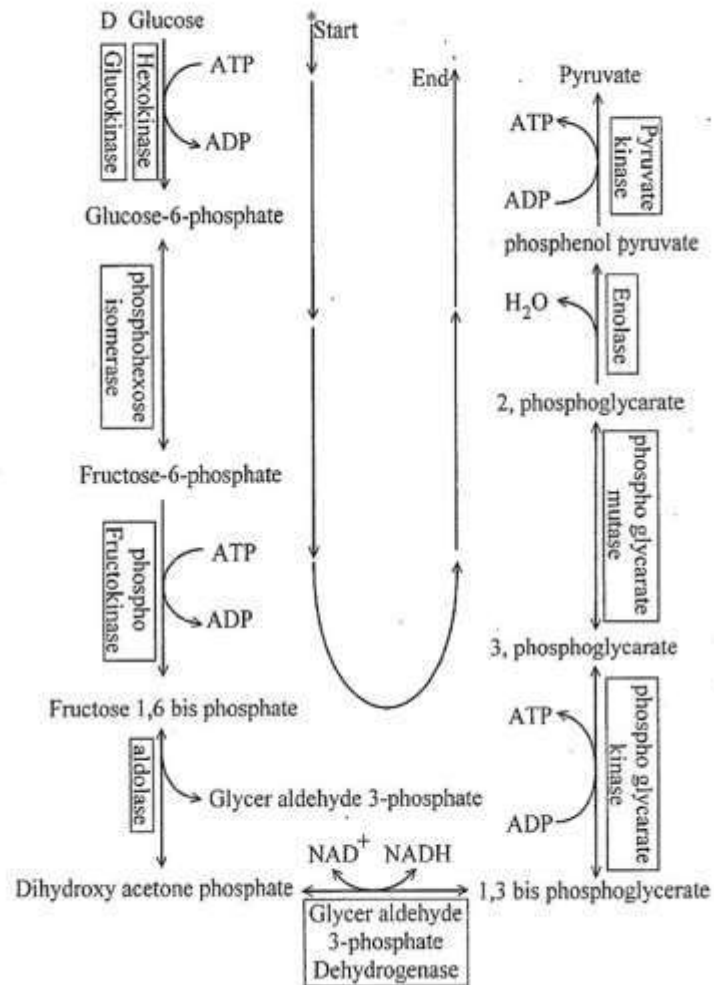
The anaerobic pathway of glucose oxidation (glycolysis)

To explain this behavior in the oxidation process of glucose it may not require entering into the details of each step. Rather, the scheme for this cycle may dispense with the details, but it is important to know the following:

Glycolysis is the process of catabolism of the monosaccharides such as glucose, fructose, galactose and mannose by the glycolysis enzymes in the cytoplasm in isolation from oxygen. Glucose is the main sugar widely used in metabolic processes.

The catabolism of glucose takes place in the cytoplasm, and the general equation for glycolysis can be written as follows:





Carbohydrates

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The biological and physiological functions of carbohydrates

1. Carbohydrates are the main source of energy generation in the body. The percentage of energy that comes from carbohydrates may reach about 90% of the total energy needed by the body. The most organs need carbohydrates is the nervous system. Not the brain, as glucose is the main nutrient for it.
2. The protein has a sparing action of carbohydrates.

3. Regulation of fat metabolism effect (antiketogenic).

In the absence of carbohydrates, the body is forced to use fat to release energy so this will need to increase catabolic processes of fat and as a result, formation and accumulation of ketone bodies will produced as intermediate substances, including (acetone, acetoacetic acid, and beta-hydroxybutyric acid). **This is what happens to people with diabetes mellitus and the condition is called “ketosis”.** While this condition does not occur in normal people because they have sufficient amounts of carbohydrates.

4. Although the heart muscles prefer to use fatty acids as a source of energy, glycogen is an important reserve for the heart muscle in an emergency ‘so in the case of heart failure (damaged heart), the decrease in glycogen stores or lack of carbohydrates leads to angina pectoris.

5. Carbohydrates are characterized by the ability to retain water and electrolytes. Any loss of water leads to a loss of electrolytes, especially sodium and potassium, and as this situation continues, involuntary dehydration will occur.

6. Carbohydrates perform various structural and physiological functions in the body, as they are considered to be part of important compounds, including:

- a. **Glucuronic acid**: It has an important function in the liver, which is to remove toxins that reach the body. It is considered a **detoxifying agent**.
- b. **Cerebrosides**: They are found in the nervous system, brain, bone marrow, and nerves.
- c. **Mycoproteins**: including Mucus, which is the substance secreted by the digestive system in the stomach and other parts **to protect cells from decomposition by enzymes, acids and other harmful substances**. It is also found in the blood.
- d. **Heparin**: is the **anticoagulant in the blood**.
- e. **Hyaluronic acid** and its function of lubrication of the body joints.

Blood Sugar

Most of the sugar in the body is in the form of glucose.

The concentration of glucose in the blood in normal cases falls between the ranges of (70-110) mg/100 ml of blood, which is the concentration of glucose in the blood of a fasting individual. After eating a meal rich in carbohydrates, the concentration of glucose increases to an extent in which its level in the blood rises as a temporary condition termed as hyperglycemia, and after a relatively long period of starvation or by performing violent and stressful exercises, the concentration of sugar falls below the normal limit for fasting and is less than its level. Temporarily normal is termed as hypoglycemia, and thus after eating food, glucose in the blood reaches a state of hyperglycemia again, and this in turn returns to the normal limit as a result of the following steps:

1. **Storage process**, either in the form of glycogen in the liver and muscles, or in the form of fat in the tissues. .
2. **Oxidized** to produce energy.
3. **Get rid of it** through the kidneys.

During the process of absorbing glucose or sugar from the intestine, the concentration of sugar in the blood rises to the state of hyperglycemia, and to restore its concentration to the normal limit, the **liver removes part of it** by converting it to stored glycogen, and the **muscles take another part** to turn into muscle glycogen, or oxidize directly to release energy in different cells. But if the increase in its concentration remains, then **glucose turns into fat** that is stored in fatty tissues, and by these processes it can control the amount of excess glucose in the blood. **If it is not controlled, it is eliminated through the kidneys.**

The liver has a very important role in balancing the concentration of sugar in the blood. It works in both cases:

During a period of high blood sugar, the liver stops pumping glucose and begins storing it in the form of glycogen.

During its low level, the liver supplies glucose to the blood by converting glycogen through the glycogenolysis process.

Hormones that (increase or decrease) blood sugar level

1. Insulin

It is a hormone secreted by beta β -cells in the pancreas.

Insulin lowers the blood sugar level by:

- Converting glucose into glycogen in the liver and muscles.
- Regulating the oxidation of glucose in the tissues.
- preventing the breakdown of liver glycogen into glucose.

Insulin accelerates the transfer of glucose through the cell wall to the inside of the cell in muscle and adipose tissue.

In the adipose tissue, Insulin inhibits the action of the enzyme adenyl cyclase and thus its effect against the action of the hormones glucagon and epinephrine by converting glycogen into glucose.

Within hepatocytes, insulin controls the phosphorylation of glucose into glucose-6-phosphate, a first step in the pathway to glycogenesis.

In the absence of insulin, glucose transfer from outside to inside the cell decreases, and also decreases converting glucose into glucose-6-phosphate.

In the case of diabetes treatment, insulin is injected under the skin to be effective. It is not given orally or in the digestive system, because it loses its effect due to the proteolytic enzymes as insulin is a protein or peptide composed of a chain of amino acids.

2. Glucagon

It is a hormone secreted by **alpha α -cells of the pancreas**. Secretion of glucagon **raises the level of sugar** in the blood. It increases the activity of the enzyme phosphorylase in the liver, which is responsible for converting glycogen into free glucose.

3. Epinephrine

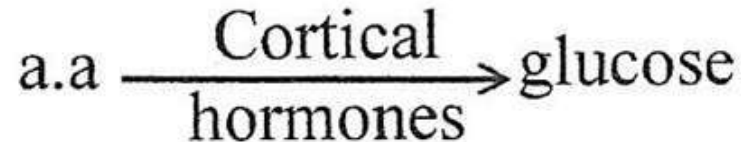
This hormone is secreted from the **central medulla of the adrenal gland** and is called adrenaline hormone. It works against the action of the hormone insulin, as it works to release glucose from the glycogen in the liver, thus increasing the level of sugar in the blood.

Also, Epinephrine has a role in increasing lactic acid in the blood, because it converts the glycogen in the muscle to lactic acid.

The secretion of epinephrine increases in psychological and emotional conditions such as fear and anger. And when it is secreted in these conditions, it increases blood sugar and makes glucose ready for muscle action as final reactions to excitement or fear.

4. Adrenal cortical hormones

They are hormones of the **outer layer of the cortex of the adrenal gland** or adrenaline, they are a number of hormones such as cortisone and cortisol, and these hormones have a role in stimulating the production of glucose in the liver from amino acids, and thus their action is antagonistic to the action of insulin and similar to epinephrine, but in another way.



Carbohydrates

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Clinical Biochemistry

There are three main elements that make up carbohydrates: Carbon, Oxygen and Hydrogen
Hydrogen and oxygen are usually found in a ratio presence in water i.e.

(2) Hydrogen to (1) oxygen atoms.

From a chemical view, the building blocks of carbohydrate are
Aldehydes or Ketones.

Classification of carbohydrates

Carbohydrates can be classified as two main groups:

- 1. Simple sugars:** is divided into two groups
 - a. Monosaccharide.
 - b. Oligosaccharides (Few building blocks).
- 2. Polysaccharides:** is divided into two groups
 - a. Homopolysaccharides
 - b. Heteropolysaccharides

1. Monosaccharides

It is the simplest type of carbohydrates, and it is the smallest building unit in sugars. It usually consists of a carbon skeleton between 3 and 7 carbon atoms.

It can be called triose if it is composed of 3 carbon atoms, tetrose, pentose, hexose and heptose if it is composed of 4, 5, 6, and 7 carbon atoms, respectively.

Triose, tetrose and heptose are found as intermediate compounds in the metabolic processes, while pentose and hexose are the most common in nature and present in animal and plant cells and tissues in large quantities and have an important physiological role, such as:

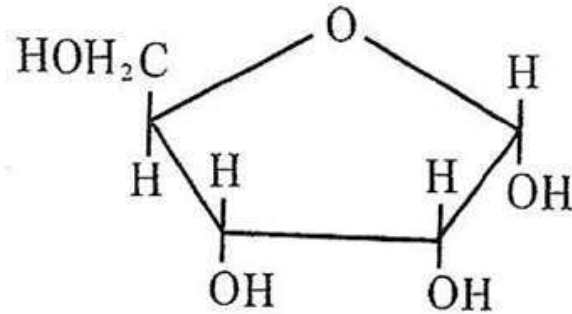
D-Ribose as an example of pentose $C_5H_{10}O_5$.

Glucose and Galactose as an example of hexoses $C_6H_{12}O_6$.

D-Ribose

It is one of the vital important pentose sugars found in nature and is included in the synthesis of nucleic acids such as ribonucleic acid (RNA), deoxyribonucleic acid (DNA), which carries genetic traits.

Ribose is also included in the synthesis of important and different compounds such as nucleotides that make up many important structures such as Adenosine Triphosphate (ATP) and various coenzymes.



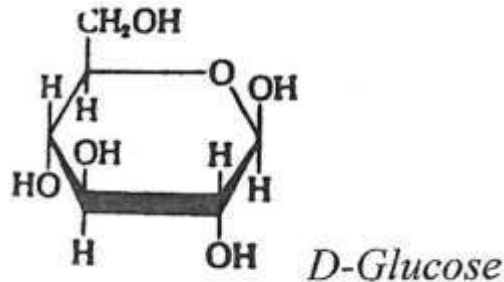
D-Ribose

Glucose

It is one of the important hexose sugars.

This sugar is called "blood sugar" and sometimes dextrose or corn sugar. It is a hexaldehyde sugar, and is one of the most important monosaccharides. It is found in free form or linked to other sugars such as fructose and galactose.

It is freely found in the blood and produced by the breakdown or digested polysaccharides, as well as by the breakdown of glycogen stored in the liver. It is the link in the representation of carbohydrates, where cells use it to release energy and other nutrients.



Galactose

Is one of the hexose sugars also found in nature in a form usually attached to glucose, such as lactose (the milk sugar), it is rare to find in free form such as glucose. galactose can be converted to glucose in the liver.

Oligosaccharides

It includes carbohydrate compounds or sugars that consist of two to 10 units of monosaccharides linked together by a glycosidic linkage. These carbohydrates are broken down into small units of sugars that make up Oligosaccharides.

These compounds are:

- a. Disaccharides are made of two units of monosaccharides.
- b. Trisaccharides are made up of three units of monosaccharides.
- C. Tetrasaccharides are made up of four units of monosaccharides.

1. Polysaccharides

Carbohydrates containing more than 10 units of monosaccharides can be counted as polysaccharides.

There are usually two types of polysaccharides:

a. Homopolysaccharides.

b. Heteropolysaccharides.

Glycogen

Is a *homopolysaccharides* called animal starch, which is the carbohydrate storage in the liver and muscles of humans and animals. It is made up of glucose units consisting of branched chains and can be hydrolyzed by starch-degrading enzymes.

Heteropolysaccharides: consists of a mixture of monosaccharides and their derivatives, including:

mucopolysaccharides

They are sugars of a mucous gelatinous nature present within the body secretions and in the interstitial spaces of cells. Examples of them are:

Hyaluronic acid

Is found in joints as a lubricant, in the umbilical cord, as well as in the skin.
It is also found in snake and bee venom.

Chondroitin

There is more than one type of these compounds, including:

Compound A is found in cornea and cartilage.

Compound B is found in the aorta, skin, and heart valves.

Compound C is found in cartilage and umbilical cord.

Heparin

It is mucopolysaccharides, Considered as an anticoagulant factor found in the liver, lungs, spleen, and blood.

Hydrolysis of peptides

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The peptide bonds that bind the amino acids are broken by one of the three factors:

(1) Acid hydrolysis:

Most proteins are completely decomposed into amino acids, by heating the peptide in an acidic medium containing 6N HCl at 110 °C for a period ranging from 20-70 hours. The decomposition is carried out in an airless and sealed glass tube to prevent any side oxidation. This method is not without side effects, including the following:

- a- Absence of all tryptophan and a small portion of serine and threonine.
- b- Glutamine and asparagine are converted to glutamic and aspartic acid, respectively.
- c- Glutamic acid loses a water molecule and turns into a cyclic compound, as pyrrolidone 5-carboxylic acid.

(2) Alkaline hydrolysis

This method is used only for the recovery of tryptophan, which is not affected by basal decomposition. In this way, some amino acids such as serine, threonine, arginine and cysteine are absent. Also, all amino acids are converted into a racemic form (Racemized).

(3) Enzymatic hydrolysis

There are a number of degrading enzymes that have the ability to dissociate the peptide bond, including trypsin, which attacks the peptide bond that links arginine or lysine with another amino acid. As well as chymotrypsin, which works to break down the peptide bond that binds tyrosine, phenylalanine, or tryptophan with another amino acid.

Separation and identification of amino acids

The free amino acids resulting from the complete hydrolysis of a peptide or protein can be separated and identified by separation methods including:

A- chromatography

The method includes the process of separating molecules from the stationary phase to the mobile phase, and this depends on the ability of the molecules to be separated from the mixture to leave the stationary phase to the mobile phase. Partition chromatography can be clarified in this example: If an amino acid solution is shaken in water with an equal volume of a non-miscible solvent such as n-butanol until the equilibrium state is achieved, then the amino acid will separate between the phases of the liquid in certain proportions representing the Partition coefficient. each amino acid has a molecular separation factor for a pair of immiscible solvents that are thoroughly mixed under a certain temperature. By successive fractional separation of the mixture of amino acids in the two phases, separation of the mixture can be achieved.

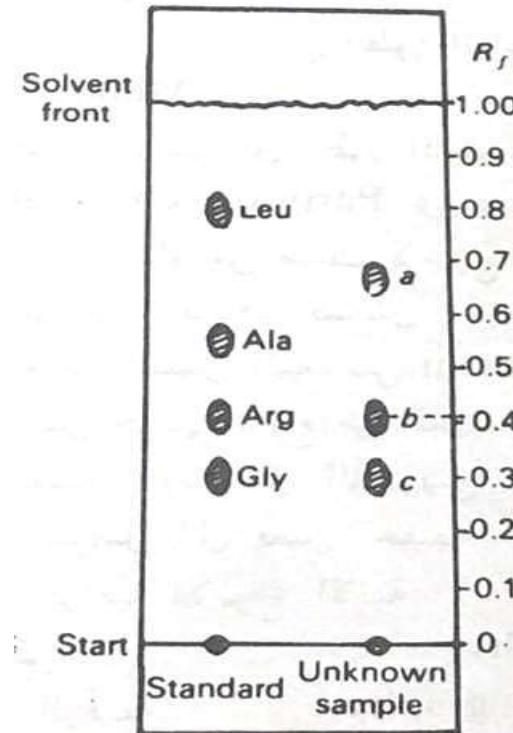
Chromatography techniques include the following types:

- 1- paper chromatography.
- 2- Thin layer chromatography.
- 3- Column chromatography.
- 4- Gel filtration chromatography.
- 5- Ion exchange chromatography.
- 6- Liquid gas chromatography.
- 7-High pressure liquid chromatography

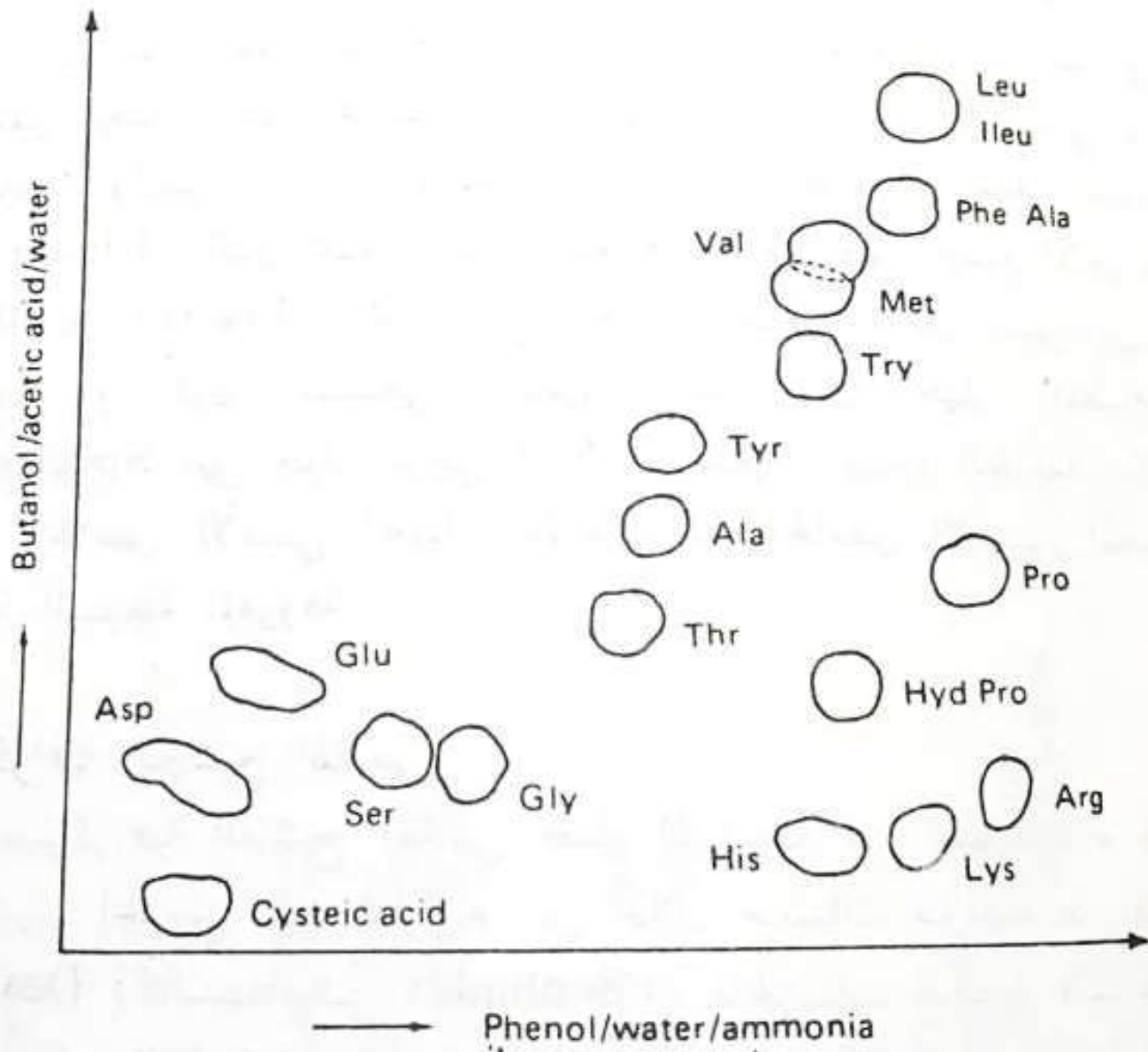
1- Paper chromatography.

Paper chromatography is used to separate many organic compounds. Including amino acids and sugars. Filter paper, which consists of hydrated cellulose fibers, is the principle of fractional separation applied to separate amino acids by paper chromatograms.

When the solvent containing the mixture of amino acids ascends vertically in the paper by the capillary phenomenon or descends in the process of chromatocra separation in the slope, the amino acids are distributed in very small quantities between the mobile phase and the stationary phase associated with the fibers of the paper. At the end of this process, the amino acids move in different dimensions from the original point, as shown in the (Fig. 1).



The paper chromatographic separation process can be carried out in two different directions on the filter paper using two different solvents, and as a result a two-way image of the different amino acids is formed (Fig. 2). In order to determine the location of any amino acid in one-dimensional chromatographic paper, or with two dimensions, the paper is sprayed with 0.5% penhydrin dissolved in acetone, and then the paper is dried under a temperature ranging between 90-110°C. Well-known amino acid patterns are used as a guide for unknown amino acids. The ratio between the distance traveled by an amino acid to the distance traveled by the solvent liquid, is called the value of R_f when a specific solvent is used. In this way, the unknown amino acid in the mixture can be separated and identified.



Enzymes

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Active site

The active site is the amino acid units in the enzyme, involved in the catalytic process, and is in the form of a hole or a coil of the polypeptide chain.

There are two theories involving the combination of the matrix with the active site and the formation of the enzyme - the ES complex:

1. The induced fit model is important and this theory can be likened to a glove that changes shape when it enters the hand. The glove here, is the active site of the enzyme. While the hand is the basis material.

The most important features of this theory are: Flexibility of the effective position,

Induced fit model

2. Lock and key model

In this theory the base material is of a shape perfectly suited to the active site, similar to the entry of a key into a lock. One of the shortcomings of this theory is the rigidity or elasticity of the active site in relation to the base material.

Isoenzymes

They are enzymes that are similar in terms of their action on the same substrate, but differ in relation to the reaction speed - and they contain two or more polypeptide chains, and these chains differ in their amino acid components and sequence. For example, the enzyme **lactate dehydrogenase (LDH)**, and these multiple chains are of two types:

One of them is predominant in **skeletal muscle** and contains **four identical chains**, i.e. of one type and is symbolized by **M₄** (meaning muscle).

The other type is predominant in the **heart** and contains **four identical chains**, i.e. of one type, which is symbolized by **H₄** (meaning the heart).

While in the other tissues LDH enzyme are found as a hybrid i.e. a mixture of (H and M) chains, **M₃H**, **M₂H₂**, and **MH₃**, these together represent five symmetric forms of LDH.

Regulatory Enzymes or Allosteric Enzymes

- In this type the molecule contains several oligomer chains of subunits, some of them contain catalytic sites, others contains Regulatory sites and sometimes allosteric site
- The activity of these enzymes are affected by the concentration of the substrate.
- The active or combined sites are affected by materials called: "Modulators" or "Effectors".

Hydrolysis of peptides

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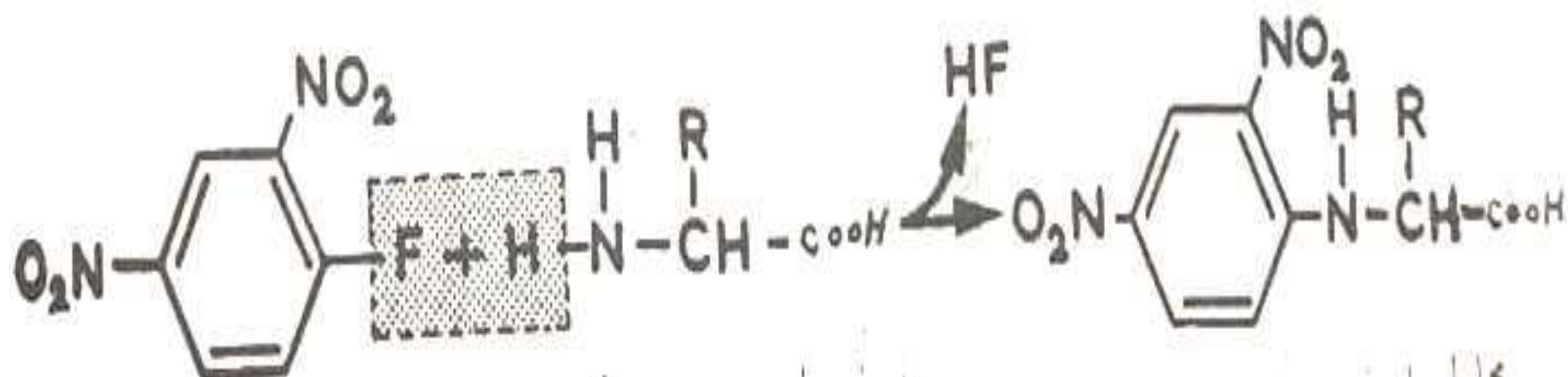
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Determination of amino acid sequence

There are special detectors used to know the amino acid in the nitrogenous end (N-terminal) or in the carboxylic side C- terminal) of the peptide. Among these statements are the following:

1- (Sanger reagent) : 1-fluoro- 2,4-dinitrobenzene FDNB

This reagent is used to identify the amino acid in the (N-terminal) end of the peptide by its association with the alpha-amine group of the acid (Fig. 4). When the compound is decomposed, it produces a derivative consisting of the amino acid bound to the Sanger reagent, which is bright yellow in color, which can be estimated by means of a spectrophotometer or by means of chromatography.



2- (Edman reagent) phenyliso thiocyanate

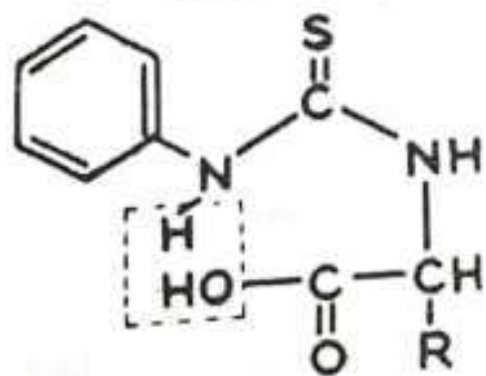
This reagent is used to identify the amino acid at the nitrogenous end (N-terminal), where it combines with the alpha-amine group of the peptide to produce phenyl thiohydantoic acid (Fig. 5). Upon acid decomposition of this compound, it produces cycle phenyl thiohydantoin, which can be diagnosed by chromatography or color spectrometry and by identifying the amino acid at the nitrogen end.



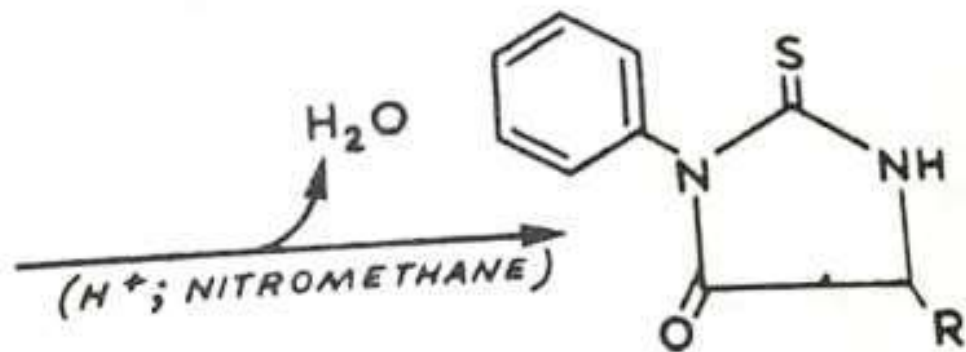
A phenylthiohydantoic acid

Phenylisothiocyanate and amino acid
(Edman reagent)

فینایل ایزوٹایوسیانیٹ
(کاشف ادمان)



Phenylthiohydantoic acid



A phenylthiohydantoin

3- Aminopeptidase

This enzyme attacks the peptide bond that binds the amino acid at the nitrogen end (N-terminal), and separates it from the original peptide. Several amino acids can be separated successively by this enzyme.

4- Carboxypeptidase

This enzyme works to break down the peptide bond that binds the amino acid at the carboxylic terminus (C-terminal) separates it from the original peptide. Several amino acids can also be separated sequentially from the carboxylic terminus by this enzyme and diagnosed.

Separation of several amino acids in succession from the carboxylic terminus by this enzyme and is diagnosed.

After knowing the detectors used to diagnose amino acids in the nitrogenous or carboxylic ends, it is necessary to install these acids in it's correct positions to give a clear picture of the amino acid sequence in the peptide.

Example :

A peptide made up of the following amino acids :

Asp, Ser, Leu, Phe, Tyr

It was treated with Sanger's reagent and gave DNP-Leu

And with the enzyme carboxypeptidase, Ser ,is separated from him. The partial acid hydrolysis of a peptide gave the following products:

Leu-phe

Tyr-Ser

Asp.

Determines knowledge of amino acids sequences in the peptide.

The solution :

Leu is the amino acid at the nitrogen end and is the result of its combination with Sanger's reagent.

Ser is the amino acid at the carboxylic terminus resulting from the attack of the enzyme carboxypeptidase.

And since Leucine is bound with phenylalanine, and serine is bound with Tyrosine as a result of partial acid hydrolysis, then aspartic acid is in the third order of the sequence. Therefore, the amino acid sequence in the peptide can be written as follows:

Leu-Phe-Asp-Tyr-Ser

Enzymes

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Clinical Biochemistry

General properties of enzymes:

1. Enzymes are proteins that build inside the cell and act as biocatalysts to speed up the rate at which biochemical reactions occur.
2. Enzymes enter reactions in small quantities without any change in their chemical composition.
3. The enzyme fully performs its function under the physiological conditions of temperature, pH and specificity of the substrate.
4. The difference between enzymatic reactions and non-enzymatic reactions is that the basic substance in the first is transformed with high efficiency and speed, while in the most uncatalyzed reactions there is a certain percentage of the starting material that is transformed into a product and the rest of the starting material is lost in many side reactions, for example : The enzymes in the muscle cytoplasm have the ability to convert glucose sugar into lactate with a high efficiency estimated at 100%.

5. Some enzymes contain chemical components needed by the enzyme to show its full activity and they are called cofactors. The catalysts are either in the form of minerals such as magnesium and iron ions, or in the form of . An organic molecule called coenzymes, while some enzymes need both types, i.e. metal ions and coenzymes.
6. The cofactors sometimes bind with the protein part of the enzyme strongly, and these cofactors are called the prosthetic group. The catalysts are stable upon heating.
7. There are three groups of enzymes based on their structural structure:
 - a. Enzymes with a single chain of polypeptide chains called monomers Ribonuclease enzyme and trypsin.
 - b. Enzymes consisting of (60-2) polypeptide chains. This type of enzyme is called an oligomer, such as hexokinase consisting of four polypeptide chains.
8. All enzymes contain a region called the active site. Active site, which are amino acid units in an enzyme involved in the catalysis process. Catalysis and blade wrapping for a smooth polypeptide.

Uses of Enzymes

Nowadays, enzymes are extracted from animal or plant tissues for the following purposes:

1. To study one of the metabolic pathways and to regulate the interactions taking place in that pathway.
2. To study the structure of enzymes and their mechanism of action.
3. They are used in industry as biological catalysts for the manufacture of hormones and drugs.
4. We use to study the efficacy of clinical enzymes in serum as an indicator of knowledge of the occurrence of a particular disease condition.

Classification of enzymes

Looking at the large numbers of enzymes, I used a systematic nomenclature, as well as a special classification. Enzymes are grouped into six classes based on the type of reaction they catalyze.

1. Oxidoreductase enzymes.

The enzymes in which electrons are transferred include:

Biological oxidation enzymes called dehydrogenase, as well as oxidation enzymes and peroxidase enzymes.

2. Transferase enzymes

They are enzymes that catalyze the transfer of different active groups such as methyl, formyl, carboxyl, aldehyde, ketone, alkyl, phosphorous and sulfur groups. and nitrogenous.

3. Hydrolyzed enzymes

They are enzymes that catalyze the hydrolysis of base materials and include:

Esterase enzymes, phosphodiesterase, phosphatase, lipase and peptidase.

4. Addition or deletion enzymes

They are enzymes that remove a group of the base material, producing a compound containing a double bond, or it works to add to the double stick, producing a compound that contains a single stick.

5. The corresponding enzymes

They include enzymes that catalyze symmetry reactions, including racemases. Cis-trans isomerase.

6. Binding enzymes

They are enzymes that bind two molecules together so as to break the pyrophosphate bond present in the ATP molecule or compounds - similar to it.

Factors affecting the rate of enzyme-catalyzed reactions

Isomerases Ligases Factors affecting the rate of enzyme-catalysed reactions

The rate of an enzyme-catalyzed reaction depends on five factors:

1. Enzyme concentration.
2. substrate concentration.
3. Temperature.
4. pH.
5. Presence of Inhibitors or Activators.

1. Effect of enzyme concentration.

The rate of an enzyme-catalyzed reaction is directly proportional to the concentration of the enzyme when the substrate is abundantly present in the reaction environment.

2. Effect of substrate concentration

When the enzyme concentration is kept constant, the increase in the concentration of the base material initially causes a rapid increase in the rate of the reaction, but when you continue to increase the concentration of the base material, the increase in the rate of speed slows down to become . The velocity is constant no matter what the concentration of the base material increases.

3. Effect of temperature

The rate of the enzyme-catalyzed reaction increases with the increase in temperature. Each increase of (10) degrees Celsius leads to a doubled rate of the rate of the enzyme-catalysed reaction.

4. Effect of pH

Each enzyme has a pH at which the enzyme starts its maximum activity and is called the maximum pH (pH optimum). pH ranges. The greatest for most enzymes is between (5-9).

5. Enzyme inhibition

Inhibitors are chemical compounds. It lowers the rate of the enzyme-catalyzed reaction.

Inhibitors are classified into two categories:

- * Competitive inhibitor: this type occurs when the inhibitor competes with the substrate for Union with the active site of the enzyme. It is represented in the following equation:

Usually, the chemical structures of the competitive inhibitor and the substrate are very similar, and this type of inhibition is inverse, and depends on the concentration of the inhibitor and the substrate.

- * Non-Competitive inhibitor : In this type there is no competition between the inhibitor and the substrate for union with the active site of the enzyme. As the inhibitor combines with another site in the enzyme other than the active site. The inhibitor may be similar in chemical composition to the main substance or not similar at all.

Hydrolysis of peptides

Dr. Khairaldeem Mohammed

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2- Thin layer chromatography

The principle of fractional separation applies to the process of separation by thin layer chromatography, this method is similar to paper chromatography method that uses an inert material such as cellulose or silica gel, which in this case is used as a stationary phase, while the Solvent Systems, is used as a mobile phase. The same method is used to measure the value of R_f .

3 - Column chromatography

The fractional chromatographic method is used by means of a long column in which granules of inert carbohydrate materials such as starch or cellulose are stacked. Each granule contains a highly cohesive water layer that is used as a stationary phase when the solvents are passed down the column by gravity. The amino acids in the mixture move down the column in different proportions depending on the equivalent of their partial separation between the mobile phase and the stationary phase. The liquid that appears at the bottom of the column is called the filtered liquid(Eluate), which is collected in small quantities by the Fraction Collector, and these parts are then analyzed by the reaction of ninhydrin, The resulting complex has a violet color that absorbs light in the Spectrophotometer at a wavelength of 570 nanometers. In this way, the concentration of the unknown amino acid can be calculated in terms of the known amino acid concentration using the well-known simple mathematical methods.

4- Gel filtration chromatography

Gel filtration chromatography involves separating compounds from each other based on a difference in molecular weight when passed through compact granules of Dextran gel (such as Sephadex). Large particles cannot penetrate the holes of the swollen dextran granules, but pass from outside the granules and exit the column with the first filtered liquid, where they can be separated. The small particles, it penetrates the dextran granules and comes out of the column with the second filtered liquid. In this way, a mixture of amino acids, peptides or proteins can be separated based on a molecular weight difference system.

5-Ion exchange chromatography

The method of chromatographic analysis mediated by ion exchange depends on the principle of partition coefficient.

The resin in this case is the stationary phase, which is a synthetic polymer that has two types:

The first type carries acidic groups (-SOH or -COOH), called positive ion exchanger (Cation exchanger).

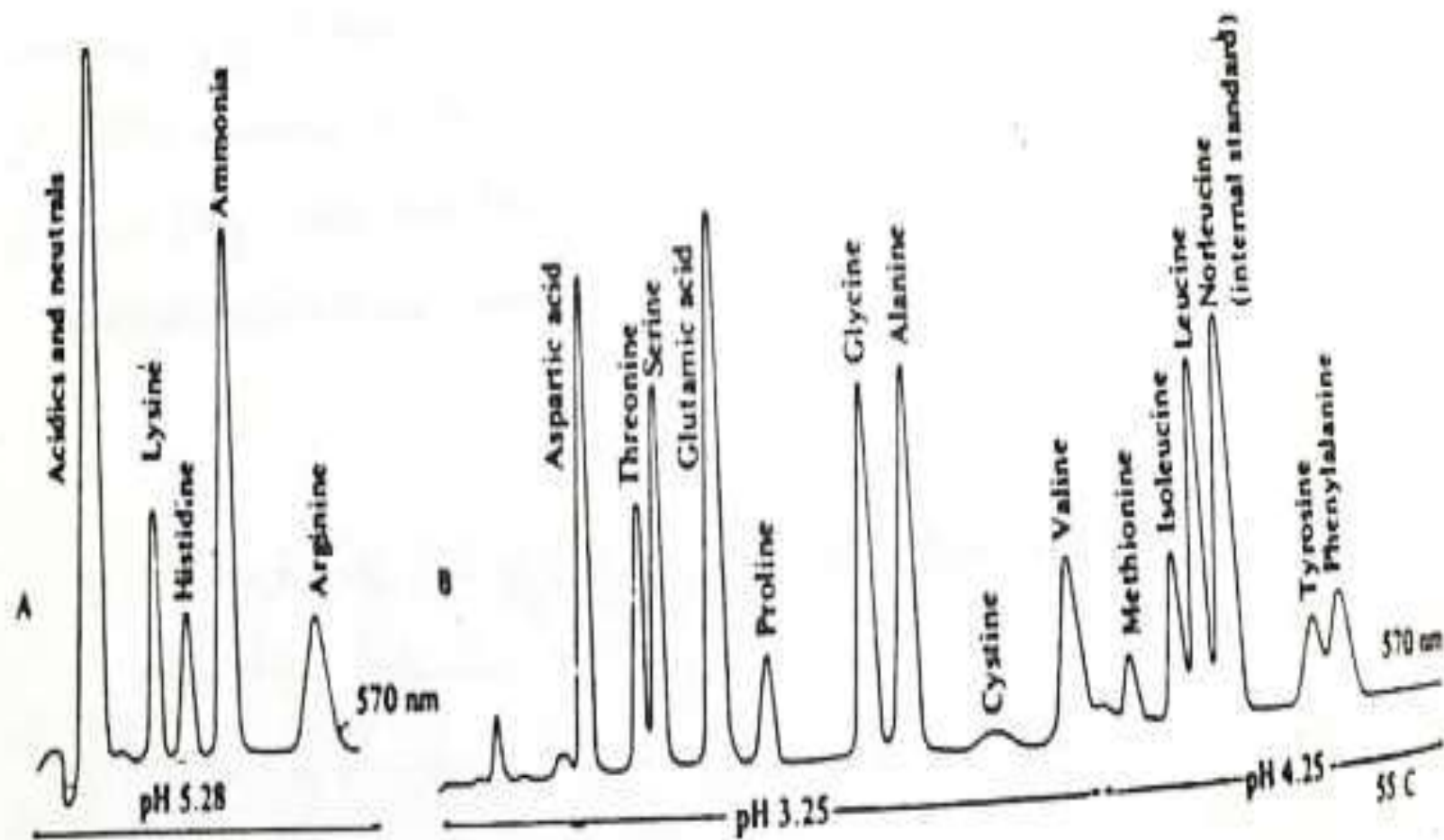
The second type carries basic groups (-OH), called negative ion exchangers (anion exchanger).

The amino acids are separated by(separating columns) containing a resin with cation exchangers, which has been pre-treated with a base solution so that the active groups carry sodium ions.

The amino acid mixture is placed on the upper surface of the resin, then a buffer solution with a (pH 3.0) is passed to filter through the column and the positively charged amino acids such as lysine, arginine and histidine displace the sodium ions resin molecules, and strongly bound with the resin.

While the acidic amino acids, such as aspartic and glutamic, are linked weakly to the stationary phase, so by this way the amino acids are separated, as they pass from the separation column at different speeds. \

The amino acids are collected and analyzed; the results are recorded



6- liquid gas chromatography

It is another good way to separate mixtures of different organic compounds, such as amino acids, organic acids, steroids or drugs. The stationary phase material (either alumina, activated carbon or silica gel) is placed in the separation column. These materials are usually painted or coated with ethylene glycol succinate, which remains in its liquid form under the column temperature, which ranges between $(175-240)^\circ\text{C}$. While the device is operating, a sample of the substance to be separated is dissolved in an organic solvent such as hexane. This dissolved substance is injected into the gas liquid chromatography apparatus by means of a micro syringe. At the same time, there is a carrier gas, such as nitrogen, that passes through the separation column. In this case, the material to be separated is considered a partition between gas and liquid. The separated materials leaving the column pass through a detector such as

7 - High pressure liquid chromatography

It is another type of fractional chromatographic analysis, and it is used to separate mixtures of amino acids, peptides, hormones, fats, or drugs. This type of separation requires the use of high pressures to push the solvent through a thin column.

*** Electrophoresis**

Electro-migration means the movement of dissolved ionic materials towards one electrode in an electric field. This type of separation is used in the analysis of proteins, peptides, amino acids, nucleic acids, nucleotides, hormones, or drugs. Electrical migration depends on the charge, the hydrogen ion of the medium in which the migration occurs, and the voltage used. Electrical migration includes the

1- High voltage electrophoresis

In this type of high-pressure electrical migration, a drop of a solution consisting of a mixture of amino acids is placed on a filter paper plate moistened with the buffer solution and an electric field of very high voltage is applied to it, ranging from (2000-5000) volts for a period ranging between (1\2-2) an hour during which amino acids move either towards the positive pole (Anode) or the negative pole (Cathode), and at different distances due to different values of pK.

The positively charged amino acids such as lysine, arginine and histidine move towards Cathode, the negatively charged amino acids such

2-Isoelectric focusing

The electrolyte focus is used to separate the mixture of amino acids or proteins. Each amino acid or protein has an Isoelectric point (pI), which is the value of (pH) at which the molecule's charge becomes zero. When a drop of a solution consisting of a mixture of amino acids is placed on the surface of the gel prepared from a wide range of a buffer solution, each amino acid moves under the influence of electric current, and collects in a region with (pH) that matches the electrolyte neutral point (pI) of the acid. The amino acids that have different neutralization points can be easily separated by the electrolyte focus.

peptide amino acid sequence

Before starting to study the sequence of amino acids in the peptide or protein, it is very necessary to be familiar with the structure of that protein or peptide to know the sequence of its amino acids. Therefore, the following items must be applied before commencing the study of the amino acid sequence.

- 1- The peptide or protein is of a high degree of purity. In this case, most chemical and physical methods are used to obtain a very pure protein.
- 2- Knowing the structures of the amino acids present in the peptide, by referring to the peptide decomposition experiment.
- 3- Knowing the molecular weight of the peptide either by physical methods, or by knowing the structures of the amino acids present in the peptide.
- 4- Estimating the number of chains present in the peptide, and separating each chain from the other.
- 5- Estimation of the amino acid sequence in each series.
- 6- Knowing the location of the Disulphide bridge.

Proteins - Structure and function

Dr. Khairaldeem Mohammed

PhD

Clinical Biochemistry

Features of the 20 common amino acids

1. *Glycine (Gly)*

It is the simplest visual inactive amino acid. It is used in many structural reactions, including the synthesis of porphyrins and purines. It contains the smallest R-group (H-) and thus fits into the crowded peptide chain. For example, glycine enters the synthesis of the Collagen protein and the fibrous protein in the third sequence, in succession.

2. *Alanine (Ala)*

It is a substrate of the enzyme glutamate pyruvate transaminase (GPT), which is a medically important enzyme.

One of the alanine derivatives is the amino acid beta-alanine.

3. *Cysteine (Cys)*

It contains thiol group (SH), which is essential to show the Effectiveness of a large number of enzymes.

Heavy metals such as mercury and lead inhibit enzymes and freeze proteins due to their strong attachment to the thiol group.

4. *Cystine (Cys -Cys)*

Is the oxidized form of the amino acid cysteine and normally links two separate polypeptide chains together. It also has the ability to form a bridge of disulfide (S-S) in one peptide chain. This amino acid does not have tRNA, and therefore it is not built into the peptide chain by the ribosome during protein biosynthesis, but is formed by the oxidation of two residues of the amino acid cysteine after completing the peptide synthesis.

The amino acid cysteine is responsible for the formation of a type of gallstone, Kidney stone.

5. Methionine (Met)

Is an essential amino acid for humans by using a methyl group in structural reactions involving trans-methylation, this amino acid is also built in the process of building protein.

6. Leucine (Leu)

Leucine is an essential acid for humans.

The R group is branched and is called the hydrophobic group and it interferes with the hydrophobic groups of amino acids.

7. Isoleucine (Ile)

Isoleucine is an essential amino acid for humans.

The lateral group has R hydrophobic and branched.

8. Valine

Is an essential amino acid for humans . The R group is hydrophobic and branched. Any deficiency in the metabolism of the amino acids leucine, isoleucine, and valine results in urine containing large amounts of ketoacids derived from these amino acids. It is a genetic metabolic disease that affects humans called maple syrup urine disease and is accompanied by mental retardation.

9. Serine (Ser)

In phosphorylated proteins, the phosphate group is attached to the OH-group of the serine. Serine included in the active sites of a large number of enzymes.

10. Threonine (Thr)

Is an essential amino acid for humans.

11. Phenylalanine (Phe)

Is an essential amino acid for humans. The R group is hydrophobic.

The metabolic error of phenylalanine results in phenylketonuria disease and its symptoms are mental retardation and an increase in the excretion of phenylalanine in the urine.

It is caused by a deficiency in the enzyme phenylalanine hydroxylase.

12. Tyrosine (Tyr)

It is involved in the construction of thyroid hormones, catechol amines, and melanin pigment.

The determination of the protein by the Folin method is due to the reduction of the phosphomoldic-phostungstic solution by the tyrosine units present in the protein.

13. Tryptophan (Trp)

An essential amino acid for humans. It is converted to serotonin in the central nervous system as well as in the intestinal mucosa.

14 Aspartic acid (Asp)

It is a precursor to the enzyme glutamate oxaloacetate transaminase (GOT), which has clinical significance.

15. Asparagine (Asn)

Is an opposite of aspartic acid. It is often present in the protein and It has its own carrier tRNA.

16. Glutamic acid (Glu)

It is the precursor to the enzyme glutamate oxaloacet transaminase (GOT), which is of clinical importance.

17. Glutamine (Gln)

It is the amide opposite to glutamic acid and is present in the protein and

has its own transporter ribonucleic acid. Glutamine enters into several important reactions, including that the gamma-amino group derived from ammonia is included in the construction of purine and pyrimidine nucleotides and is converted into urea in the liver or excreted in the form of ammonia in the peripheral cells of the renal tubules.

18. Arginine (Arg)

It enters into the construction of urea, and it contains the guanido group.

19. Lysine (Lys)

Lysine is an essential acid for humans. It is included in the composition of both Collagen and Elastin. Also, lysine is involved in the reaction that forms fibrin, a fibrous protein essential for blood clotting, produced from the union of the fibrous protein containing the glutamine residue with the fibrous protein containing the lysine residue and the formation of a peptide bond

20. Histidine (His)

The hemoglobin molecule is a proton transporter from various tissues to the lungs, and in fact, the histidine present in hemoglobin is involved in the proton transfer process. Histidine is also involved in the function of the heme group. Histidine is also a general base for the active sites of a large number of enzymes. It is converted to histamine by deleting the carbon dioxide molecule. Histamine is generated in a large number of cells. In the blood, histamine is formed in basophils called basophils.

21. Proline (Pro)

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In specialized proteins there are a few rare amino acids derived from the 20 amino acids, found in proteins.

LABORATORY SAFETY AND REGULATIONS

Dr. Khairaldeem Mohammed
PhD
Clinical Biochemistry

Chemical Waste

In some cases, it is permissible to flush water-soluble substances down the drain with copious quantities of water. However, strong acids or bases should be neutralized before disposal. Foul-smelling chemicals should never be disposed of down the drain. Possible reaction of chemicals in the drain and potential toxicity must be considered when deciding if a particular chemical can be dissolved or diluted and then flushed down the drain. For example, sodium azide, which is used as a preservative, forms explosive salts with metals, such as the copper in pipes. Most institutions restrict the use of sodium azide due to this hazard.

Other liquid wastes, including flammable solvents, must be collected in approved containers and segregated into compatible classes. If practical, solvents such as xylene and acetone may be filtered or redistilled for reuse. If this is not feasible, disposal arrangements should be made by specifically trained personnel. Flammable material also can be burned in specially designed incinerators with afterburners and scrubbers to remove toxic products of combustion.

Also, before disposal, hazardous substances that are explosive, such as carcinogens and peroxides, should be transformed to less hazardous forms whenever feasible. Solid chemical wastes that are unsuitable for incineration must be buried in a landfill. This practice, however, has created an environmental problem, and there is now a shortage of safe sites.

Radioactive Waste

The manner of use and disposal of isotopes is strictly regulated by the Nuclear Regulatory Commission (NRC) and depends on the type of waste (soluble or nonsalable), its level of radioactivity and the radio toxicity and half-life of the isotopes involved. The radiation safety officer should always be consulted about policies dealing with radioactive waste disposal. Many clinical laboratories transfer radioactive materials to a licensed receiver for disposal.

Biohazardous Waste

On November 2, 1988, President Reagan signed into law The Medical Waste Tracking Act of 1988. Its purpose was to (1) charge the Environmental Protection Agency with the responsibility to establish a program to track medical waste from generation to disposal, (2) define medical waste, (3) establish acceptable techniques for treatment and disposal, and (4) establish a department with jurisdiction to enforce the new laws. Several states have implemented the federal guidelines and incorporated additional requirements. Some entities covered by the rules are any health care-related facility including, but not limited to, ambulatory surgical centers: blood banks and blood drawing centers, clinics, including medical, dental, and veterinary: clinical, diagnostic, pathologic, or biomedical research laboratories: emergency medical services; hospitals, long-term-care facilities; minor emergency centers; occupational health clinics and clinical laboratories; and professional offices of physicians and dentists .

Medical waste is defined as special waste from health care facilities and is further defined as solid waste that, "Improperly treated or handled "may transmit infectious diseases" (For additional information, see the JCAHO Web site: www.jcaho.org). It comprises animal waste, bulk blood and blood products, microbiologic waste, pathologic waste, and sharps. The approved methods for treatment and disposition of medical waste are incineration, steam sterilization, burial, thermal activation chemical disinfection, or encapsulation in a solid matrix.

Generators of medical waste must implement the following procedures:

- Employers of health care workers must establish and implement an infectious waste program.
- All biomedical waste should be placed into a bag marked with the biohazard symbol and then placed into a leak-proof container that is puncture resistant and equipped with a solid, tight-fitting lid. All containers must be clearly marked with the word biohaz. and or its symbol.
- All sharp instruments, such as needles, blades, and glass objects, should be placed into special puncture resistant containers before placing them inside the bag and container.
- Needles should not be transported, recapped, bent, or broken by hand.
- All biomedical waste must then be disposed of by one of the recommended procedures.
- Potentially bio hazardous material, such as blood or blood products and contaminated laboratory waste, cannot be directly discarded. Contaminated combustible waste can be incinerated. Contaminated noncombustible waste, such as glassware, should be autoclaved before being discarded. Special attention should be given to the discarding of syringes, needles, and broken glass that also could inflict accidental cuts or punctures. Appropriate containers should be used for discarding these sharp objects.

ACCIDENT DOCUMENTATION AND INVESTIGATION

Any accidents involving personal injuries, even minor ones, should be reported immediately to a supervisor. Under OSHA regulations, employers are required to maintain records of occupational injuries and illnesses for length of employment plus 30 years. The recordkeeping requirements include a first report of injury, an accident investigation report, and an annual summary that is recorded on an OSHA injury log (Form 300).

The first report of injury is used to notify the insurance company and the human resources or employee relations department that a workplace injury has occurred. The employee and the supervisor usually complete the report, which contains information on the employer and injured person, as well as the time and place, cause, and nature of the injury. The report is signed and dated: then it is forwarded to the institution's risk manager or insurance representative.

The investigation report should include information on the injured person; a description of what happened; the cause of the accident (environmental or personal); other contributing factors; witnesses; the nature of the injury; and actions to be taken to prevent a recurrence. This report should be signed and dated by the person who conducted the investigation.

Annually, a log and summary of occupational injuries and illnesses should be completed and forwarded to the U.S. Department of Labor, Bureau of Labor Statistics (OSHA Injury Log No. 300). The standardized form requests information similar to the first report of injury and the accident investigation report. Information about every occupational death, nonfatal occupational illness, biologic or chemical exposure, and nonfatal occupational injury that involved loss of consciousness, restriction of work or motion, transfer to another job, or medical treatment (other than first aid) must be reported.

Because it is important to determine why and how an accident occurred, an accident investigation should be conducted. Most accidents can be traced to two underlying causes: environmental (unsafe conditions) or personal (unsafe acts). Environmental factors include inadequate safeguards, use of improper or defective equipment, hazards associated with the location, or poor housekeeping. Personal factors include improper laboratory attire, lack of skills or knowledge, specific physical or mental conditions, and attitude. The employee's positive motivation is important in all aspects of safety promotion and accident prevention.

It is particularly important that the appropriate authority be notified immediately if any individual sustains a needle puncture during blood collection or a cut during subsequent specimen processing or handling. For a summary of recommendations for the protection of laboratory workers, refer to Protection of Laboratory Workers from Instrument Biohazards and Infectious Disease Transmitted by Blood, Body Fluids and Tissue, Approved Guideline M29-A2 (NCCLS).

Proteins - Structure and function

Dr. Khairaldeem Mohammed

PhD

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Features of the 20 common amino acids

1. Glycine (Gly)

It is the simplest visual inactive amino acid. It is used in many structural reactions, including the synthesis of porphyrins and purines. It contains the smallest R-group (H-) and thus fits into the crowded peptide chain. For example, glycine enters the synthesis of the Collagen protein and the fibrous protein in the third sequence, in succession.

2. Alanine (Ala)

It is a substrate of the enzyme glutamate pyruvate transaminase (GPT), which is a medically important enzyme.

One of the alanine derivatives is the amino acid beta-alanine.

3. *Cysteine (Cys)*

It contains thiol group (SH), which is essential to show the Effectiveness of a large number of enzymes.

Heavy metals such as mercury and lead inhibit enzymes and freeze proteins due to their strong attachment to the thiol group.

4. *Cystine (Cys -Cys)*

Is the oxidized form of the amino acid cysteine and normally links two separate polypeptide chains together. It also has the ability to form a bridge of disulfide (S-S) in one peptide chain. This amino acid does not have tRNA, and therefore it is not built into the peptide chain by the ribosome during protein biosynthesis, but is formed by the oxidation of two residues of the amino acid cysteine after completing the peptide synthesis.

The amino acid cysteine is responsible for the formation of a type of gallstone, Kidney stone.

5. Methionine (Met)

Is an essential amino acid for humans by using a methyl group in structural reactions involving trans-methylation, this amino acid is also built in the process of building protein.

6. Leucine (Leu)

Leucine is an essential acid for humans.

The R group is branched and is called the hydrophobic group and it interferes with the hydrophobic groups of amino acids.

7. Isoleucine (Ile)

Isoleucine is an essential amino acid for humans.

The lateral group has R hydrophobic and branched.

8. Valine

Is an essential amino acid for humans . The R group is hydrophobic and branched. Any deficiency in the metabolism of the amino acids leucine, isoleucine, and valine results in urine containing large amounts of ketoacids derived from these amino acids. It is a genetic metabolic disease that affects humans called maple syrup urine disease and is accompanied by mental retardation.

9. Serine (Ser)

In phosphorylated proteins, the phosphate group is attached to the OH-group of the serine. Serine included in the active sites of a large number of enzymes.

10. Threonine (Thr)

Is an essential amino acid for humans.

11. Phenylalanine (Phe)

Is an essential amino acid for humans. The R group is hydrophobic.

The metabolic error of phenylalanine results in phenylketonuria disease and its symptoms are mental retardation and an increase in the excretion of phenylalanine in the urine.

It is caused by a deficiency in the enzyme phenylalanine hydroxylase.

12. Tyrosine (Tyr)

It is involved in the construction of thyroid hormones, catechol amines, and melanin pigment.

The determination of the protein by the Folin method is due to the reduction of the phosphomoldic-phostungstic solution by the tyrosine units present in the protein.

13. Tryptophan (Trp)

An essential amino acid for humans. It is converted to serotonin in the central nervous system as well as in the intestinal mucosa.

14 Aspartic acid (Asp)

It is a precursor to the enzyme glutamate oxaloacetate transaminase (GOT), which has clinical significance.

15. Asparagine (Asn)

Is an opposite of aspartic acid. It is often present in the protein and It has its own carrier tRNA.

16. Glutamic acid (Glu)

It is the precursor to the enzyme glutamate oxaloacet transaminase (GOT), which is of clinical importance.

17. Glutamine (Gln)

It is the amide opposite to glutamic acid and is present in the protein and

has its own transporter ribonucleic acid. Glutamine enters into several important reactions, including that the gamma-amino group derived from ammonia is included in the construction of purine and pyrimidine nucleotides and is converted into urea in the liver or excreted in the form of ammonia in the peripheral cells of the renal tubules.

18. Arginine (Arg)

It enters into the construction of urea, and it contains the guanido group.

19. Lysine (Lys)

Lysine is an essential acid for humans. It is included in the composition of both Collagen and Elastin. Also, lysine is involved in the reaction that forms fibrin, a fibrous protein essential for blood clotting, produced from the union of the fibrous protein containing the glutamine residue with the fibrous protein containing the lysine residue and the formation of a peptide bond

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CONTROL OF OTHER HAZARDS

Electrical Hazards

Most individuals are aware of the potential hazards associated with the use of electrical appliances and equipment. Hazards of electrical energy can be direct and result in death, shock, or burns. Indirect hazards can result in fire or explosion. Therefore, there are many precautionary procedures to follow when operating or working around electrical equipment:

- Use only explosion-proof equipment in hazardous atmospheres.
- Be particularly careful when operating high-voltage equipment, such as electrophoresis apparatus.
- Use only properly grounded equipment (three-prong plug).
- Check for frayed electrical cords.
- Promptly report any malfunctions or equipment producing a "tingle" for repair.
- Do not work on "live" electrical equipment.
- Never operate electrical equipment with wet hands.
- Know the exact location of the electrical control panel for the electricity to your work area.
- Use only approved extension cords and do not overload circuits. (Some local regulations prohibit the use of any extension cord.)
- Have ground checks and other periodic preventive maintenance performed on equipment.

Compressed Gases Hazards

Compressed gases, which serve a number of functions in the laboratory, present a unique combination of hazards in the clinical laboratory: danger of fire, explosion, asphyxiation, or mechanical injuries. There are several general requirements for safely handling compressed gases:

- Know the gas that you will use.
- Store tanks in a vertical position.
- Keep cylinders secured at all times.
- Never store flammable liquids and compressed gases in the same area.
- Use the proper regulator for the type of gas in use.
- Do not attempt to control or shut off gas flow with the pressure relief regulator.

- Keep removable protection caps in place until the cylinder is in use.
- Make certain that acetylene tanks are properly piped (the gas is incompatible with copper tubing).
- Do not force a "frozen" or stuck cylinder valve.
- Use a hand truck to transport large tanks.
- Always check tanks on receipt and then periodically for any problems such as leaks.
- Make certain that the cylinder is properly labeled to identify the contents.

Empty tanks should be marked "empty."

Cryogenic Materials Hazards

Liquid nitrogen is probably one of the most widely used cryogenic fluids (liquefied gases) in the laboratory. There are, however, several hazards associated with the use of any cryogenic material: fire or explosion, asphyxiation, pressure buildup, embrittlement of materials, and tissue damage similar to that of thermal burns.

Only containers constructed of materials designed to withstand ultralow temperatures should be used for cryogenic work. In addition to the use of eye/face protection, hand protection to guard against the hazards of touching supercooled surfaces is recommended. The gloves, of impermeable material, should fit loosely so that they can be taken off quickly if liquid spills on or into them. Also, to minimize violent boiling/frothing and splashing, specimens to be frozen should always be inserted into the coolant very slowly. Cryogenic fluids should be stored in well-insulated but loosely stoppered containers that minimize loss of fluid resulting from evaporation by-boil-off and that prevent plugging and pressure buildup.

Mechanical Hazards

In addition to physical hazards such as fire and electric shock, laboratory personnel should be aware of the mechanical hazards of equipment such as centrifuges, autoclaves, and homogenizers.

Centrifuges, for example, must be balanced to distribute the load equally. The operator should never open the lid until the rotor has come to a complete stop. Safety locks on equipment should never be rendered inoperable.

Laboratory glassware itself is another potential hazard. Agents, such as glass beads, should be added to help eliminate bumping/boilover when liquids are heated. Tongs or gloves should be used to remove hot glassware from ovens, hot plates, or water baths. Glass pipets should be handled with extra care, as should sharp instruments such as cork borers, needles, scalpel blades and other tools. A glassware inspection program should be in place to detect signs of wear or fatigue that could contribute to breakage or injury. All infectious sharps must be disposed in OSHA-approved containers to reduce the risk of injury and infection.

Ergonomic Hazards

Although increased mechanization and automation have made many tedious and repetitive manual tasks obsolete, laboratory processes often require repeated manipulation of instruments, containers, and equipment. These physical actions can, over time, contribute to repetitive strain disorders such as tenosynovitis, bursitis, and ganglion cysts. The primary contributing factors associated with repetitive strain disorders are position/posture, applied force, and frequency of repetition. Remember to consider the design of hand tools (eg, ergonomic pipets), adherence to ergonomically correct technique, and equipment positioning when engaging in any repetitive task. Chronic symptoms of pain, numbness, or tingling in extremities may indicate the onset of repetitive strain disorders. Other hazards include acute musculoskeletal injury. Remember to lift heavy objects properly, keeping the load close to the body and using the muscles of the legs rather than the back. Gradually increase force when pushing or pulling, and avoid pounding actions with the extremities.

DISPOSAL OF HAZARDOUS MATERIALS

The safe handling and disposal of chemicals and other materials requires a thorough knowledge of their properties and hazards. Generators of hazardous wastes have a moral and legal responsibility, as defined in applicable local, state, and federal regulations, to protect both the individual and the environment when disposing of waste. There are four basic waste-disposal techniques: flushing down the drain to the sewer system, incineration, landfill burial, and recycling.

Proteins - Structure and function

Dr. Khairaldeem Mohammed

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Clinical Biochemistry

Classification of proteins

Proteins are classified on the basis of their chemical structure or their association with other organic and inorganic substances into:

First: Simple proteins:

They are the simplest proteins and consist of peptides and chains consisting only of amino acids, and they are divided into:

1. Scleroproteins (fibrous proteins):

The supporting parts or protective functions of animal organs.

For examples:

Collagen, which is the basis for the formation of connective tissue, skin, cartilage and bone.

Keratin is the tissue located in the skin, nails, and hair, as well as the horns, hooves, and feathers of animals.

Elastins are found in cartilage and arterial walls, which give them flexibility.

2. Globular proteins (soluble proteins) including:

Albumins: They are proteins that dissolve in water and salts and coagulate with heat, including the protein in egg white, Ovalbumin, milk, Lactalbumin, and serum albumin.

Globulins: including:

Serumglubulin, muscleglubulin and , lactoglobulin, as well as Thyroglubulin in the thyroid gland

Histones:

It dissolves in water and in dilute solutions and coagulates by heat. Usually this protein accompanies nucleic acids, as it has a role in heredity, such as nucleohistone

Second: Conjugated proteins

They are made up of a protein portion paired with another

non-protein portion such as carbohydrates and fats called the

Prosthetic group, including:

1. Nucleoproteins:

It consists of the association of nucleic acids with one or more protein molecule inside the nucleus where it is associated with DNA, and in the cytoplasm it is associated with RNA and so-called “ ribosomes ” which have a role in the synthesis of proteins.

2. Mucoproteins & Glycoproteins

It consists of the association of carbohydrates with proteins and these are called mucous sugars such as "Mucin" in the stomach wall, as well as globulins found in the blood.

3. Phosphoproteins:

Proteins combined with compounds containing phosphoric acid, such as casein, a milk protein, and ovovitellin, a protein found in egg yolks.

4. Chromoproteins:

Proteins contain a color group called: chromophoric group or prosthetic group, As the presence of a mineral such as iron in hemoglobin.

The biological significance of the amino acid sequence

The knowledge of amino acids and their sequence in polypeptides is one of the important subjects in chemistry and life and lies in:

1. When knowing the number and sequence of amino acids in a polypeptide extracted from natural sources, it is possible to manufacture that peptide in the laboratory by a chemical method, for example, the manufacture of the enzyme ribonuclease, which consists of 124 units of amino acid units. It is now possible to manufacture any protein chemically for industrial purposes.

2. The sickle cell anemia can be studied. It is a disease caused by a genetic mutation that led to the replacement of the natural glutamic acid unit in position 6 of the beta chain of the healthy hemoglobin molecule in adults, which is expressed as (HbA).

With the unit of the amino acid valine, this substitution results in that the red blood cells take a sickle shape (a crescent) and it is expressed as (HbS), and this sick blood cell is characterized by its low absorption of oxygen.

3. A view of progress. Genetic biochemistry sciences.

In the future, it is expected to control the gene, which synthesizes protein, and direct the gene to generate a healthy protein, thus overcoming the genetic mutation in genetic diseases.

LABORATORY SAFETY AND REGULATIONS

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Corrosive Chemicals

Corrosive chemicals are injurious to the skin or eyes by direct contact or to the tissue of the respiratory and gastrointestinal tracts if inhaled or ingested. Typical examples include acids (acetic, sulfuric, nitric, and hydrochloric) and bases (ammonium hydroxide, potassium hydroxide, and sodium hydroxide).

Reactive Chemicals

Reactive chemicals are substances that, under certain conditions, can spontaneously explode or ignite or that evolve heat or flammable or explosive gases. Some strong acids or bases react with water to generate heat (exothermic reactions). Hydrogen is liberated if alkali metals (sodium or potassium) are mixed with water or acids, and spontaneous combustion also may occur. The mixture of oxidizing agents, such as peroxides, and reducing agents, such as hydrogen, generate heat and may be explosive.

Carcinogenic Chemicals

Carcinogens are substances that have been determined to be cancer-causing agents. OSHA has issued lists of confirmed and suspected carcinogens and detailed standards for the handling of these substances. Benzidine is a common example of a known carcinogen. If possible, a substitute chemical or different procedure should be used to avoid exposure to carcinogenic agents. For regulatory (OSHA) and institutional safety requirements, the laboratory must maintain an accurate inventory of carcinogens.

Chemical Spills

Strict attention to good laboratory technique can help prevent chemical spills. However, emergency procedures should be established to handle any accidents. If a spill occurs, the first step should be to assist/evacuate personnel, then confinement and cleanup of the spill can begin. There are several commercial spill kits available for neutralizing and absorbing spilled chemical solutions .

However, no single kit is suitable for all types of spills. Emergency procedures for spills should also include a reporting system.

RADIATION SAFETY

Environmental Protection

A radiation safety policy should include environmental and personnel protection. All areas where radioactive materials are used or stored must be posted with caution signs, and traffic in these areas should be restricted to essential personnel only: Regular and systematic monitoring must be emphasized, and decontamination of laboratory equipment, glassware, and work areas should be scheduled as part of routine procedures. Records must be maintained as to the quantity of radioactive material on hand as well as the quantity that is disposed. A Nuclear Regulatory Commission (NRC) license is required if the total amount of radioactive material exceeds a certain level. The laboratory safety officer must consult with the institutional safety officer about these requirements.

Personal Protection

It is essential that only properly trained personnel work with radioisotopes and that users are monitored to ensure that the maximal permissible dose of radiation is not exceeded. Radiation monitors must be evaluated regularly to detect degree of exposure for the laboratory employee. Records must be maintained for the length of employment plus 30 years.

Nonionizing Radiation

Nonionizing forms of radiation are also a concern in the clinical laboratory. Equipment often emits a variety of wavelengths of electromagnetic radiation that must be protected against through engineered shielding or use of personal protective equipment.

These energies have varying biologic effects, depending on wavelength, power intensity, and duration of exposure. Laboratories must be knowledgeable regarding the hazards presented by their equipment to protect themselves and ancillary personnel.

FIRE SAFETY

The Chemistry of Fire

Fire is basically a chemical reaction that involves the rapid oxidation of a combustible material or fuel, with the subsequent liberation of heat and light. In the clinical chemistry laboratory, all the elements essential for fire to begin are present-fuel, heat or ignition source, and oxygen (air).

However, recent research suggests that a fourth factor is present. This factor has been classified as a reaction chain in which burning continues and even accelerates. It is caused by the breakdown and recombination of the molecules from the material burning with the oxygen in the atmosphere.

The fire triangle has been modified into a three-dimensional pyramid known as the fire tetrahedron .

This modification does not eliminate established procedures in dealing with a fire but does provide additional means by which fires may be prevented or extinguished. A fire will extinguish if any of the three basic elements are removed.

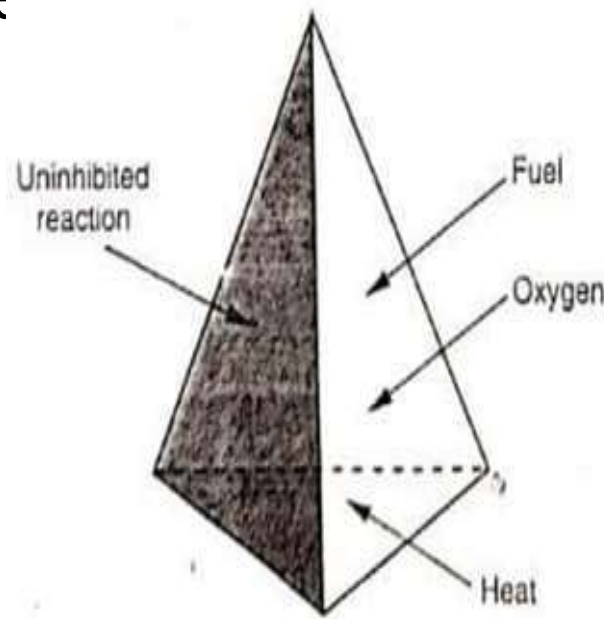


FIGURE 2-3. Fire tetrahedron.

Classification of Fires

Fires have been divided into four classes based on the nature of the combustible material and requirements for extinguishment:

Class A: ordinary combustible solid materials, such as paper, wood, plastic, and fabric.

Class B: flammable liquids/gases and combustible petroleum products. Class C: energized electrical equipment.

Class D: combustible/reactive metals, such as magnesium, sodium, and potassium.

Types/Applications of Fire Extinguishers

Just as fires have been divided into classes, fire extinguishers are divided into classes that correspond to the type of fire to be extinguished. Be certain to choose the right type-using the wrong type of extinguisher may be dangerous. For example, do not use water on burning liquids or electrical equipment.

Pressurized-water extinguishers, as well as foam and multipurpose dry-chemical types, are used for Class A fires. Multipurpose dry-chemical and carbon dioxide extinguishers are used for Class B and C fires. Halogenated hydrocarbon extinguishers are particularly recommended for use with computer equipment. Class D fires present special problems, and extinguishment is left to trained firefighters using special dry-chemical extinguishers. Personnel should know the location and type of portable fire extinguisher near their work area and know how to use an extinguisher before a fire occurs. In the event of a fire, first evacuate all personnel, patients, and visitors who are in immediate danger and then activate the fire alarm, report the fire, and attempt to extinguish the fire, if possible. Personnel should work as a team to carry out emergency procedures. Fire drills must be conducted regularly and with appropriate documentation.

Proteins - Structure and function

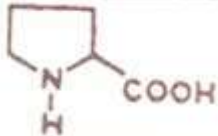

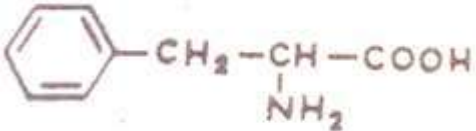
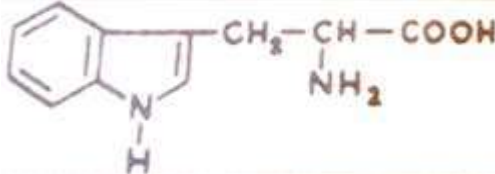
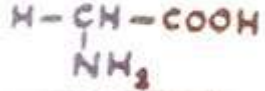
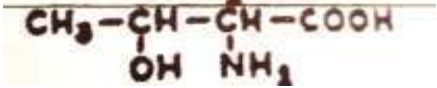
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Table (1)

<i>Chemical structures</i>	<i>Symbol</i>	<i>Amino acid</i>
$\begin{array}{c} \text{CH}_3 - \text{CH} - \text{COOH} \\ \\ \text{NH}_2 \end{array}$	Ala	Alanine
$\begin{array}{c} \text{H}_3\text{C} \\ \\ \text{H}_3\text{C} - \text{CH} - \text{CH} - \text{COOH} \\ \\ \text{NH}_2 \end{array}$	Val	Valine
$\begin{array}{c} \text{H}_3\text{C} \\ \\ \text{H}_3\text{C} - \text{CH} - \text{CH}_2 - \text{CH} - \text{COOH} \\ \\ \text{NH}_2 \end{array}$	Leu	Leucine
$\begin{array}{c} \text{CH}_3 \\ \\ \text{CH}_2 \\ \\ \text{CH} - \text{CH} - \text{COOH} \\ \quad \\ \text{CH}_3 \quad \text{NH}_2 \end{array}$	Ile	Isoleucine

	Pro	Proline
	Met	Methionine
	Phe	Phenyl alanine
	Trp	Tryptophan
	Gly	Glycine
	Thr	Threonine

$\begin{array}{c} \text{CH}_2 - \text{CH} - \text{COOH} \\ \quad \\ \text{OH} \quad \text{NH}_2 \end{array}$	Cys	Cysteine
$\text{HO} - \text{C}_6\text{H}_4 - \text{CH}_2 - \text{CH} - \text{COOH}$ $\quad \quad \quad $ $\quad \quad \quad \text{NH}_2$	Tyr	Tyrosine
$\begin{array}{c} \text{H}_2\text{N} - \text{C} - \text{CH}_2 - \text{CH} - \text{COOH} \\ \quad \\ \text{O} \quad \text{NH}_2 \end{array}$	Asn	Asparagine
$\begin{array}{c} \text{H}_2\text{N} - \text{C} - \text{CH}_2 - \text{CH}_2 - \text{CH} - \text{COOH} \\ \quad \\ \text{O} \quad \text{NH}_2 \end{array}$	Gln	Glutamine
$\begin{array}{c} \text{CH}_2 - \text{CH}_2 - \text{CH}_2 - \text{CH}_2 - \text{CH} - \text{COOH} \\ \quad \quad \quad \\ \text{NH}_2 \quad \quad \quad \text{NH}_2 \end{array}$	Lys	Lysine
$\begin{array}{c} \text{H} - \text{N} - \text{CH}_2 - \text{CH}_2 - \text{CH}_2 - \text{CH} - \text{COOH} \\ \quad \quad \quad \\ \text{C} = \text{NH} \quad \quad \quad \text{NH}_2 \\ \\ \text{NH}_2 \end{array}$	Arg	Arginine

$\text{HN} \begin{array}{c} \diagup \\ \text{C} \\ \diagdown \end{array} \text{N} - \text{CH}_2 - \underset{\text{NH}_2}{\text{CH}} - \text{COOH}$	His	Histidine
$\begin{array}{c} \text{H} \\ \\ \text{HO}-\text{C}-\text{CH}_2 \\ \quad \\ \text{H}_2\text{C} \quad \text{CH}-\text{COOH} \\ \\ \text{N} \\ \\ \text{H} \end{array}$		Hydroxyproline
$\text{NH}_2 - \text{CH}_2 - \underset{\text{OH}}{\text{CH}} - \text{CH}_2 - \text{CH}_2 - \underset{\text{NH}_2}{\overset{\text{H}}{\text{C}}} - \text{COOH}$		Hydroxylysine

Peptides

A peptide is two or more amino acids linked together by a bond called a peptide bond. If the number of amino acids in a peptide exceeds **ten**, it is called a "**polypeptide**."

If a peptide consists of **two** amino acids, it is called a **dipeptide**, and if it consists of **three** amino acids, it is called a **tripeptide**, but if it is made of **four** amino acids, it is called a **tetrapeptide**, and thus it is called a polypeptide.

Most of the peptides are in the form of an open chain with two ends: . The first one is at the far left and is called the amino terminal end and the other is at the far right and is called the carboxyl terminal end.

Some biological important peptides:

Animal, plant and bacterial cells contain different types of peptides with small molecular weights that have great life importance. Some of them are hormones, and some are antibiotics. Here are some of these peptides:

1. *Glutathione*:

It is a tripeptide, which is composed of three amino acids: glutamic, cysteine, and glycine and is symbolized by GSH. Its most important function is **to maintain enzymes in their effective reduced form** due to the fact that it contains the “SH-” group “Sulphydryl” because the enzyme in its oxidized form is considered inactive.

2. *Bradykinin*;

It is made up of nine amino acids from the plasma by the action of the enzyme trypsin. It is considered a sedative agent as it lowers smooth muscle tension.

3. *Oxytocin*:

It is a cyclic hormone consisting of nine amino acids, secreted by the posterior lobe of the pituitary gland.

Its secretion increases during pregnancy and works to **contract the uterus during childbirth**. It also performs the function of smooth muscle contraction in the mammary gland, generating the **secretion of milk**.

4. *Vasopressin*

It is also a cyclic hormone consisting of nine amino acids and also secreted from the posterior lobe of the pituitary gland, but it performs a function different from oxytocin.

It increases blood pressure when its concentration is increased.

It is used to delay bleeding after labour.

Vasopressin is also called antidiuretic **hormone** and its acronym (**ADH**), meaning anti-diuretic.

Biological and physiological functions of the hormone:

- Allows the passage of water molecules through the wall of the urinary tract in the kidney.
- Re-absorption of water during the filtration of urine in the kidney.
- It prevents the loss of water in large quantities with urine.
- Increases the osmotic pressure of the blood plasma.
- Reduces the volume of blood plasma, by absorbing water and as a result reduces blood pressure .

5. Gramicidin S

A cyclic peptide consisting of ten amino acids is produced from fungi and is **considered an antibiotic.**

Biosynthesis of amino acids

In every tissue of the body, proteins are built and others are broken down. Protein is built when the twenty amino acids are present in abundance.

A person cannot build all these amino acids, but rather he must obtain them from food, so it becomes a necessity and they are called *essential amino acids*. It has been found that there are ten amino acids necessary in the nutrition of an adult person. As for the rest of the other amino acids, the body can manufacture them or represent them inside the body from other amino acids. Thus, their presence in the food is not necessary, so they are called *nonessential amino acids* as in the following table:

LABORATORY SAFETY AND REGULATIONS

Dr. Khairaldeem Mohammed
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CHEMICAL SAFETY

Hazard Communication

In the August 1987 issue of the Federal Register, OSHA published the new Hazard Communication Standard (Right to Know Law). The Right to Know Law was developed for employees who may be exposed to hazardous chemicals. Employees must be informed of the health risks associated with those chemicals. The intent of the law is to ensure that health hazards are evaluated for all chemicals that are produced and that this information is relayed to employees.

To comply with the regulation clinical laboratories must:

Plan and implement a written hazard communication program.

Obtain material safety data sheets (MSDS) for each hazardous compound present in the workplace and have the MSDSs readily accessible to employees.

Educate all employees annually on how to interpret chemical labels, MSDSs, and health hazards of the chemicals and how to work safely with the chemicals.

Maintain hazard warning labels on containers received or filled on site.

Material Safety Data Sheet (MSDS)

The MSDS is a major source of safety information for employees who may use hazardous materials in their occupations. Employers are responsible for obtaining from the chemical manufacturer or developing an MSDS for each hazardous agent used in the workplace. A standardized format is not mandatory, but all requirements listed in the law must be addressed. A summary of the MSDS information requirements includes the following:

- Product name and identification.
- Hazardous ingredients.
- Permissible Exposure Limit (PEL).
- Physical and chemical data.
- Health hazard data and carcinogenic potential.
- Primary routes of entry.
- Fire and explosion hazards.

- Reactivity data.
- Spill and disposal procedures.
- Personal protective equipment recommendations.
- Handling.
- Emergency and first aid procedures.
- Storage and transportation precautions.
- Chemical manufacturer's name, address, and phone number.
- Special information section.

The MSDS must be printed in English and provide the specific compound identity, together with all common names. All information sections must be completed, and the date that the MSDS was printed must be indicated. Copies of the MSDS must be readily accessible to employees during all shifts.

Laboratory Standard

Occupational Exposure to Hazardous Chemicals in Laboratories, also known as the laboratory standard, was enacted in May 1990 to provide laboratories specific guide. Lines for handling hazardous chemicals. This OSHA standard requires each laboratory that uses hazardous chemicals to have a written chemical hygiene plan. This plan provides procedures and work practices for regulating and reducing exposure of laboratory personnel to hazardous chemicals. Hazardous chemicals are those that pose a physical or health hazard from acute or chronic exposure. Procedures describing how to protect employees against teratogens (substances that affect cellular development in a fetus or embryo), carcinogens, and other toxic chemicals must be described in the plan. Training in use of hazardous chemicals to include recognition of signs and symptoms of exposure, location of MSDS, a chemical hygiene plan, and how to protect themselves against hazardous chemicals must be provided to all employees. A chemical hygiene officer must be designated for any laboratory using hazardous chemicals. The protocol must be reviewed annually and updated when regulations are modified or chemical inventory changes. Remember that practicing consistent and thorough hand washing is an essential component of preventative chemical hygiene.

Toxic Effects from Hazardous Substances

Toxic substances have the potential of deleterious effects (local or systemic) by direct chemical action or interference with the function of body systems. They can cause acute or chronic effects related to the duration of exposure (ie, short-term or single contact versus long. term or prolonged, repeated contact). Almost any substance, even the most harmless, can risk damage to a worker's lungs, skin, eyes, or mucous membranes following long. or short-term exposure and can be toxic in excess. Moreover, some chemicals are toxic at very low concentrations. Exposure to toxic agents can be through direct contact (absorption), inhalation, ingestion, or inoculation/injection.

In the clinical chemistry laboratory personnel should be particularly aware of toxic vapors from chemical solvents, such as acetone, chloroform, methanol, or carbon tetrachloride, that do not give explicit sensory-irritation warnings, as do bromide, ammonia, and formaldehyde. Air sampling or routine monitoring may be necessary to quantify dangerous levels. Mercury is another frequently disregarded source of poisonous vapors. It is highly volatile and toxic and is rapidly absorbed through the skin and respiratory tract. Mercury spill kits should be available in areas where mercury thermometers are used. Most laboratories are phasing out the use of mercury and mercury-containing compounds. Laboratories should have a policy and method for legally disposing of mercury. Laboratory engineering controls, personal protective equipment, and procedural controls must be adequate to protect employees from these substances.

Storage and Handling of Chemicals

To avoid accidents when handling chemicals, it is important to develop respect for all chemicals and to have a complete knowledge of their properties. This is particularly important when transporting, dispensing, or using chemicals that, when in contact with certain other chemicals, could result in the formation of substances that are toxic, flammable, or explosive. For example, acetic acid is incompatible with other acids such as chromic and nitric, carbon tetrachloride is incompatible with sodium, and flammable liquids are incompatible with hydrogen peroxide and nitric acid.

Arrangements for the storage of chemicals will depend on the quantities of chemicals needed and the nature or type of chemicals. Proper storage is essential to prevent and control laboratory fires and accidents. Ideally, the storeroom should be organized so that each class of chemicals is isolated in an area that is not used for routine work. An up-to-date inventory should be kept that indicates location of chemicals; minimum/maximum quantities required, shelf life, and so on. Some chemicals deteriorate over time and become hazardous (eg, ether forms explosive peroxides). Storage should not be based solely on alphabetical order because incompatible chemicals may be stored next to each other and react chemically. They must be separated for storage

Flammable/Combustible Chemicals

Flammable and combustible liquids, which are used in numerous routine procedures, are among the most hazardous materials in the clinical chemistry laboratory because of possible fire or explosion. They are classified according to flash point, which is the temperature at which sufficient vapor is given off to form an ignitable mixture with air. A flammable liquid has a flash point below 37.8°C (100°F), and combustible liquids, by definition, have a flash point at or above 37.8°C (100°F). Some commonly used flammable and combustible solvents are acetone, benzene, ethanol, heptane, isopropanol, methanol, toluene, and xylene. It is important to remember that flammable chemicals also include certain gases, such as hydrogen, and solids, such as paraffin.

Proteins - Structure and function

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Biological and physiological functions of growth hormone

1. Protein Synthesis.
2. Carbohydrate Metabolism: It increases the rate of blood sugar and works on the formation of glycogen, meaning that its action is the opposite of the action of insulin.
3. Fats metabolism liberates free fatty acids FFA.
4. Mineral Metabolism works on the balance of calcium, magnesium and phosphate. Its increase leads to acromegaly and its decrease leads to dwarfism.

Parathyroid hormone

This regulates the life processes of calcium and phosphate.

5- Protective agents

Some proteins have defensive and protective functions against viruses and harmful bacteria. These proteins are called antibodies, as they combine and disrupt foreign bodies that enter the body called antigens.

6- Storage proteins

This type of protein is used to store nutrients such as egg albumin, ovalbumin, and milk containing casein, protein-rich vegetable seed proteins such as beans, cowpeas and peas, and ferritin protein found in animal tissues and containing iron.

7- Contractile proteins

Some proteins act as basic elements in contraction and relaxation, the most important of these well-known proteins are “Actin” and “Myosin” as two essential components of the musculoskeletal system.

8- Proteins to maintain osmotic pressure and hydrogen ion

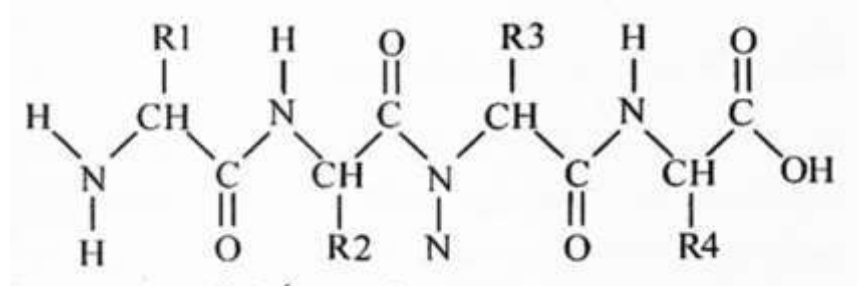
Proteins for maintenance of osmotic pressure & pH Blood plasma proteins, especially albumin, play an important role in maintaining the isometric pressure of tissue cells and keeping the pH in the normal range “pH 7.4 ” perpetuating life in the cell.

Structure of proteins

Proteins are complex structures due to their high molecular weight and the way the atoms of the protein molecule itself are arranged. Therefore, there are four systems that specialize in the synthesis of proteins:

1. Primary structure

The primary structure of proteins includes the number, quality, and sequence of amino acids in the polypeptide chain. A polypeptide can be represented by the following general formula:



2. Secondary structure

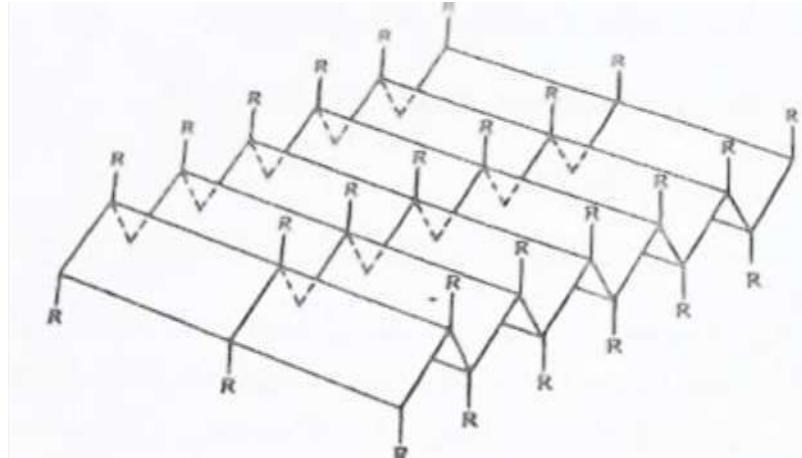
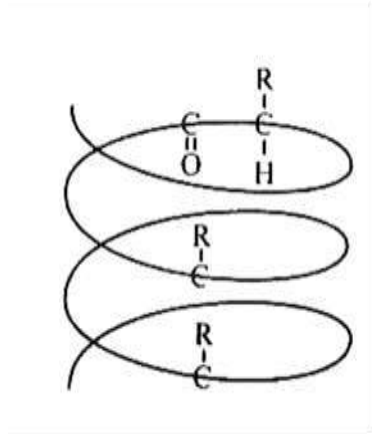
The secondary structure of a protein includes how the polypeptide chain is twisted to give fixed specific shapes by hydrogen bonding. In general, there are two models:

a. The helical curve: the R groups are prominent outward due to the presence of the hydrogen bond linking carbonyl oxygen and amide nitrogen.

b. folded plate:

Peptide chains are arranged along each other to form shapes called folded sheets.

The folded plates of the peptide chains of R groups are located at the top and bottom of the plates



3. Tertiary structure

The triple structure of the protein includes the three dimensional structure of the globular protein resulting from the interactions of the R-groups with each other so that the polypeptide chain is strongly folded and condensed in a tightly packed form in the form of a ball of tissue.

4. Quaternary structure

If a polypeptide contains more than one peptide chain, the protein belongs to the quaternary structure. The quaternary structure is the association of a group of protein subunits, whether they are similar or not, to form what is called an oligomer (that is, a small polymer). The following table shows some of the protein compounds

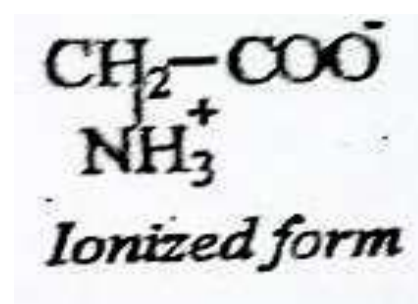
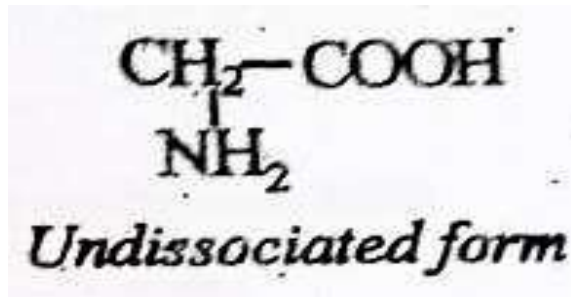
Protein	M. Wt.	No. of chains
Bovine insulin	5.733	2
Human hemoglobin	64.500	4
Chymotrypsin from cow pancreas	22.600	3
Glutamate dehydrogenase from beef liver	336.000	6
Lactate dehydrogenase from beef liver	237.000	4
Myoglobin from the muscle of the horse's heart	16.900	1
Ribonuclease from cow pancreas	12.640	1

Proteins and amino acids

Amino acids are commonly found in protein.

The common amino acids of proteins:

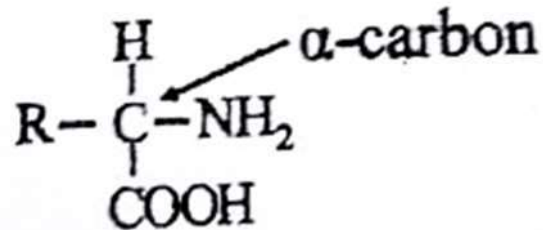
Amino acids are high in organic acids containing an amino group (NH₂-). The chemical compound of an amino acid is often represented in an unionized form for the purpose of emphasizing the amine (NH₂-) and carboxyl (COOH-) groups, but amino acids are mostly present in ionic form in body fluids at a pH close to (7.0).



There are about twenty types of amino acids that are generally found in all types of proteins. They constitute the basic building blocks of all proteins, and thus they are called protonated amino acids. Table No. (1) shows the common names of the general amino acids, followed by their abbreviations that are often used to refer to the arrangement of these amino acids in a particular protein.

The table also shows the chemical structure of the general amino acid groups in the ionized form, as it is found in living body fluids. As for the general structure of the alpha-amino acid, it can be represented by the following formula:

All the amino acids found in proteins are alpha-amino acids, meaning that the amino group (NH₂-), the carboxyl group (COOH-), the hydrogen atom and the side group called (R) are all attached to the alpha-carbon atom.



LABORATORY SAFETY AND REGULATIONS

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Biosafety Hoods

Biohazard hoods remove particles that may be harmful to the employee who is working with infective biologic specimens. The Centers for Disease Control and Prevention (CDC) and the National Institutes of Health have described four levels of biosafety, which consist of combinations of laboratory practices and techniques, safety equipment, and laboratory facilities. The biosafety level of a laboratory is based on the operations performed, the routes of transmission of the infectious agents, and the laboratory function or activity. Accordingly, biohazard hoods are designed to offer various levels of protection, depending on the biosafety level of the specific laboratory.

Chemical Storage Equipment

Safety equipment is available for the storage and handling of chemicals and compressed gases. Safety carriers should always be used to transport 500-ml bottles of acids, alkalis, or other solvents, and approved safety cans should be used for storing, dispensing, or disposing of flammables in volumes greater than 1 qt. Safety cabinets are required for the storage of flammable liquids, and only specially designed, explosion-proof refrigerators should be used to store flammable materials. Only that amount of chemical needed for the day should be available at the bench. Gas-cylinder supports or clamps must be used at all times, and large tanks should be transported using handcarts.

Personal Protective Equipment

The parts of the body most frequently subject to injury in the clinical laboratory are the eyes, skin, and respiratory and digestive tracts. Hence, the use of personal protective equipment is very important. Safety glasses, goggles, Visors, or work shields protect the eyes and face from splashes and impact. Contact lenses do not offer eye protection. It is strongly recommended that they not be worn in the clinical chemistry laboratory. If any solution is accidentally splashed into the eye(s), thorough irrigation is required.

Gloves and rubberized sleeves protect the hands and ms when using caustic chemicals. Gloves are required for routine laboratory use: however, polyvinyl or other nonlatex gloves are an acceptable alternative for people with latex allergies. Certain glove materials offer better protection against particular reagent formulations. Nitrile gloves, for example, offer a wider range of compatibility with organic solvents than latex. Lab coats, preferably with cuffed sleeves, should be full length, buttoned, and made of liquid-resistant material. Proper footwear is required; shoes constructed of porous materials, opentoed shoes, or sandals are considered hazardous.

Respirators are required for various procedures in the clinical laboratory: Whether used for biologic or chemical hazards, the correct type of respirator must be used for the specific hazard. Respirators with high-efficiency particulate air (HEPA) filters must be worn when engineering controls are not feasible, for example, when working directly with tuberculosis (TB) patients or performing procedures that may aerosolize specimens of patients with suspected or confirmed cases of TB. Training maintenance, and written protocol for use of respirators are required according to the respiratory protection standard.

Each employer must provide (at no charge) lab coats, gloves, or other protective equipment to all employees who may be exposed to biologic or chemical hazards. It is the employer's responsibility to clean and maintain all personal protective equipment. All contaminated personal protective equipment must be removed and properly disposed of before leaving the laboratory.

BIOLOGIC SAFETY

General Considerations

All blood samples and other body fluids should be collected, transported, handled, and processed using strict precautions. Gloves, gowns, and face protection must be used if splashing or splattering is likely to occur. Consistent and thorough hand washing is an essential component of infection control.

Centrifugation of biologic specimens produce finely dispersed aerosols that are a high-risk source of infection. Ideally, specimens should remain capped during centrifugation. As an additional precaution, the use of a centrifuge with an internal shield is recommended.

Spills

Any blood, body fluid, or other potentially infectious material spill must be cleaned up and the area or equipment disinfected immediately. Recommended cleanup includes the following:

- Wear appropriate protective equipment.
- Use mechanical devices to pick up broken glass or other sharp objects.
- Absorb the spill with paper towels, gauze pads, or tissue.
- Clean the spill site using a common aqueous detergent.
- Disinfect the spill site using approved disinfectant or 10% bleach, using appropriate contact time.
- Rinse the spill site with water.
- Dispose of all materials in appropriate biohazard containers.

Bloodborne Pathogen Exposure Control Plan

In December 1991, OSHA issued the final rule for occupational exposure to blood borne pathogens. To minimize employee exposure, each employer must have a written exposure control plan. The plan must be available to all employees whose reasonable anticipated duties may result in occupational exposure to blood or other potentially infectious materials. The exposure control plan must be discussed with all employees and be available to them while they are working. The employee must be provided with adequate training of all techniques described in the exposure control plan at initial work assignment and annually thereafter. All necessary equipment and supplies must be readily available and inspected on a regular basis.

Clinical laboratory personnel are knowingly or unknowingly in frequent contact with potentially biohazardous materials. In recent years, new and serious occupational hazards to personnel have arisen. and this problem has been complicated because of the general lack of understanding of the epidemiology, mechanisms of transmission of the disease, or inactivation of the causative agent. Special precautions must be taken when handling all specimens because of the continual increase of infectious samples received in the laboratory: Therefore, in practice, specimens from patients with confirmed or suspected hepatitis, acquired immunodeficiency syndrome. Creutzfeldt-Jakob disease, or other potentially infectious diseases should be handled no differently than other routine specimens. Adopting a standard precautions policy, which considers blood and other body fluids from all patients as potentially infective, is required.

AIRBORNE PATHOGENS

Because of the recent resurgence of tuberculosis (TB). OSHA issued a statement in 1993 that the agency would enforce the CDC Guidelines for Preventing the Transmission of Tuberculosis in Health Care Facilities. The purpose of the guidelines is to encourage early detection, isolation, and treatment of active cases. A TB exposure control program must be established and risks to laboratory workers must be assessed. In 1997, a proposed standard (29 CFR 1910.1035, Tuberculosis) was issued by OSHA. The standard mandates the development of a tuberculosis exposure control plan by any facility involved in the diagnosis or treatment of cases of confirmed infectious TB. TB isolation areas with specific ventilation controls must be established in health care facilities. Those workers in high-risk areas may be required to wear a respirator for protection. All health care workers considered to be at risk must be screened for TB infection

Shipping

Clinical laboratories routinely ship regulated material. The U.S. Department of Transportation (DOT) and the International Air Transport Association (IATA) have specific requirements for carrying regulated materials. There are two types of specimen classifications. Known or suspect infectious specimens are labeled infectious substances if the pathogen can be readily transmitted to humans or animals and there is no effective treatment available. Diagnostic specimens are those tested as routine screening or for initial diagnosis. Each type of specimen has rules and packaging requirements. The DOT guidelines are found in Code of Federal Regulations 49; IATA publishes its own manual, Dangerous Goods Regulations.

Proteins - Structure and function

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Definition of proteins:

Proteins are defined as having high molecular weights ranging from $(1 \times 10^4 - 1 \times 10^6)$ daltons. Made up of amino acid units linked together by a peptide bond.

Functions of proteins:

1- Enzymes

They are biocatalysts, and their number exceeds more than (1500) enzymes, each of which catalyzes a specific chemical reaction, such as: arabinonuclease, lactate dehydrogenase, phosphatase, hexokinase.

2- Structural elements

Many of the vital compounds in the organs and tissues of the body include protein, and examples of this are the fibrous protein called “*collagen*”, which is included in the composition of tissues.

The bond that helps bind cell aggregates to form tissues in higher animals - the protein "*elastin*" that makes up the walls of blood vessels. *Keratin* protein, which is part of the skin, hair, nails and feathers.

3- Transport proteins

There are certain compounds that are transported from one tissue to another by carrier proteins, such as: - Hemoglobin, which transports oxygen from the lungs to different tissues, where oxygen binds to the iron atoms found in the four heme groups in the hemoglobin molecule - albumin, which is found in the blood serum. It combines with "Free Fatty Acids" and is transported between fatty tissues and other organs in the vertebrates.

4- Hormones

Hormones are compounds secreted by the endocrine glands, which work to control life processes in the body. There are many hormones with a protein structure

Insulin hormone

It is secreted from the pancreas gland and regulates life processes glucose and sugar and its deficiency in humans causes diabetes "*Diabetes Mellitus*".

Biological and physiological functions of insulin

A. Liver

1. Increases glycogen build-up
2. Increases Fatty acid synthesis
3. Reduces the formation of glucose Gluconeogenesis
4. Decreases production of ketone bodies
5. Reduces glycogen breakdown

B. muscle

1. Increases glucose metabolism
2. Increases glycogen build-up
3. Increases protein synthesis
4. Reduces protein catabolism

C. adipose tissue

1. Increases glucose metabolism
2. Increases moderate fat storage
3. Reduces moderate lipid catabolism

Glucagon hormone

Biological and physiological functions

Affect the **liver** tissues as follows:

1. Reduces the build-up of glycogen.
2. Increases glycogen catabolism
3. Increases the formation of glucose sugar.
4. Increases the production of ketone bodies.
5. Increases the breakdown of proteins and amino acids.
6. Increases moderate lipolysis.

Adrenal medulla hormones

The adrenal gland secretes catecholamines, including three hormones:

- Adrenaline
- Noradrenaline
- Dopamine

These are the hormones that respond to the fight or flight response catecholamine hormones.

Biological and physiological functions of catecholamine hormones

1. Increases blood flow, and increases glucose metabolism in the brain.
2. Increases the rate of force of cardiac muscle contraction.
3. Increase the supply of oxygen and the expansion of the bronchi.
4. Increases the conversion of glycogen to glucose (glycogenolysis) in the muscles.
5. Increase the formation of glucose sugar in the liver (Gluconeogenesis).
6. Reduces blood flow to the skin.
7. Increases the breakdown of triacylglycerol in the lipolysis process.
8. Increases the breakdown of proteins (Proteolysis) in the lymphatic tissues.

Growth hormone

Which is secreted from the anterior pituitary gland, regulates the process of growth and integration, and it is also called "somatropin hormone" SH, which is a single chain of polypeptides and contains (19.a.a).