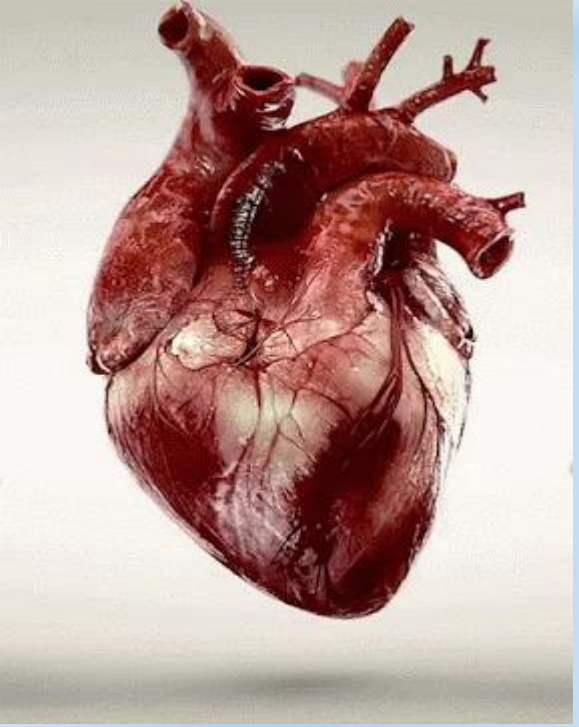


Biology Grade 9

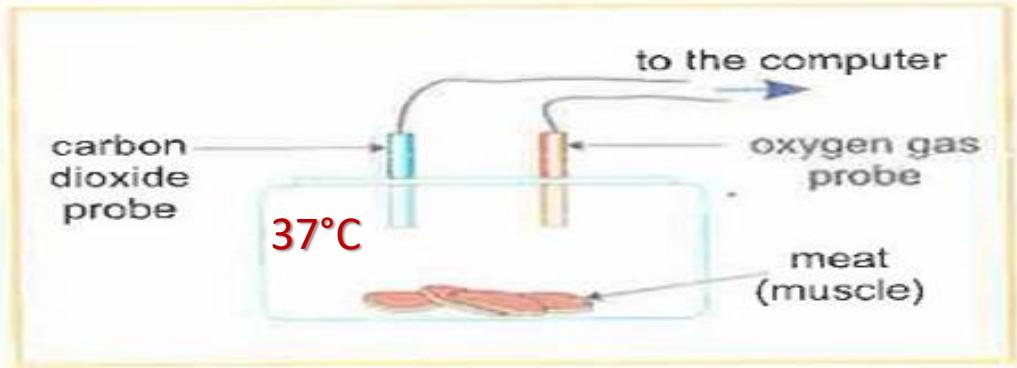
CHAPTER 3: CARDIAC SYSTEM

INSTRUCTOR: SUHAIB AUDI

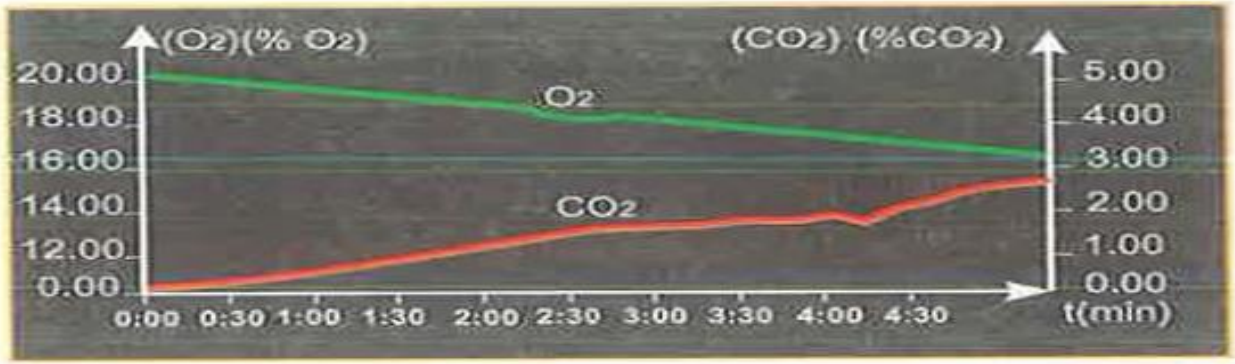
Activity 5: Usage of Nutrients and Oxygen Gas by the Cells

- Living cells are the site of a series of chemical reactions of synthesis (manufacturing new matter) and degradation (production of energy"). All these reactions constitute the cellular metabolism.
- How is the energy and the new matter produced and used?

❖ Tissues and cell respire



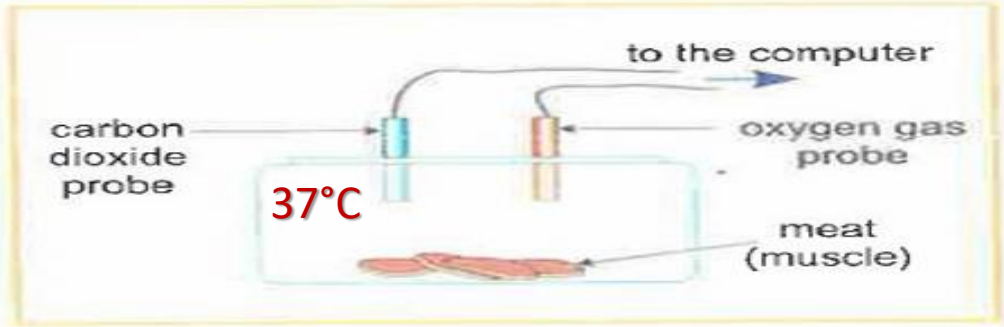
a The experimental setup



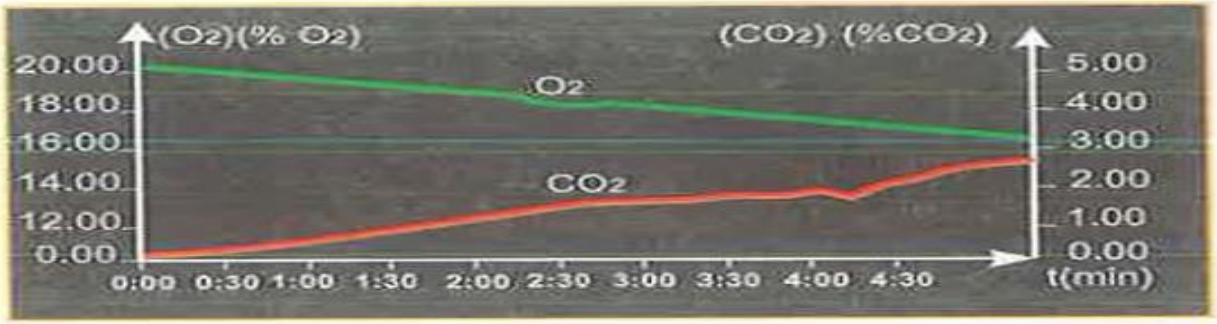
b Recordings by C.A.S.E

The variation of the concentration of oxygen gas and that of carbon dioxide found in the container are parallel.

Computer assisted scientific experimentation C.A.S.E allows to measure the amount of oxygen gas and carbon dioxide gas in a container.



a The experimental setup



b Recordings by C.A.S.E

The variation of the concentration of oxygen gas and that of carbon dioxide found in the container are parallel.

1. **Describe** the experimental setup in document (a).

A fresh piece of meat (living tissue) is placed in a closed container maintained at 37°C. A carbon dioxide probe and an oxygen gas probe are inserted into the container and connected to a computer for measurement.

2. The probes measured the amount of each gas in the container. Document (b) represents the variation of the amount of each gas present in the container as a function of time.

2.1. **Interpret** document (b).

At t=0 min (beginning of the experiment) the percentage of oxygen gas in the container was 20% and that of carbon dioxide was 0%. As time increases to 5 minutes, the amount of oxygen decreases from 20% to 16.5% while the amount of carbon dioxide increases from 0% to 2.8%. This indicates that meat takes up oxygen gas and releases carbon dioxide gas.

2.2. What do you conclude?

Cells that make up the tissue respire.

3. Explain why the experiment was carried on at 37°C.

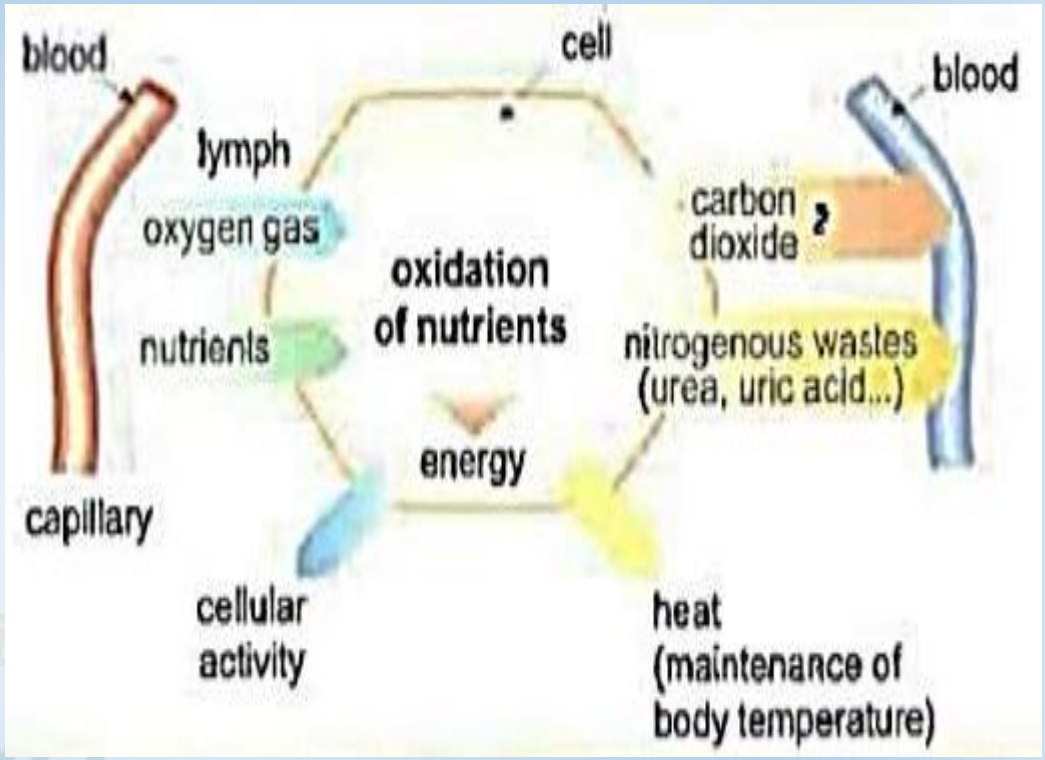
37°C is the optimal temperature for the activity and cell survival. The enzymes catalyze all the metabolic reactions needed for the functioning of the cell.

❖ Cells use nutrients and oxygen gas to produce energy

The adjacent document represents the intracellular chemical mechanisms.

- Write a paragraph explaining these mechanisms.

Oxygen gas dissolved in the blood and nutrients diffuse across the lymph from blood capillaries into the cells. Inside the cell, **oxidation** of nutrients in the presence of oxygen gas takes place. This reaction liberates energy needed for maintaining body temperature in the form of heat and for cellular activities. Also, carbon dioxide and nitrogenous wastes (urea, uric acid) are released and diffuse from the cell into the blood.



The chemical reaction of breaking down of nutrients using oxygen gas is called an oxidation reaction. Nutrients such as glucose or amino acids that take part in these reactions are called metabolites. Carbon dioxide and nitrogenous wastes (urea, uric acid) are the products of oxidation of nutrients. Nitrogenous wastes are the products of amino acids degradation or breaking down. Carbon dioxide gas is exhaled and nitrogenous wastes are excreted outside body in urine.

2. Pick out from the above text:

2.1. The definition of oxidation.

The chemical reaction of breaking down of nutrients using oxygen gas is called oxidation reaction.

2.2. The definition of metabolites.

The nutrients that take part of the oxidation reaction are called metabolites.

2.3. The name of the nutrients involved in oxidation reaction.

Glucose and amino acids.

3. Specify the origin of nitrogenous wastes.

Nitrogenous wastes are the products of amino acid degradation or breaking down, because nitrogen is a chemical element that is found in amino acids, not in glucose neither in fatty acids.

4. Indicate the fate of the waste products obtained.

Carbon dioxide is exhaled and nitrogenous wastes are excreted outside body in urine.

5. Write the reaction of glucose oxidation.

$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + Energy$

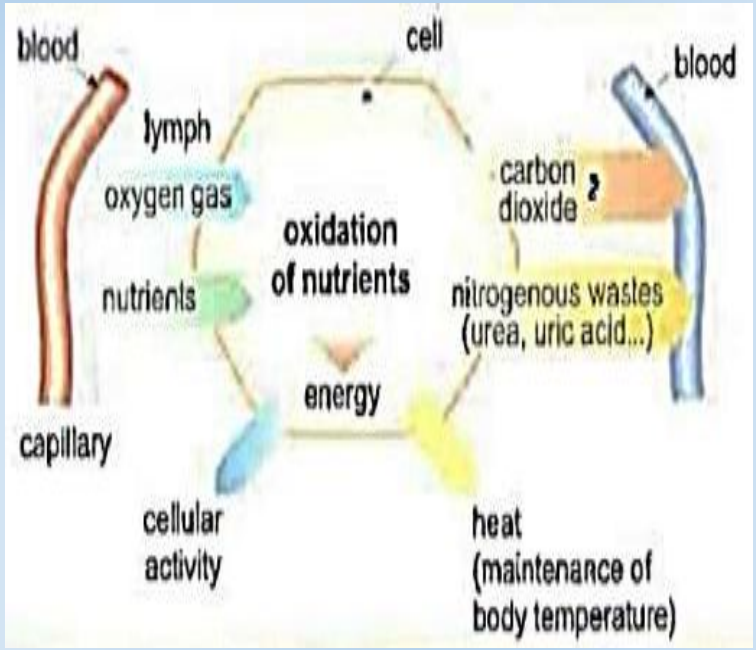
- $C_6H_{12}O_6$ = glucose (sugar)
- O_2 = oxygen gas
- CO_2 = carbon dioxide (waste)
- H_2O = water

Be Smart ACADEMY

Summary

1. Oxidation (degradation of nutrients):

- Cells break down (degrade) the nutrients (mainly glucose supplied by the blood and sometimes the fats (surrounding the cells) in the presence of oxygen to produce carbon dioxide, nitrogenous wastes and energy.
- Carbon dioxide and wastes are taken away by the blood.
- Energy, produced is divided into two parts: Part is transformed into heat that regulates our body temperature and the other part is stored in the cells to be used later for cellular activities.



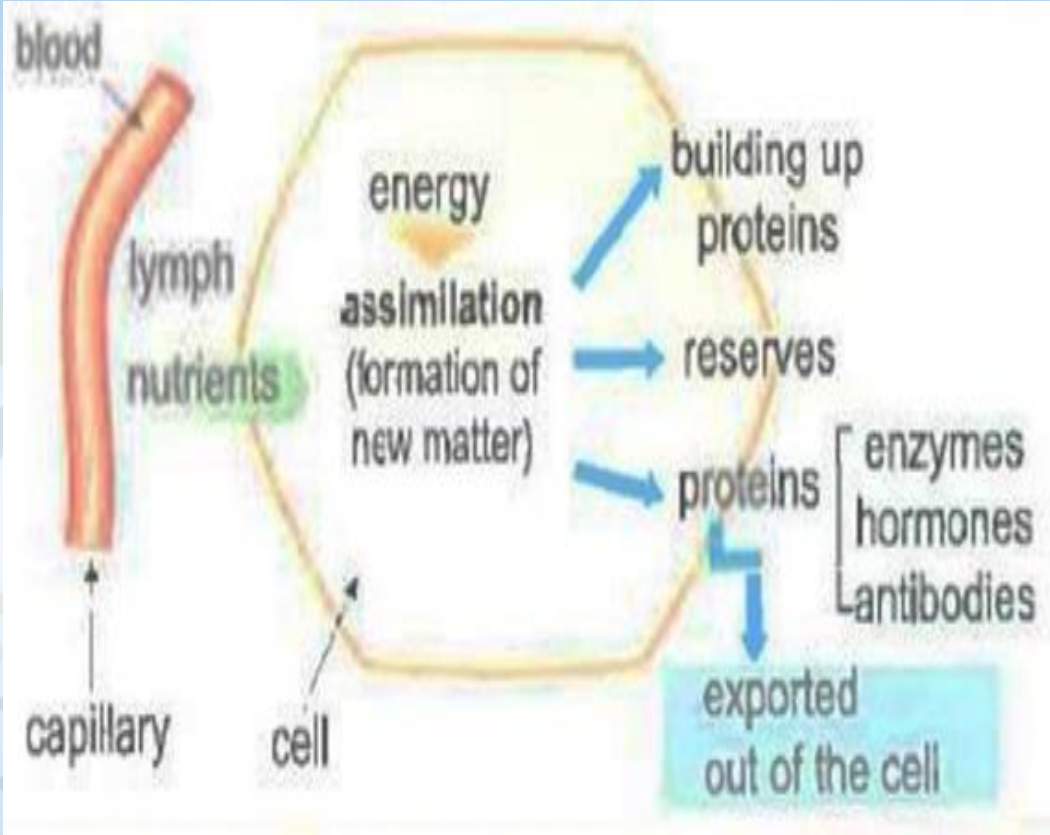
- Nutrients + oxygen → carbon dioxide + nitrogenous wastes + energy
- Glucose + oxygen → carbon dioxide + water + energy
- Fatty acids + oxygen → carbon dioxide +water + energy
- Amino acids + oxygen → nitrogenous wastes +water +energy +carbon dioxide.

❖ Synthesis of organic matter by cells

1- The adjacent document represents intracellular chemical mechanisms.

- Write in a short text these mechanisms.

Nutrients such as **amino acids** pass from the blood to the cell across the lymph. These nutrients enter the **assimilation reaction** which **requires energy** to occur. This assimilation reaction leads to the production of new matter such as **functional proteins** (enzymes, hormones and antibodies) that are **exported outside the cell, building up proteins** (muscle proteins..) and reserves that are stored inside the cells.

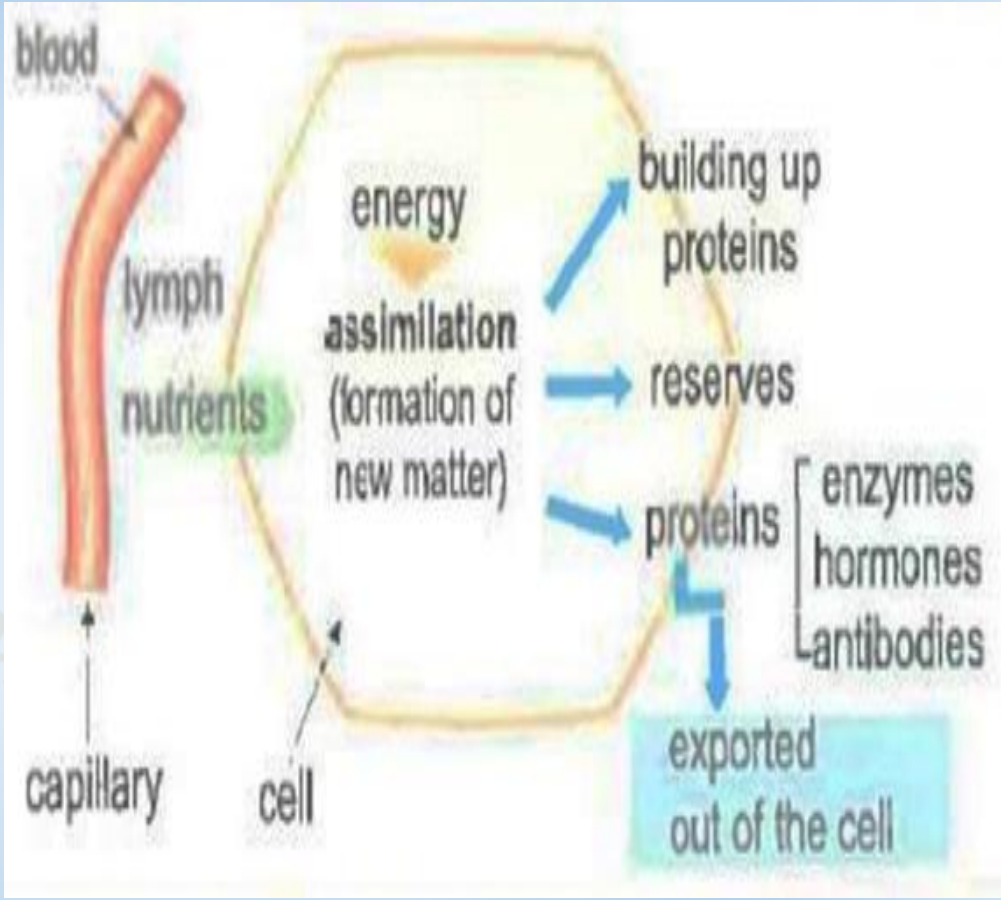


2. Assimilation (synthesis of new organic matter):

- Cells use the energy produced during oxidation and the nutrients (amino acids given by the blood and sometimes fatty acids given by the lymph) to produce new organic matter: Proteins and fats.
- Proteins produced by the cells are of different forms:

1) **Building up proteins** (for growth and renewing the cells)
2) **Functional proteins**: exported outside the cells (antibodies, enzymes, hormones, hemoglobin....)

- Fats that are produced stored around the cells.
- Amino acids + energy → proteins.
- Fatty acids + energy → fats.



Summary:

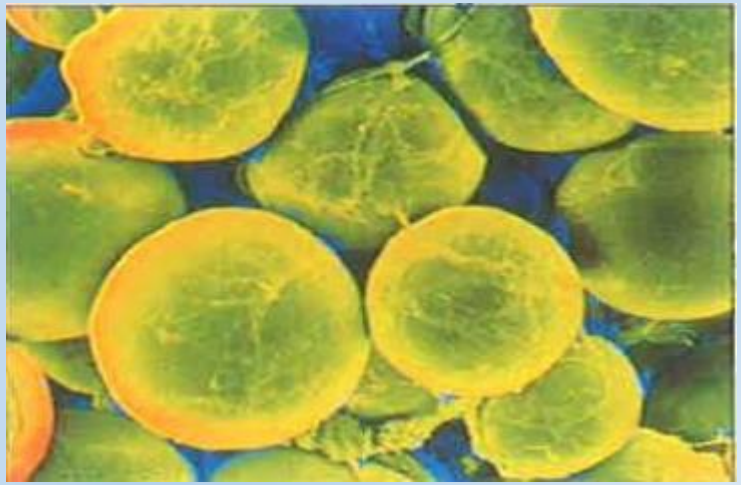
❑ **Two main types of chemical reactions take place inside cells:**

1. **Oxidation** (catabolism) – breaking down nutrients to release energy.
2. **Assimilation** (anabolism) – building cellular components from nutrients.

Together, they form what is known as **cellular metabolism**.

➢ **Metabolism** is the **sum of all chemical reactions** in the cell, and it includes:

1. **Catabolism**: breakdown of molecules (like glucose) to release energy.
2. **Anabolism**: synthesis of complex molecules (like proteins, fats).



The Cells store nutrients in the form of fats.

Renewal of skin cells; dead cells are eliminated at the surface (seen under the electron microscope).

1. Indicate the form in which the nutrients are stored inside the cells.

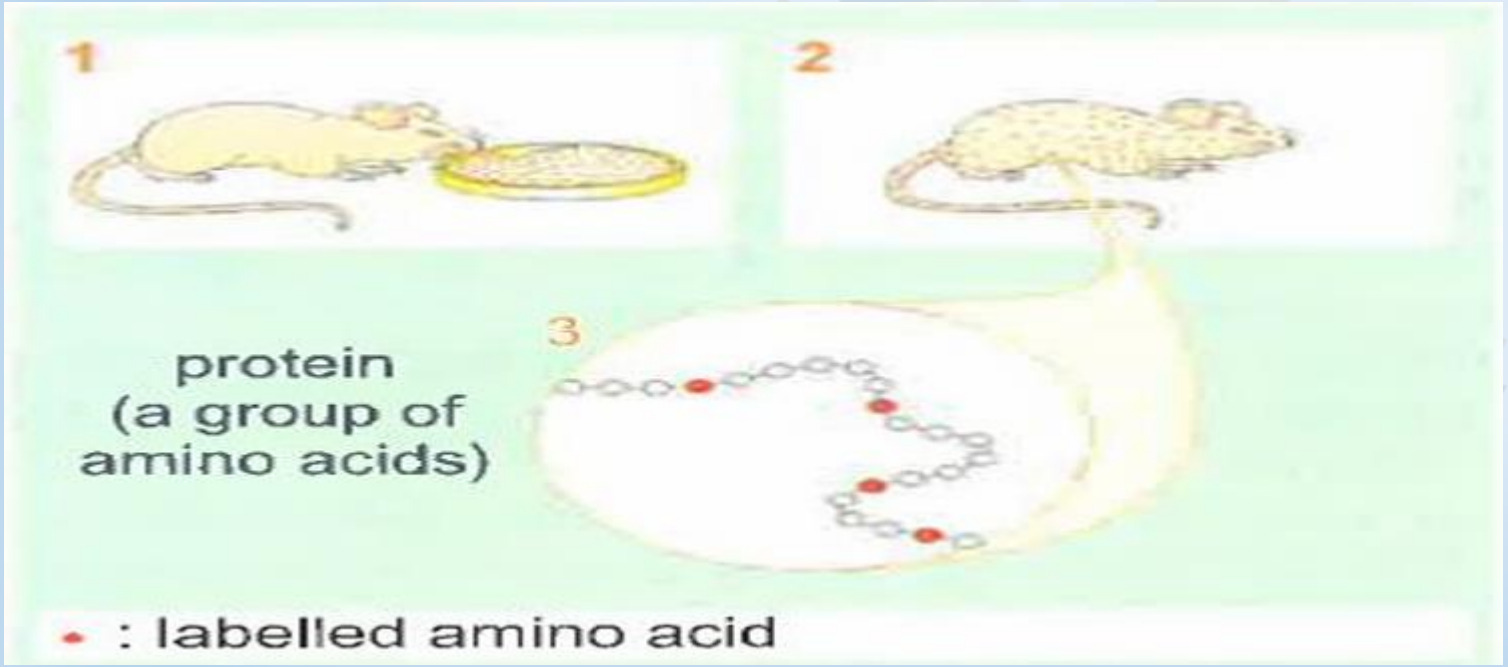
Cells store nutrients in the form of fats.

2. Indicate the importance of the formation of new matter.

The formation of new matter allows the renewal of cells, growth and accumulation of reserves.

❖ Assimilation of amino acids:

To show that new matters are synthesized out from nutrients inside the cells, labeled amino acids are given to rats as food. Labeled amino acids are **radioactive amino acids** that are capable of **emitting light**, and they are harmless to the animals. A few days later, the **labeled amino acids are located in all the cells of the rats in form of proteins.**



Assimilation of amino acids (nutrients) in adult rats.

1. Indicate the importance of using radioactive amino acids.

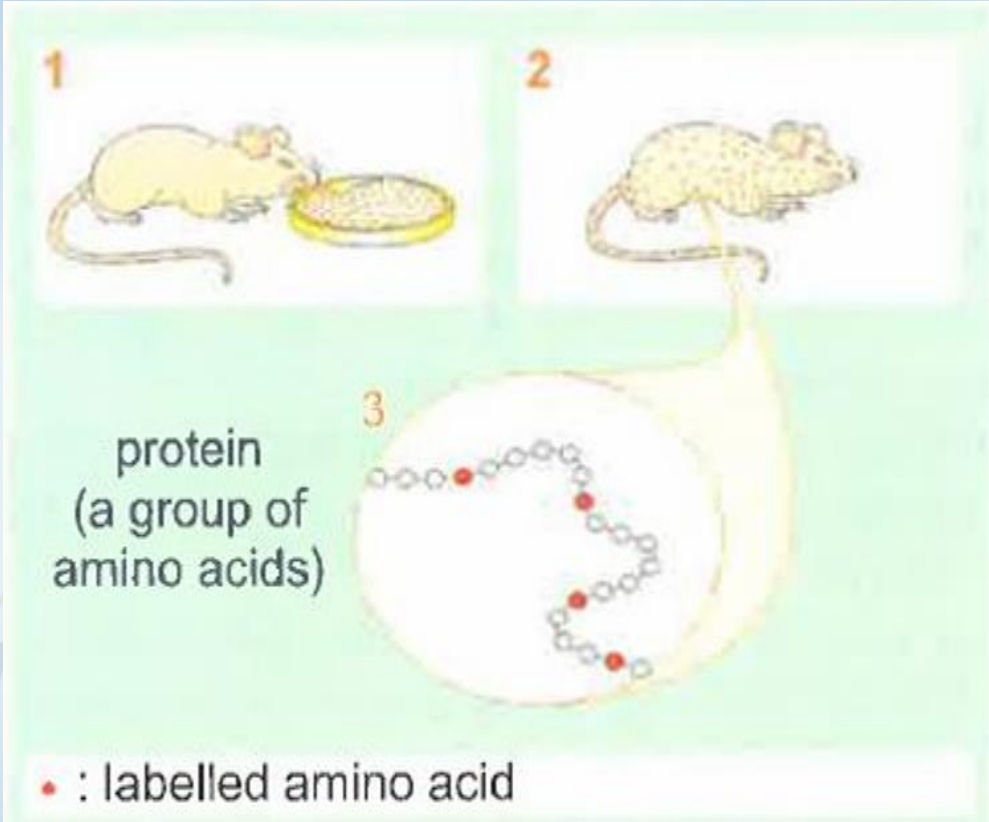
By the help of labeled radioactive amino acids, it is possible to follow up and trace the fate of the labeled or radioactive amino acids in the body by special computerized instruments.

2. Based on the above text, name the organic matter produced from these radioactive amino acids.

The organic matter produced by the radioactive amino acids is protein.

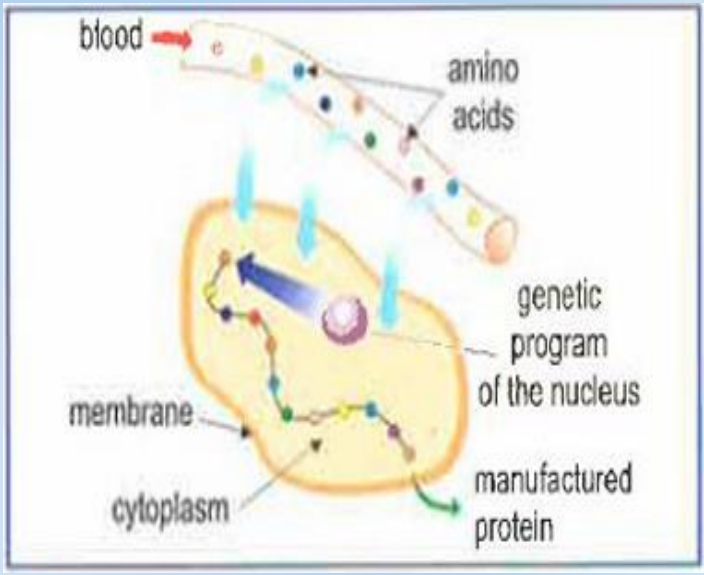
3. Indicate whether assimilation of nutrients takes place. Justify the answer.

The results obtained at the end of the experiment showed that assimilation process occurred. A new matter (protein) is formed out from the nutrients (amino acids) inside the rat cells.



❖ Formation of protein molecule:

Proteins are formed of chains of 20 different amino acids arranged in different order. Each protein consists of a group of amino acids arranged in a specific order which is always the same for the same protein. Cells make specific proteins according to a genetic program present in their nucleus. Free amino acids circulating in the blood enters the cell; Inside the cell, in the cytoplasm, amino acids are arranged in specific order dictated by the genetic program to form protein. The manufactured protein is then transported outside the cell.



1- Indicate:

1.1. How proteins differ from each other.

Proteins differ from each other by the sequence and the number of the amino acids that formed each protein.

1.2- The origin of this difference.

The genetic program located inside the cell's nucleus.

2. "A cell produces many proteins from 20 different amino acids". Justify this statement.

Each protein can be formed of chain of 20 different amino acids arranged in a different and specific order.

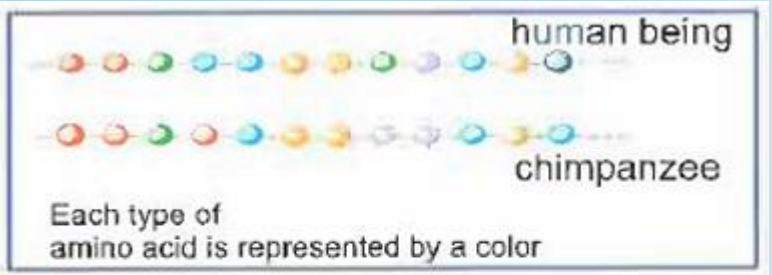
❖ Human and chimpanzee hemoglobin:

1- Compare the two hemoglobin molecules in the adjacent document.

Both molecules have the same number of amino acids (12 a.a). All amino acids are the same in both molecules except for the 4th and the 8th amino acids.

2- What can you conclude?

Each protein within different species consists of a group of amino acids arranged in a specific and different order.



Hemoglobin is a protein that possesses the same properties in the human being and in the chimpanzee. However, the chains of amino acids that constitute each are not the same.