# RESPIRATION

# THE CONCEPT OF ‘RESPIRATION’ IS CENTRAL TO ALL LIVING PROCESSES

It is worth while studying this presentation thoroughly because it is essential for an understanding of all the activities of living cells and organisms

All living cells are made up of **chemical substances**

The processes of living involve **reactions** between the substances

A **reaction** is an event which produces a change in a substance

For example, a reaction between carbon and oxygen (such as burning coal in air) changes the carbon in the coal, and oxygen in the air into carbon dioxide

This reaction can be represented by the equation

$$C + O_2 \longrightarrow CO_2$$

carbon + oxygen → carbon dioxide

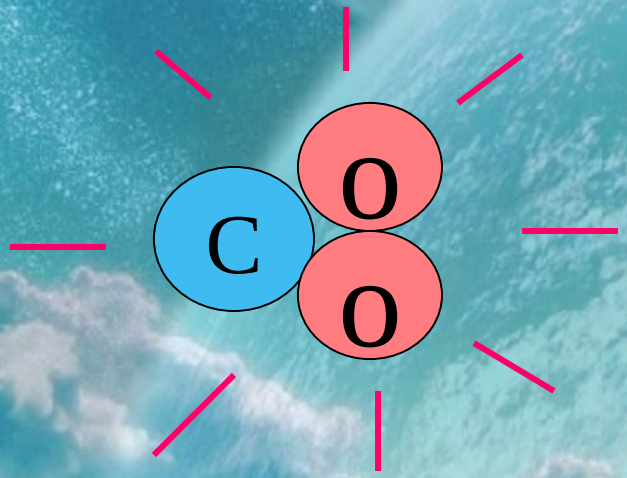
an atom of carbon

**C**

plus

a molecule of oxygen

**$O_2$**

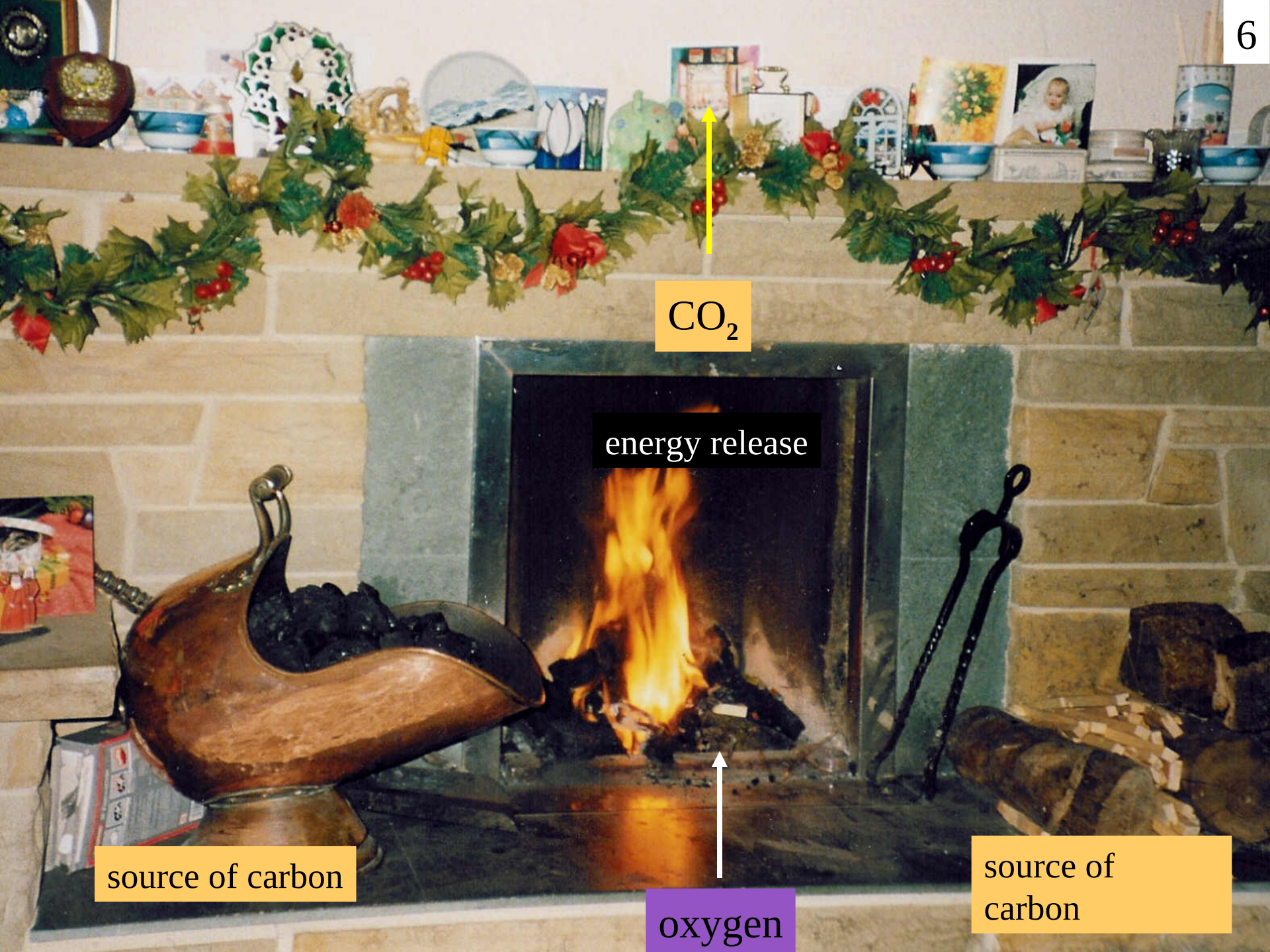



combine to form a molecule of carbon dioxide

**$CO_2$**

The reaction between carbon and oxygen also releases **energy** in the form of heat and light (flames)

Living organisms get their energy from reactions like this (but not reactions which are violent enough to produce flames)


$CO_2$
energy release
source of carbon
oxygen
source of carbon

One of the energy-producing reactions is called **respiration**

(Respiration is not the same thing as breathing)

The chemical reactions of respiration take place in all living cells

The reaction takes place between oxygen and a substance which contains carbon. The reaction produces carbon dioxide and water, and releases energy

The carbon-containing substances come from **FOOD**

The oxygen comes from the **AIR** (or water)

The **energy** is used to drive other chemical reactions taking place in cells

One example of this is the release of energy in muscle cells to make them contract and produce movement

One example of an energy-producing reaction in cells is the breakdown of sugar when it combines with oxygen

This can be represented by the equation

$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O +$ **energy**

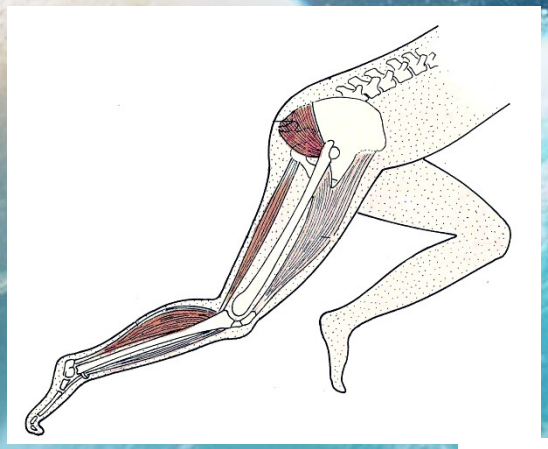
sugar (glucose) + oxygen → carbon dioxide + water + energy

This means that one molecule of sugar reacts with six molecules of oxygen to produce six molecules of carbon dioxide and six molecules of water.

**Energy** is released during this process

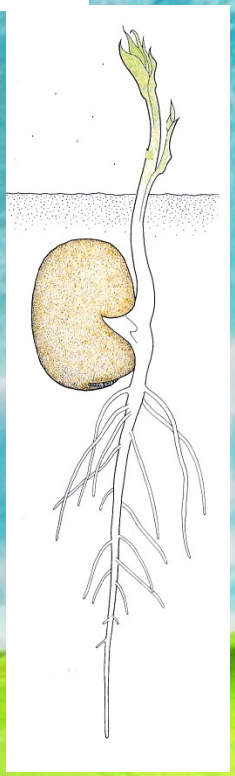
# Some examples of the use of energy in organisms

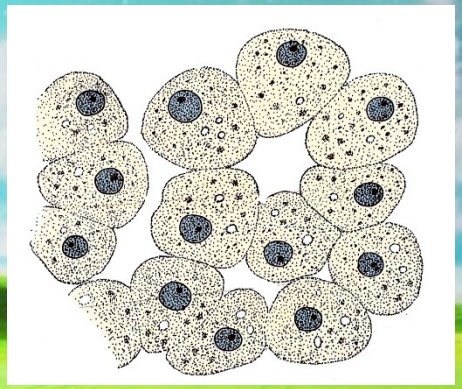
**Respiration supplies the energy for**



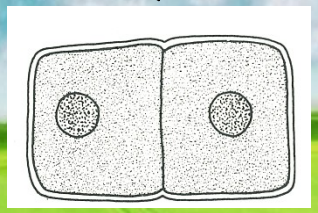
muscle contraction

germination





chemical changes in cells

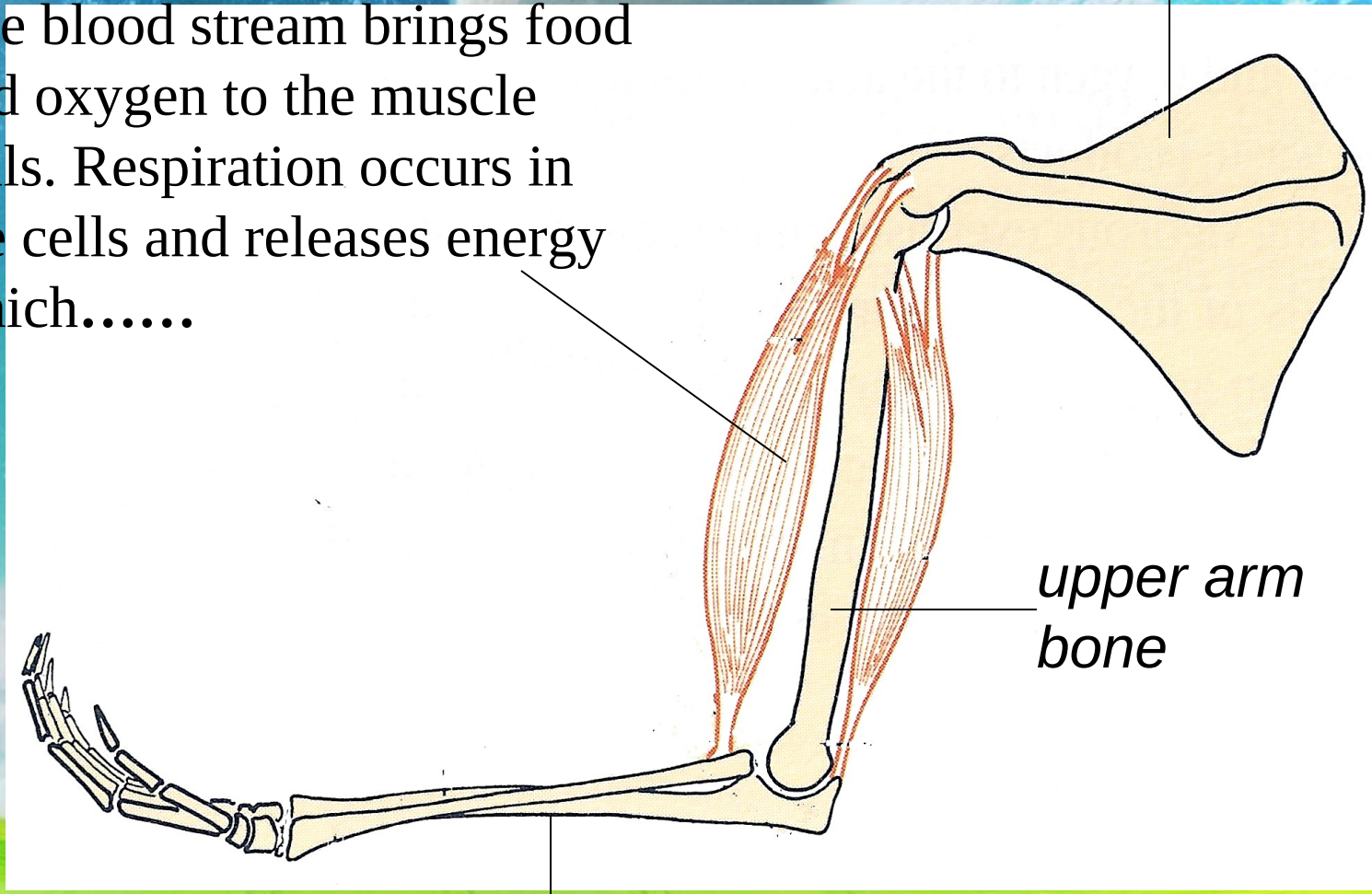


cell division

# Energy use in muscle contraction



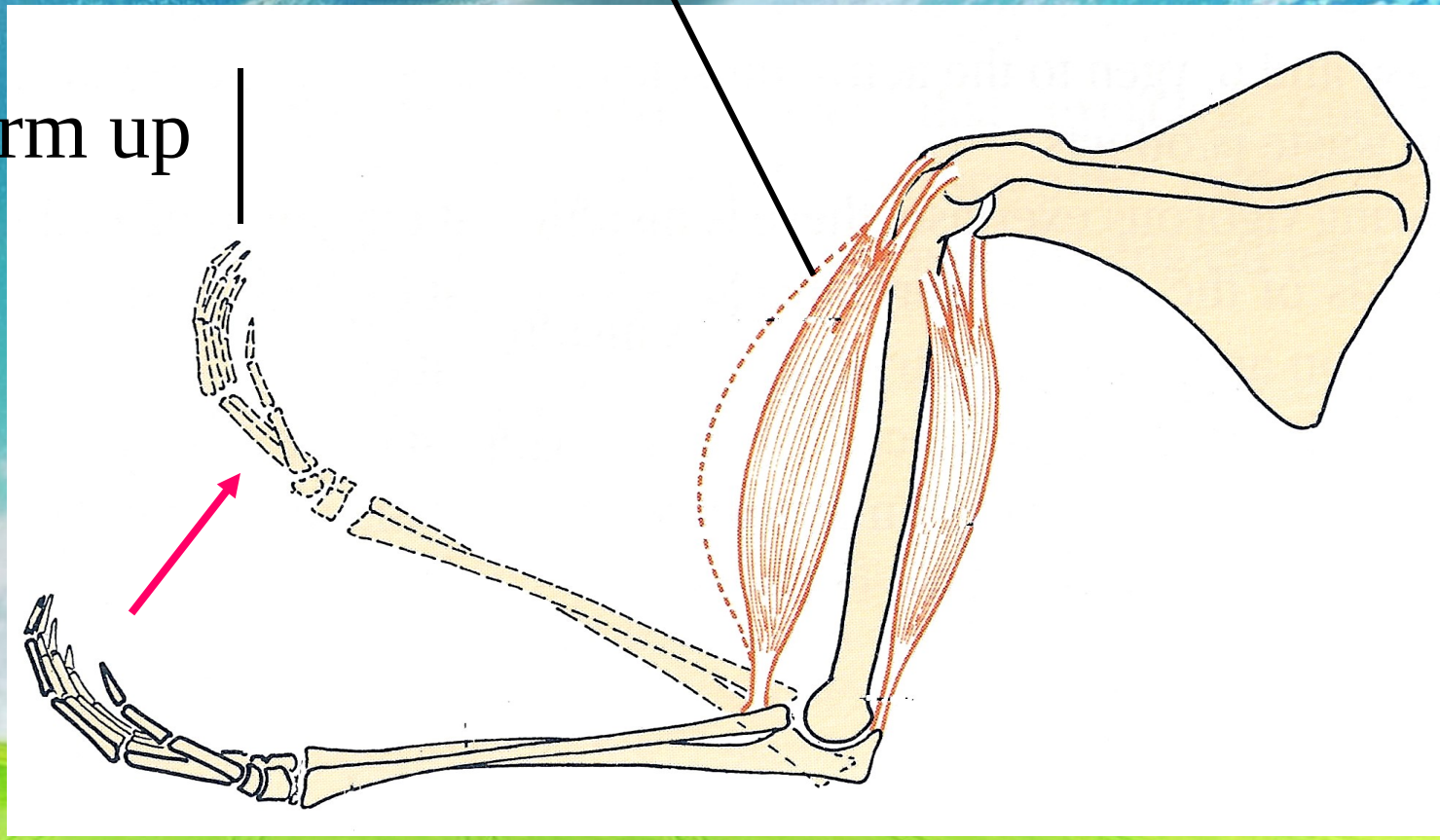
The blood stream brings food and oxygen to the muscle cells. Respiration occurs in the cells and releases energy which……



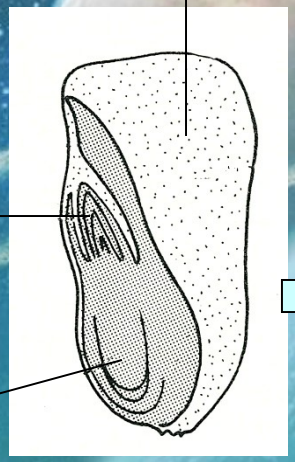
.....makes the muscle contract

and pull the lower

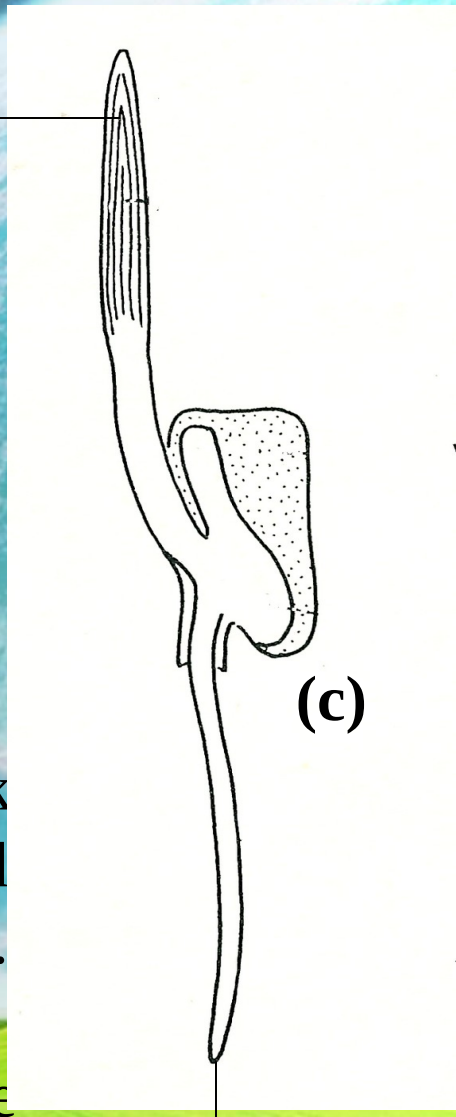
arm up



(a)




(b)



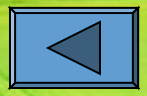

(c)

(a) is a section cut through the length of a maize seedling. Areas of rapid respiration are stained pink (b) and (c) are drawings of the seed and the seedling that grows from it. Can you suggest reasons why respiration should be so rapid in the stained regions?

# Answer

The most intensely stained areas are in the root tip and the shoot tip. These are regions where very rapid cell division is taking place to produce growth. Making new cells and new cytoplasm takes a great deal of energy.

You might also have noticed that, in the root, there are two faint streaks of pink. These occur in the conducting tissue of the seedling. Energy is needed to transport food from the food store to the growing region.

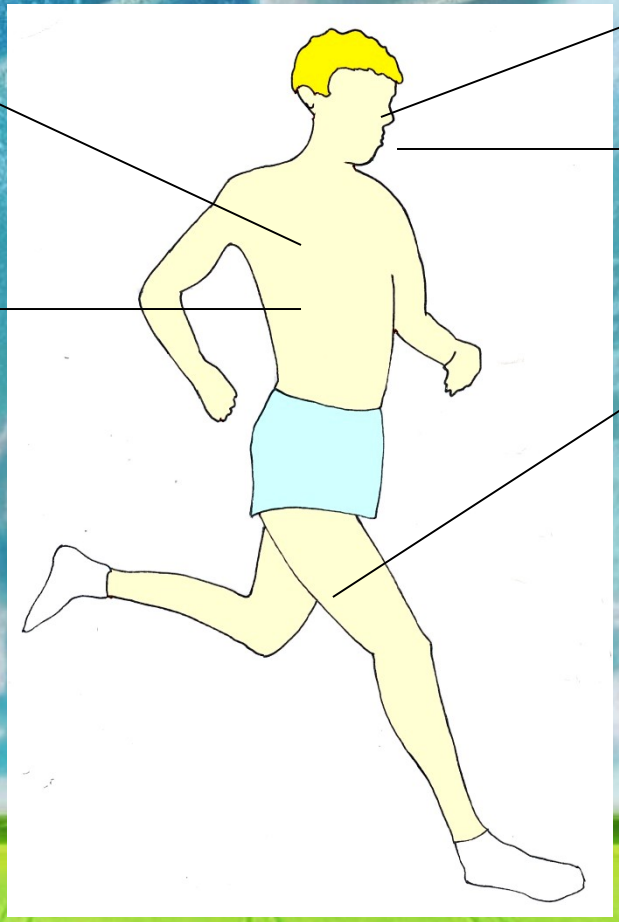


# One example of respiration in ourselves

**2.** The lungs absorb oxygen from the air

**2.**The stomach and intestine digest food. One of the products is glucose

**4** RESPIRATION
Glucose and oxygen react to produce energy for muscle contraction



**1**. Air taken in

**1**.Food taken in

**3.**The blood stream carries glucose and oxygen to the muscles

**5** Carbon dioxide is carried to the lungs by the blood

# Question 1

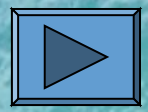
What is the **most important** point about respiration?

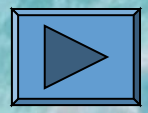
(a) it uses oxygen

(b) It produces energy

(c) It produces carbon dioxide

(d) It needs food and air

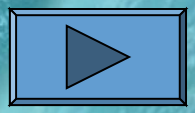




# Question 2

In which part of the human body is respiration most likely to be occurring?

(a) The lungs



(b) The heart

(c) The muscles

(d) All of these

# Question 3

Which of these are waste products of respiration?

(a) Carbon dioxide

(b) Water

(c) Oxygen

(d) Nitrogen

# Question 4

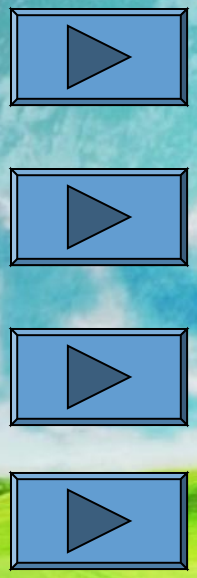
Which of the following would be reliable indicators of respiration in a living organism?

(a) Output of water vapour ($H_2O$)

(b) Output of carbon dioxide ($CO_2$)

(c) Uptake of oxygen ($O_2$)

(d) Production of energy



# Question 5

Which of the following statements are correct?

(a) We breathe in air

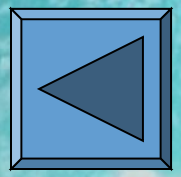
(b) We breathe in oxygen

(c) We breathe out air

(d) We breathe out carbon dioxide

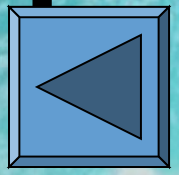
# Answer

Correct



# Answer

Incorrect



# Anaerobic Respiration

The process of respiration described so far has been defined as the release of **energy** when foodstuffs such as glucose react with oxygen to produce carbon dioxide and water.

This form of respiration, which needs oxygen, is called **aerobic** respiration.

There is another form of respiration which does not need oxygen and is called **anaerobic** respiration.

In anaerobic respiration, glucose is still broken down to carbon dioxide with the release of **energy**, but without the involvement of oxygen

The glucose is not completely broken down to $CO_2$ and $H_2O$ but to $CO_2$ and alcohol (ethanol).

Anaerobic respiration can be represented by the equation

The energy released by anaerobic respiration is considerably less than the energy from aerobic respiration.

Anaerobic respiration takes place at some stage in the cells of most living organisms.

For example, our own muscles resort to anaerobic respiration when oxygen is not delivered to them fast enough.

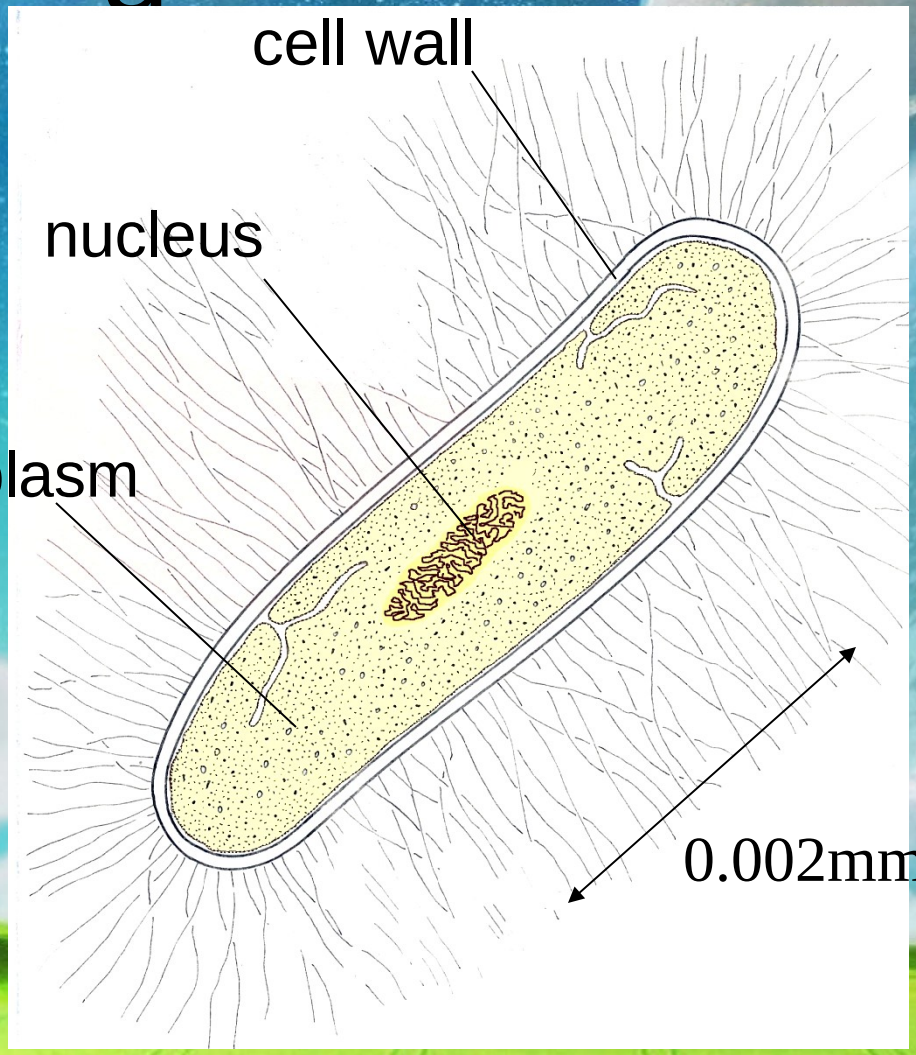
Anaerobic respiration is widely used by many micro-organisms such as **bacteria** and **yeasts**.

Bacteria and yeasts are microscopic single-celled organisms.

Bacteria are to be found everywhere, in or on organisms, in water, air and soil

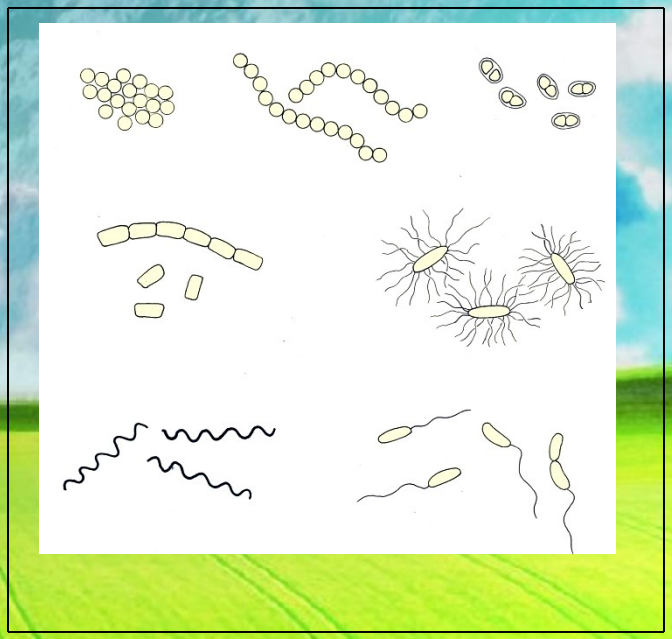
Yeasts are usually found in close association with vegetable matter such as fruit

# Bacteria




a single bacterium

there are many species of bacteria and they have different shapes and sizes



# Aerobic and anaerobic bacteria

Bacteria which need oxygen in order to respire are called **aerobic bacteria**.

Aerobic bacteria are likely to be found in the air, water and soil where oxygen is available

Bacteria which can respire without needing oxygen are called **anaerobic bacteria**

Anaerobic bacteria are to be found in situations where oxygen is lacking, such as in stagnant water, waterlogged soils or the intestines of animals

# Fermentation

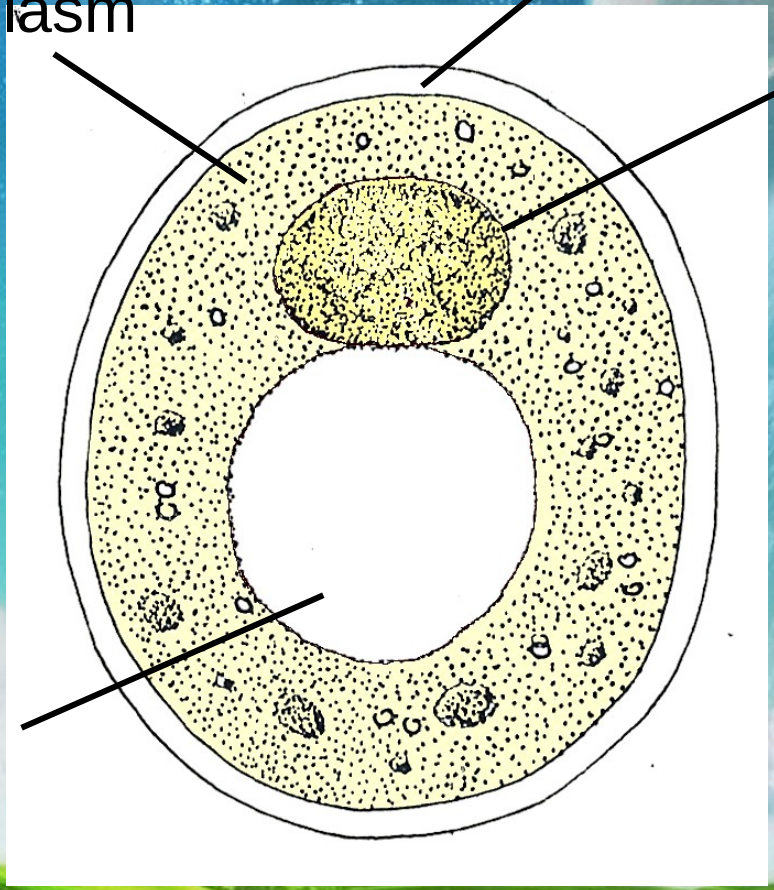
One form of anaerobic respiration in bacteria and yeasts is called **fermentation**.

During fermentation, sugar is broken down to alcohol and carbon dioxide

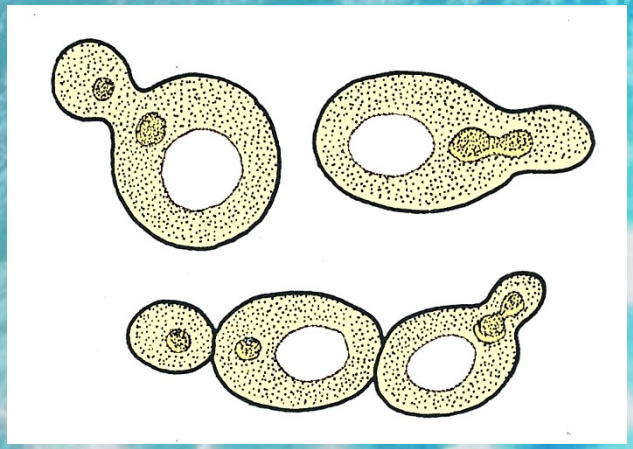
The reaction described in slide 25 is an example of fermentation

Fermentation is involved in brewing and wine-making

# Yeasts




single yeast cell



Yeast cells dividing

# Wine making

Grapes are crushed and the sugar they contain is fermented by yeasts to produce alcohol and carbon dioxide.

The carbon dioxide usually escapes but if the wine is bottled before fermentation is complete, the carbon dioxide dissolves and escapes as bubble when the bottle is opened

This is the case with ‘sparkling’ wines such as Champagne

Different varieties of grape produce different types of wine

# Black grapes growing in a vineyard

# Brewing

In brewing beer, a sugary product (malt) is dissolved out of germinating barley

Yeast is added to this solution and fermentation begins, producing alcohol and carbon dioxide

Some of the carbon dioxide escapes but the rest dissolves in the beer when it is bottled or put into casks

When the bottles or casks are opened, the dissolved $CO_2$ escapes as bubbles

# Beer fermenting

©Stuart Boreham/CEPHAS

# Baking

In baking, yeast is added to a mixture of flour and water, made into the form of a dough

The yeast first changes the flour starch into sugar and then ferments the sugar into alcohol and $CO_2$

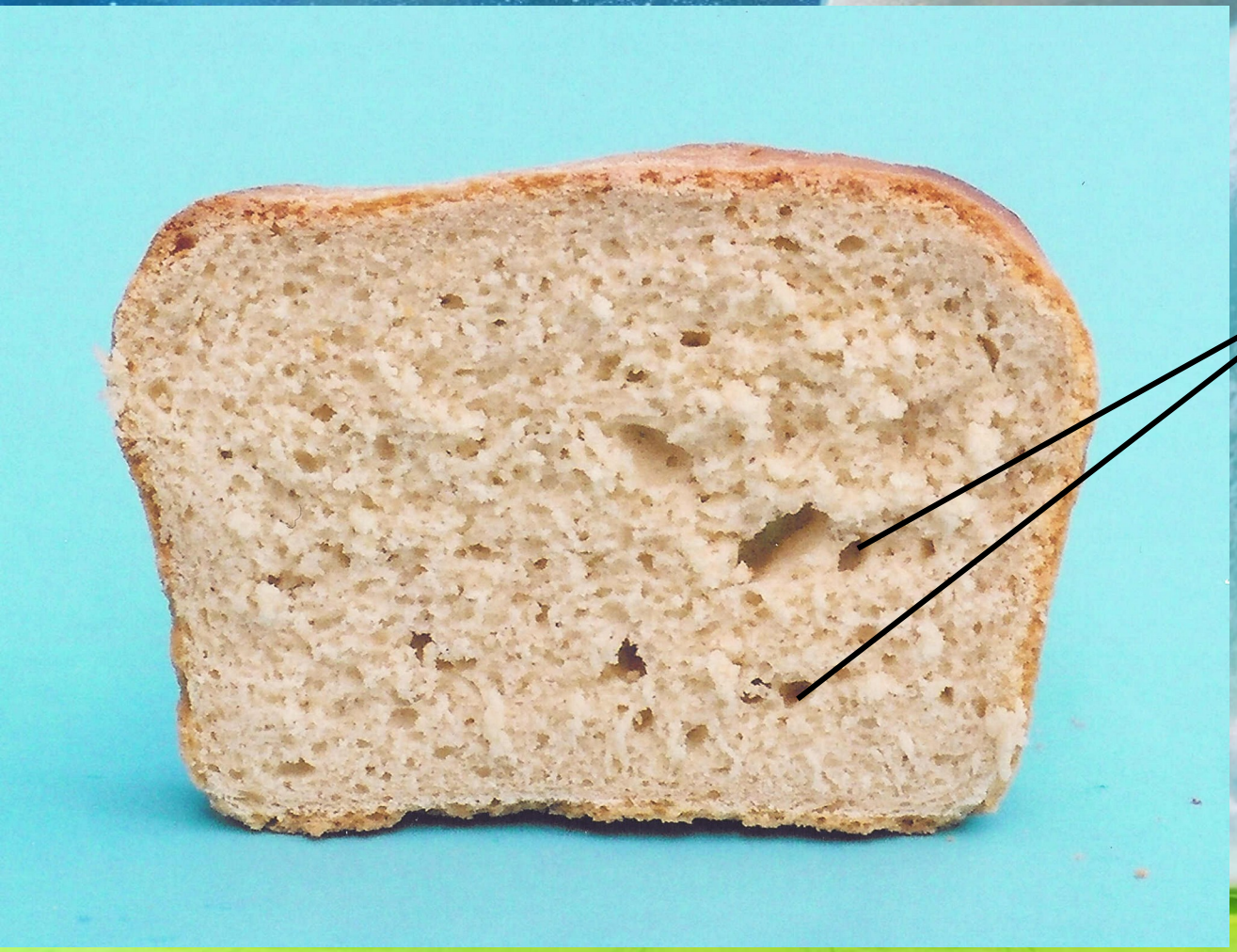
The $CO_2$ forms bubbles in the dough which cause it to expand (‘rise’)

When the dough is baked, the heat evaporates the alcohol but makes the trapped bubbles expand giving the bread a ‘light’ texture

# Dough rising

The yeast is mixed with the dough

After 1 hour in a warm place the dough has risen as a result of the carbon dioxide produced by the yeast



The ‘holes’ in the bread are made by the carbon dioxide bubbles.
This gives the bread a ‘light’ texture

# Question 1

Which statements are correct ?

Anaerobic respiration **is different** from aerobic respiration because

**a** it produces $CO_2$

**b** it does not need glucose

**c** it does not need oxygen

**d** it produces less energy

# Question 2

In what circumstances do our muscle use anaerobic respiration ?

**a** When insufficient glucose reaches the muscles

**b** When the carbon dioxide level increases

**c** When insufficient oxygen reaches the muscles

**d** When we are asleep

# Question 3

Anaerobic bacteria are **most** likely to be found

**a** in the middle of a compost heap

**b** in the air

**c** in fast-flowing streams

**d** on the surface of the skin

# Question 4

In which of the following is the production of $CO_2$ more important than the production of alcohol ?

**a** Brewing beer

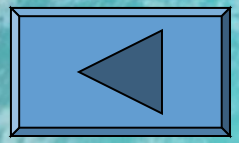
**b** Fermenting grape juice

**c** Making bread

**d** Bottling wine

# Answer

Incorrect



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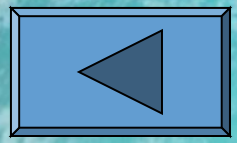
Correct