UNIT - VI

RESPIRATION AND PRODUCTION OF ENERGY

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Friends,

It is very well known to you that each and every cell of a living Organism should get sufficient food, oxygen and other substances in order to carry out its metabolic activities. Through Unit-V, namely, 'Transportation and Circulation', you have come to know how food and other substances are transported to each and every cell in plants and animals. You can very well guess the consequences, if we do not supply an organism with food, water and oxygen. An organism can live for weeks without food, and for several days without water, but only for a few minutes without oxygen. The question that arises here is, why is it oxygen so important for the life of an organism?

You will find an answer to this question in Part-I of this Unit. You will study that the body of an organism is like a machine that releases energy from food. It does this by combining oxygen with food. But, the question is;

--- how exactly oxygen helps in releasing energy from the food?

You will get an answer to this question when you go through the second part of this Unit. After understanding

this, in part three of this Unit, you will study the mechanism of breathing in animals. In other words, you will be studying how plants and animals take in oxygen from atmosphere for the process of respiration, and give out carbon-di-oxide.

The learning material in the three parts of this Unit are presented in three different ways. How to study the material under each part has been explained at the beginning of each part.

P A R T - I

RESPIRATION AND PRODUCTION OF ENERGY

Dear pupil :

As you have already read in the introduction to this Unit, this part deals with the Question;

--- Why is it oxygen so important for the life of an organism?

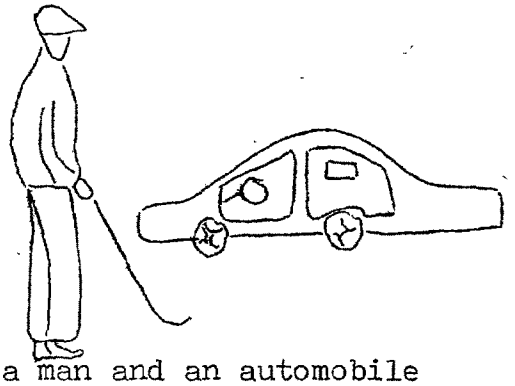
In simpler terms, you will be studying why all organisms require oxygen to exist on this world?

This you would be studying in a different way. The learning material is presented in the form of small paragraphs illustrated with sketches.

As you read through, you will also find a few activities to perform and some questions to answer. These activities and questions will help you to understand the idea better. If you get any doubt while going through the material, you may note down, and discuss them with your teacher.

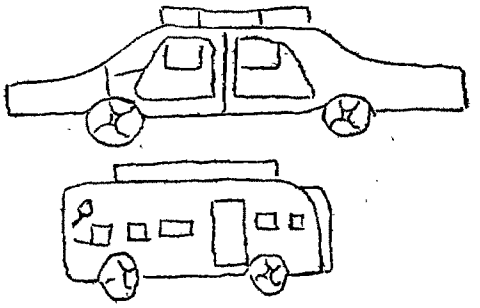
Hope you will find the learning material interesting.

In the introduction to the Unit, you have read that the plant or animal body is a machine which releases energy from the food. Let us consider the case of our own body and try to compare it with an automobile.



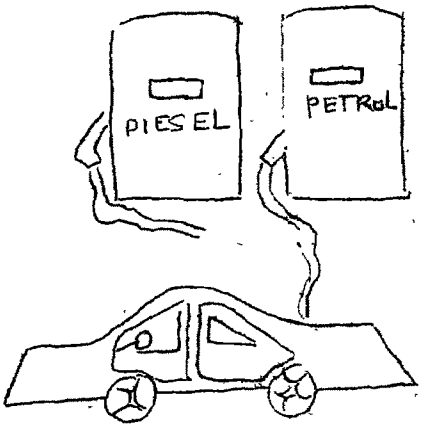
Are a man and an automobile alike?

You are all familiar with different types of automobiles e.g., a car or a bus. You know very well that energy is required if the car or bus has to move on its own. Think, from where does a car or bus gets energy to move.



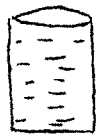
From where does an automobile getsenergy to move.

I am sure, you would say that a car or bus gets energy to move,from the petrol or diesel that is fed into it. Petrol or diesel contains energy, with the help of which the car or bus moves. But the question is what should happen to petrol or diesel if the energy stored in it is to be released?

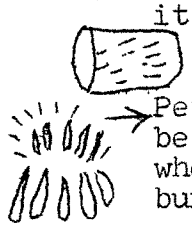


An automobile gets energy to move from the gas (petrol or diesel).

Suppose, we keep petrol or diesel in a Cup: will the energy be released? You may say no. The energy contained in petrol or diesel will be released only when it is burnt.



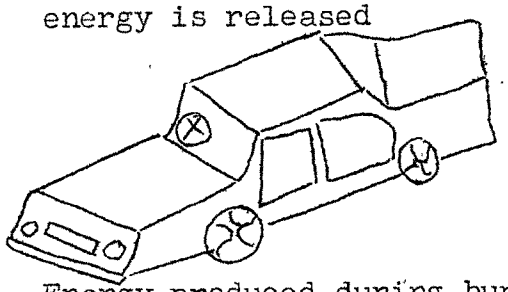
Will petrol kept in a Tumbler release Energy on its own accord?



Petro-Energy will be released only when petrol is burnt.

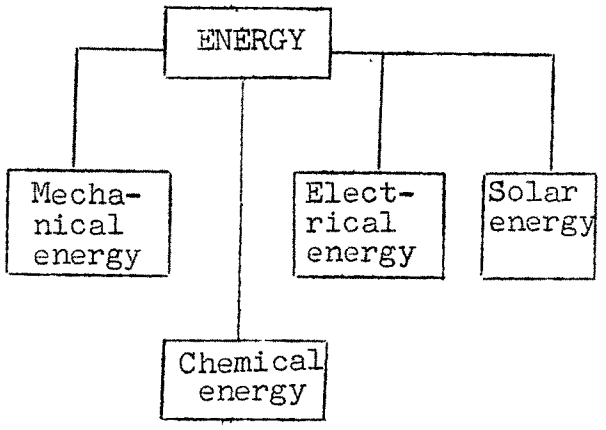
In the same way, in the case of a Car or bus also, energy is released only when the petrol or diesel is burnt. The energy thus produced during burning will be utilized for the movement of car or bus.

Petrol is burnt in the engine & energy is released



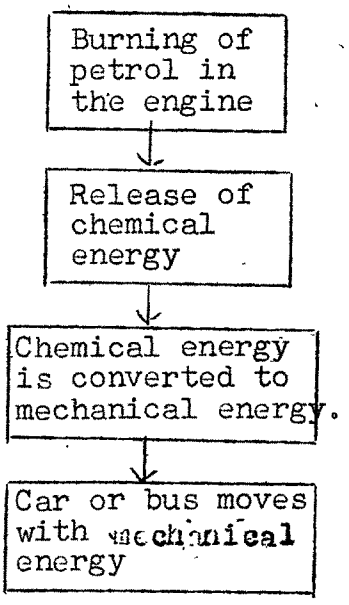
Energy produced during burning of petrol is utilized for the movement.

For a moment, recall what you have studied about the different forms of energy, in your 7th standard. You have studied about various forms of energy e.g., mechanical energy, solar energy, chemical energy, electrical energy etc. Let us apply our knowledge about the different forms of energy to understand how energy is produced from Petrol/diesel in an automobile.

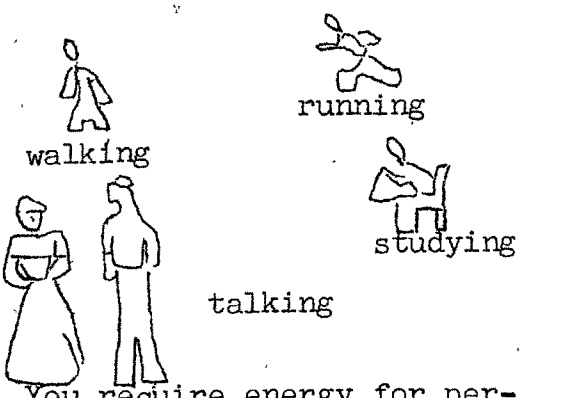


Energy exists in different forms, e.g., Mechanical, Electrical, Solar, etc.

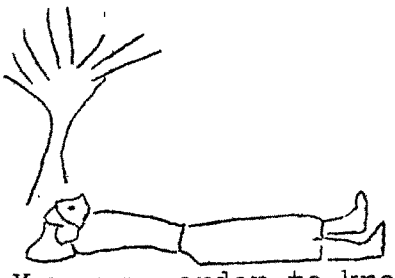
In the case of car or bus, the chemical energy stored in petrol or disel gets released when it is burnt in the engine. This chemical energy is converted into mechanical energy, with the help of which the car or bus moves.



Now, think of the living organisms. They exhibit various activities. You can take your own example. You play, study, talk, listen to your teacher, and perform many other activities. You know that you require energy for performing these various activities. Even while sleeping you will be utilizing energy (all the systems of your body will be working during sleep also). Think, from where do you get energy to perform all these activities?



You require energy for performing all these activities.



You may wonder to know that you will be utilising energy even while sleeping.

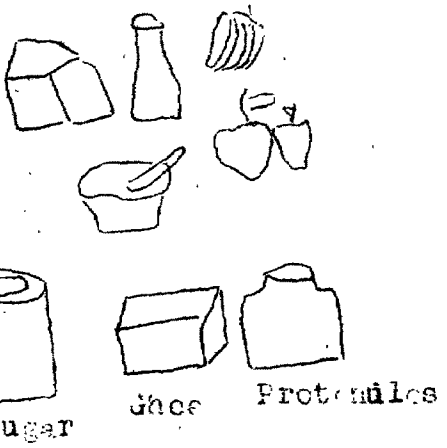
You would definitely say that you get energy from the food you take. Very much right. Food is the main source of energy for all living organisms. We can even say that as petrol or diesel is to car, so is food to living organisms'. You are quite familiar with different energy rich food stuffs. Think, what should happen to these food stuffs if the energy stored in them is to be released?

Let us consider one example viz., fats.

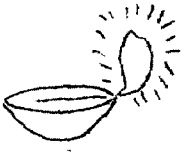
Suppose, you keep Ghee (a fatty substances) in a lamp, without lighting the wick; will it produce energy, say light or heat? Your answer will be surely 'no'. On the other hand, you burn the ghee by lighting the wick, you will get light as well as heat energy. We can say that energy contained in fat is released when it is burnt.

Let us take another example viz., Common sugar.

THE QUESTION IS, FROM WHERE DO YOU GET ENERGY TO PERFORM ALL THESE ACTIVITIES.



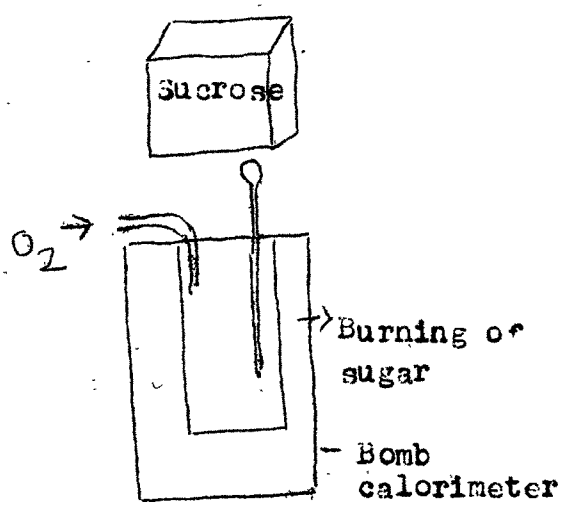
Ghee in a lamp



light and heat.

Energy contained in the fat is released when it is burnt.

As you know, it is Sucrose - an energy containing food stuff. If you burn sugar in a special instrument known as Bomb calorimeter, (Bomb calorimeter is an instrument in which substances can be burnt without an external flame, with the help of oxygen) you will find the reading of the thermometer shooting high revealing the amount of energy produced during the burning of sugar.



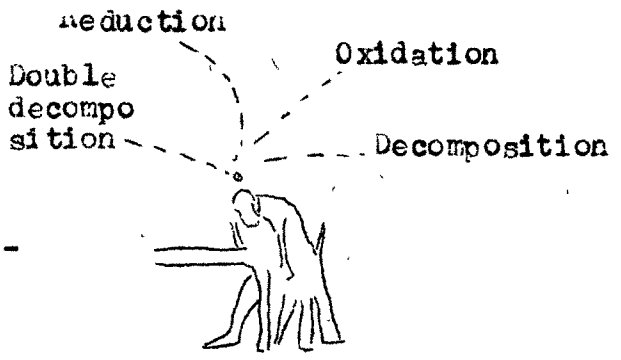
When sugar is burnt energy is released

In the same way, in the body of a living organism also food stuffs are burnt, and the energy liberated from the food stuffs are utilized for various activities. You may wonder as to how food stuffs are burnt in the body of a living organism without an external flame. You will come to know this in your next Sub-unit, Viz., Biochemistry of respiration

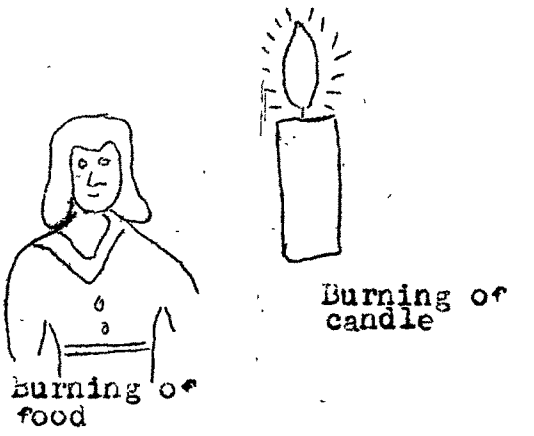
Energy

How food stuffs are burnt in the body of an organism without an external flameL

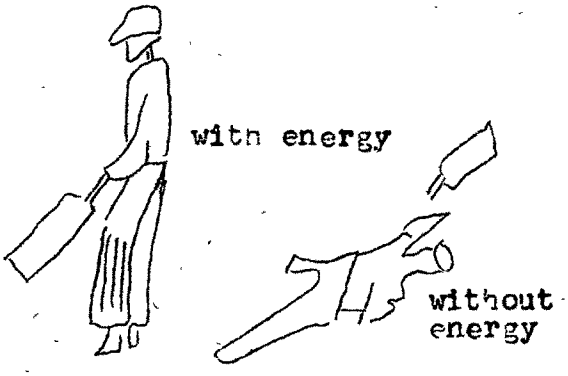
Recall what you have studied about different chemical reactions in your chemistry classes this year. You have studied about reactions like oxidation, reduction, decomposition etc. Think as to what type of reaction is burning of glucose or sugar in our body?



From your knowledge of chemistry, you may say that it is an oxidation reaction. True. Burning of food or for that sake burning of any substance, is an oxidation reaction, since oxygen is the main element needed for burning. Since oxygen is the main element needed for oxidation, all living organisms require oxygen for burning the food in their bodies, and utilizing the energy contained in them.



You can very well reason out as to what will happen if oxygen is not supplied to an organism. If oxygen is not supplied to an organism, then oxidation of food will not take place. Hence, energy will not be produced. Because of the lack of energy, organs of the body will not work and the organism will die.



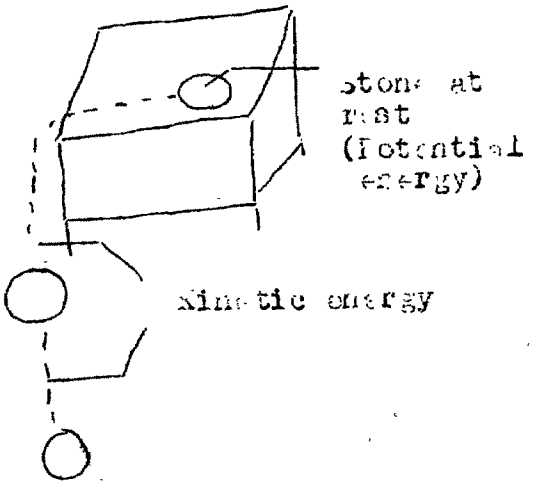
Have you got an answer to the question "why all living organisms require oxygen", Which was raised in the beginning. Now let us summarise what we have studied so far.

"I have got an answer to the question, why all living organisms require oxygen.

S U M M A R Y:

1. Food form the main source of energy to all living organisms.
2. Food is burnt or oxidised in the body of an organism, and the energy produced during burning is utilised by the organism for performing various life activities.

Let us examine the process of burning of food in a living organism further. Recall what you have studied in your 7th standard about potential energy and kinetic energy. Let us apply this knowledge to the process of burning of food in a living organism. You know that the energy that is stored in the food stuffs is the potential energy. During burning of food, this potential energy is converted into kinetic energy, which is utilized for various life activities.



In a single sentence we can say that during oxidation of food in a living organism, the potential energy stored in the food is released as kinetic energy, which is utilized by the cells of the organism for performing various life activities.

This process of oxidation of food and utilization of energy by the cells is called as Respiration. As you know, it is essentially a chemical process and goes on in the cells of all living organisms continuously from birth to death.

SUMMARY

All living organisms require energy to perform the different metabolic activities, and food forms the main source of energy for all living organisms. The energy rich food stuffs are burnt in the body, and energy thus liberated during burning is made use of for various life activities. This process of burning of food inside the bodies of living organisms is called as "Physiological Burning", or "Respiration".

Activities to perform:

It is always a fun to do some activities in Biology. You may do the following activities and experience yourself.

Here are given a few activities. Name the activities which require the maximum energy to perform, and the activities which require minimum energy to perform.

a) Running fast
b) Running slowly
c) Reading loudly
d) Reading slowly
e) Listening to others
f) Walking slowly
g) Sleeping.

Think as to why these activities require more energy or less energy to perform.

Questions:

1. Where in your body is energy needed?
2. Explain how your body gets energy from the food. Be sure to tell where the energy comes from and into what forms it is changed.
3. (a) How is your body like a kerosine stove or a locomotive, in the way it gets energy.
   (b) What important differences are there?

Check your answers:

1. Every cell of the body requires energy to perform life activities.
2. When food is oxidised, energy is produced which is utilized by the body cells. Energy comes from the food substances such as Carbohydrates, Fats and Proteins; But mainly from Carbohydrates. The potential energy stored in the food is converted into kinetic energy.
3. In both, oxidation is essential to release energy.
   As Kerosine is to Stove, so is food to living organisms.

P A R T - II

BIOCHEMISTRY OF RESPIRATION

About the Material in this Part:

Dear pupil:

Here you will find the explanation given to you by your Teacher on the topic 'Biochemistry of Respiration", or the "Mechanism of Respiration", in the form of notes.

Further, you will also find the details regarding the experiments conducted in the class by the Teacher. The discussions you had with him about the experiments are given in the form of small frames. However, if you get any doubt while going through the material, you may note them down and discuss with your Teacher. The summaries given intermittently and at the end will help you to revise the material quickly.

Hope you will find the learning material as interesting as the earlier one.

Through Part-I of this Unit, you have come to know about the process, namely, Respiration. You know that it is a chemical process by which the food is 'burnt' or 'oxidised', and energy contained in the food is made available to cells. You may remember that we had compared the burning of food in living organisms with that of burning of petrol or diesel in automobiles. In both the cases there is liberation of energy. The difference between the two is, in automobiles, the burning of the fuel is very rapid, whereas in living organisms burning of food is very slow. In other words, the process of oxidation in living organisms is very slow. You may thing as to why the process of oxidation in living organisms is very slow, unlike the automobiles.

Scientists through a long period of experimentation have found out that nearly 690,000 calories of energy is produced when one mole of glucose is burnt in the body of a living organism. (A mole is the weight of a substance that is numerically equal to its molecular weight. A mole of glucose, weighs 180 gms). You can just imagine the fate of an organism if 690,000 calories of energy is produced at a stretch in its body. The energy evolved would be sufficient to burn its body. Secondly, the cells of the living organisms cannot use a large burst of energy at once. Naturally, a lot of energy produced becomes a waste. It is

because of these reasons, cells of the living organisms oxidise the food gradually thereby utilizing most of the energy liberated during burning. But the question is, how is food oxidised slowly in the body of an organism?

To understand this, you may have to recall what you have studied about the constituents of protoplasm in the second Unit, namely, "Protoplasm and its constituents". You have studied that the basic energy containing substance is the glucose, which is the simplest carbohydrate. During respiration, in the cells, oxidation or "burning" of glucose takes place. Glucose is oxidised into carbon-di-oxide and water, and energy is released. This oxidation of glucose takes place in several steps (nearly 30-40 steps) and energy is released in every step. Imagine how slow a process is this oxidation. However, for the sake of convenience, these steps could be studied under two major Groups: (1) Glycolysis, and (2) Krebs Cycle or Citric acid Cycle.

Glycolysis:

During glycolysis, 6-carbon glucose molecule is oxidised to two-three carbon substances known as pyruvic acid.

Kreb's Cycle:

During Kreb's Cycle (It is named after a Scientist by name Sir Hans Krebs of the University of Oxford, who first

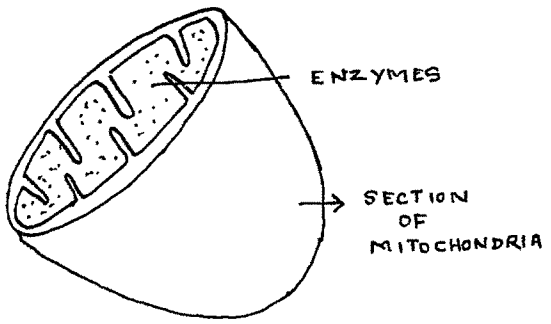
postulated it in 1937 after continuous ten years of research), the pyruvic acid formed during glycolysis is once again oxidised to Carbon-di-oxide and water. The whole process of oxidation can be represented in the form of an equation.

$C_6H_{12}O_6 + 6O_2 \text{ --- } 6CO_2 + 6H_2O + 673$ Calories of energy.
(Glucose)

Now the question is with the fuel (food) completely oxidised, what has become of the potential energy it contained?

This was a major question to scientists during early 1030's. Many scientists worked in their laboratories to find an answer to this question. Among them, the credit goes to two scientists, viz., Herman H. Kalckar of Denmark and U.A. Belister of the U.S.S.R., who found out that during respiration, the potential energy contained in the food is liberated in the form of high energy phosphate molecules which goes to form the Adenosinetriphosphate (ATP). This gave a clue to Bio-chemists who were working in the same area. They further carried out the research and found out that oxidation of one molecule of glucose leads to the production of nearly 60 A.T.P. molecules. Today, ATP is regarded as "Universal intra-cellular carrier of chemical energy". This was possible mainly because of the Scientists' curiosity to know everything and to question everything. Further, they had the perseverance to find a solution to the problem.

Now we know that when one molecule of glucose is oxidised in our body, 60 ATP molecules are produced. Of these 60 ATPs', two ATPs' are produced during Glycolysis and the rest during Kreb's Cycle. In other words, we can say that major amount of energy is produced in Kreb's Cycle. The enzymes that take part in the reactions of Kreb's Cycle are packed in the mitochondria. It is because of this reason, mitochondria are called as the "power-houses of cells", since they contain enzymes which help in the release of energy.



Mitochondria contains enzymes that are needed for the process of respiration and release of energy. Hence, they are called "Power Houses of Cells".

The important feature of the whole mechanism of respiration is, through oxidation, the potential energy stored in the organic food is released step by step in the form of kinetic energy, which is made use of for the metabolic activities. In this process of oxidation, a considerable amount of energy is lost in the form of heat.

You may recall what you have studied about the formation of ATP in the Sub-unit "Cell and its Organelles". The energy

Diagram-2

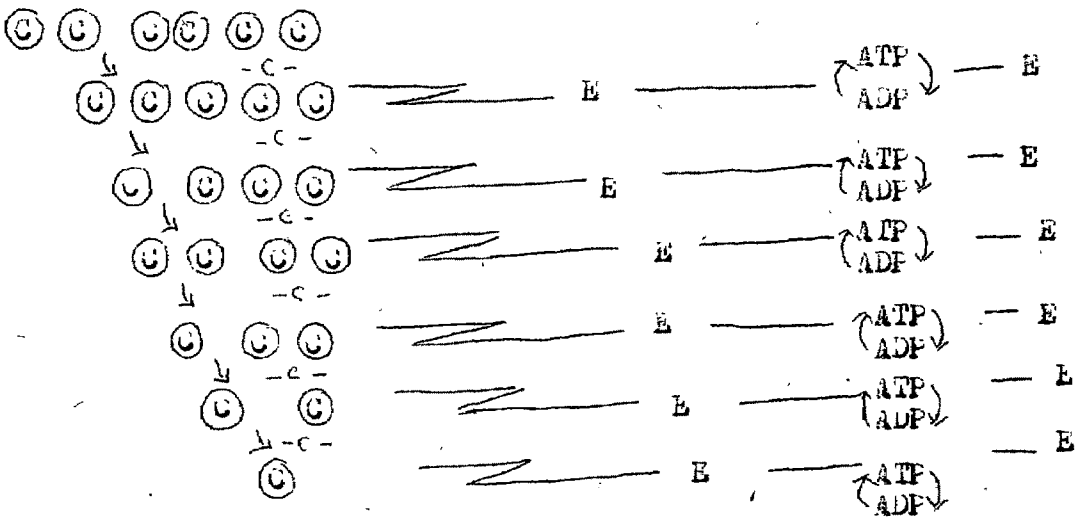
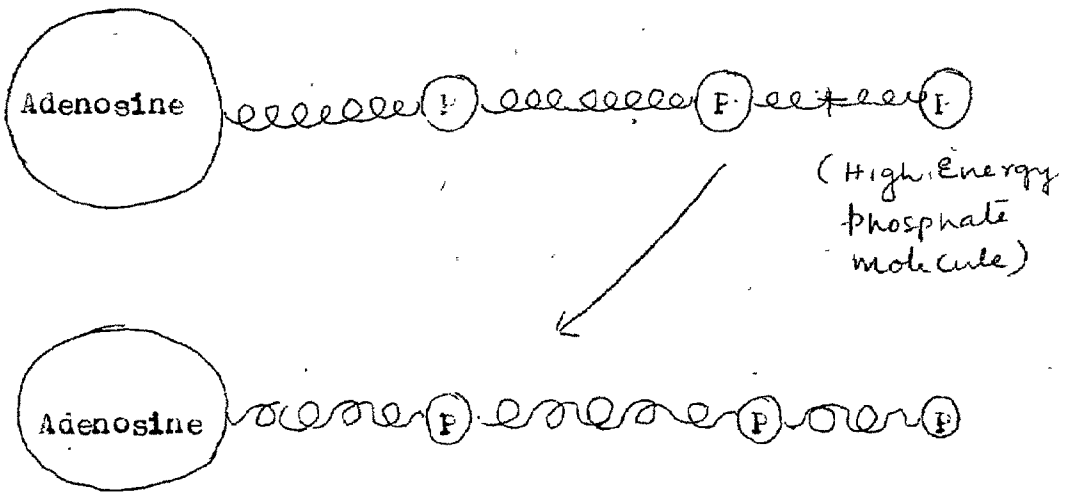


Diagram showing the slow oxidation of glucose and release of energy. Energy is released in the form of high energy phos. - phate molecule, which is picked up by the Adenosine di phosp- hate.



With the addition of one high energy phosphate molecule, Adenosinedi phosphate (ADP) gets converted into Adenosi- ne tri phosphate.

released in the form of high energy phosphate molecule is picked up by the molecules of ADP (refer Dia. 2).

Owing to the addition of one high phosphate energy molecule, ADP gets converted into ATP. Whenever energy is needed, ATP breaks into ADP and a high energy phosphate molecule. The high energy phosphate molecule is utilized by the body cells for various activities. The converted ADP again traps energy relèased during oxidation and becomes ATP. Thus, it is a continuous process that goes on in the body of an organism. The chemical steps involved in the process of respiration is same in both plants as well as animals. Even the enzymes that take part in the process are same. The only difference is with regard to the intake of oxygen which you will be studying in Part-III of this Unit.

Hope you are clear about the Bio-chemistry of respiration. This type of respiration, where oxygen is made use of for the process of burning of food is called as "aerobic respiration", Aerobic respiration is a type of respiration wherein free oxygen of atmosphere is made use of for the process of burning of food.

Let us Summarise what we have studied so far:

SUMMARY

1. Respiration is a process by which food is oxidised in the body of an organism, and energy is released.

2. It is a slow oxidation process unlike burning of petrol or candle.

3. Burning or oxidation of food takes place in nearly 30-40 steps and in every step certain amount of energy is released.

4. All these steps can be grouped under two headings, viz., Glycolysis and Kreb's Cycle.

5. Major amount of energy is released during Kreb's Cycle; the energy released in the form of high energy phosphate molecule is trapped by ADP and gets converted into ATP.

6. Whenever energy is required, ATP breaks into ADP and high energy phosphate molecule which is utilized for various metabolic activities.

7. Since respiration takes place in the presence of oxygen, this type of respiration is called as 'Aerobic Respiration'.

Brief Introduction:

Well, by now, you are clear about what is respiration and how it takes place in the body of an organism,etc. Let us compare the processes of respiration with that of

photosynthesis in plants, and try to understand the differences. You will come to know the differences as you read the following frames. You are quite familiar as to how to go through the frames. However, if you have forgotten the instruction, you may refer to the Introduction in Sub-unit-II of the Unit-I.

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1. Recall what you have studied about photosynthesis in the Unit 'Autotrophic Nutrition'. You have studied that photosynthesis is a process by which green plants manufacture their foods.

   The process by which green plants manufacture _____ is called as photosynthesis.

---

food

2. Correct. The main event in the process of photosynthesis is the manufacture of complex food molecules like carbohydrates, fats, etc., with the help of simple substances like CO_2 and H_2O. We can say that it is a constructive process since complex food molecules are built or manufactured.

   Think about the process of respiration. As you know, it is a process by which the complex food molecules are 'burnt' or 'oxidised' and energy is released.

   Hence, respiration is a _____ Process.
   (Constructive/destructive)

   If you have written constructive-go to frame-3.
   If you have written destructive-go to frame -4.

3. You might have written respiration as a constructive process keeping in mind the production of energy. But think, during respiration, the complex molecules of food are oxidised into simpler substances, and energy stored in the food is released.

Hence, it is not a constructive process, rather it is a _____ process.
(go to frame-4).

Destructive

4. You are right. Respiration is a destructive process, since the food that is manufactured during photosynthesis is burnt or oxidised to release energy.

By comparing the process of photosynthesis with that of Respiration, we can say that the first difference between photosynthesis and respiration is;

Photosynthesis is a _____process, whereas respiration is a _____process.

Constructive, Destructive

5. Recall the different factors that are needed for photosynthesis. You know that one of the factors is Sunlight.

You have learnt that photosynthesis takes place only during d y time.

---

6. You are correct. Photosynthesis takes place only when there is sunlight. It is not a continuous process, since it takes place only during day time.

Since photosynthesis does not take place during both day and night times, it is _____ a continuous process.

---

not

7. In the case of respiration, as you know, it takes place both during day and night times.

In other words, we can say that it is a _____process.

Continuous

8. You are correct, if you have written respiration as a continuous Process. Putting frames 6 and 7 together, we can say that second difference between photosynthesis and respiration is, photosynthesis is _____ a continuous process, whereas respiration is a _____ process.

Not, continuous

9. You know that even during day time, photosynthesis takes place only in leaves and sometimes in stems.

In other words, photosynthesis takes place only in G_____ parts of a plant.

---

green

10. True. Phbtosynthesis takes place only in the green parts of a plant, since they contain the pigment chlorophyll.

So, we can also say that photosynthesis is restricted to only cells having_____ pigment.

Chlorophyll

11. You are right. Only chlorophyll containing cells have the ability to manufacture their food. Recall what you have studied about respiration. You have studied that it takes place in all cells irrespective of the presence or absence of chlorophyll.

In simpler words, we can say that it is c n to all the cells

Common

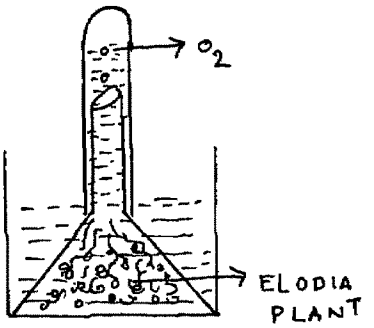
12. From the frames 10 and 11, can we draw any difference between photosynthesis and respiration?

We can draw one difference between photosynthesis and respiration, and that is, photosynthesis takes place only in _____ cells, whereas, Respiration takes place in _____ the cells

---

Green, c- all

13. You may recall the experiment with elodia plants which we did while studying about photosynthesis. The diagram will help you to recall the experiment. In the experiment you observed oxygen gas bubbling up in the test tube.



We inferred from the experiment that during photosynthesis _____ gas is evolved and it is not at all utilised in the process.

Oxygen

14. It can also be said that in a different way. The Gas _____ is not utilised by plants to manufacture food.

Oxygen

15. You are correct. For the process photosynthesis to take place, oxygen is not a necessary element. Think of Respiration. You know that it is an oxidation process. Hence, the main element needed for oxidation is oxygen.

In other words, without the element of _____, respiration cannot take place.

Oxygen

16. We can also say that during respiration, _____ gas is utilised and is not thrown out as in the case of photosynthesis.

Oxygen

17. So, from the frames 13, 14, 15 and 16 we can say that another difference between photosynthesis and respiration is, during _____ oxygen is not utilised, whereas during _____ oxygen is utilised.

Photosynthesis, Respiration

18. You are right. Now we know four differences between photosynthesis and respiration. Let us put them together (fill in the blanks and check your answer).

Photosynthesis	Respiration
1. _____process	1. Destructive process.
2. Not a _____ process	2. Continuous process
3. Takes place only in green cells	3. Takes place in _____ cells.
4. Oxygen is_____ utilised.	4. Oxygen is _____

Correct Answers:

1. Constructive Process,
2. Continuous
3. All — 3. All
4. not — 4. Utilised

Besides these differences, Respiration differs from photosynthesis with regard to

the production of certain end products.

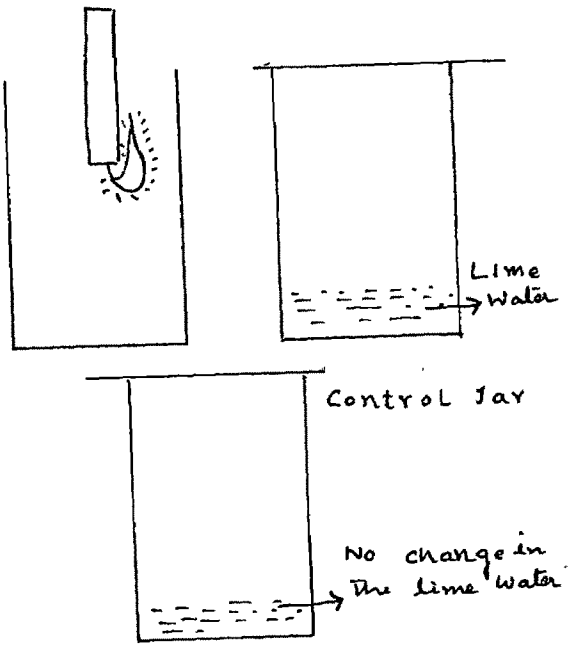
Let us do some experiments and find out the different end products produced during respiration.

(Your teacher would proceed in the following way to show you that Carbon-di-oxide is produced during burning).

Materials Needed:

1. Two Gas Jars
2. Wax Candle
3. Lime water
4. Match box.

Experimental Jars



Procedure:

1. To one of the gas jars a lighted candle will be introduced.
2. When the candle puts off, the jar will be covered with a glass plate. To this jar, again a lighted candle will be introduced.
3. When the candle puts off, due to lack of O_2, immediately lime water will be poured into it and shaken well.
4. As a control, lime water will be poured into another jar and shaken well.

Discussion 19. In our experiment with candle and gas jar, you noticed that when the gas jar was inverted over the burning candle, it extinguished after some time.

It is because, the candle utilised all the _____ present in the jar for burning, and was put off when there was no additional _____ supply of it.
(Oxygen/Air)

If your answer is oxygen, to
(go to frame - 21)

If your answer is air,
(go to frame - 20)

---

20. You may recall the composition of air which you have studied in your earlier classes. You know that air is composed of gases like Nitrogen, Carbondioxide, oxygen etc. You know that of all these gases, Oxygen is the only gas which is a supporter of combustion.

So, only _____ present in the gas jar was utilised by the burning candle, and not all other gases.

Go to frame..21

Oxygen 21. You are right. The burning candle used all the oxygen present in the jar and was put off when no more oxygen was available. You may remember, we tested the fas in the jar with the help of an another lighted candle.

We noticed that the candle did not burn due to lack of _____ in the jar.

Oxygen

22. To the same jar, we poured lime water and shook thoroughly. You observed the lime water turning milky. You may recall that the same experiment was done in chemistry class to study the properties of carbon-di-oxide. It is a sure test for carbondioxide.

From the experiment, we can say that the jar contained _____ gas in it.

Carbon-di-oxide

23. True. Think from where did this carbon-di-oxide come?

We can say that CO_2 present in the jar was produced during burning of the candle?
(yes/no)

If your answer is 'yes' go to frame - 24
if your answer is 'no' go to frame - 25

---

24. As students of science, we should not jump to conclusion without adequate evidence. Think of the composition of air. CO_2 present in the might be of the air.

Hence, we cannot say that _____ was produced during burning.
go to frame No. 25.

Carbon-di-oxide

25. You are correct. We cannot say that CO_2 present in the jar was produced during burning of the candle, because air in the jar itself contains CO_2. Recall what we

did to find out whether CO_2 was produced during burning of the candle. We poured lime water into another jar containing air, which we treated as a control jar and shook thoroughly. We did not observe the lime water turning milky.

From the experiment we inferred that _____ present in the gas jar was not sufficient to turn the lime water milky.

Carbon-di-oxide

26. You are right. The percentage of CO_2 in the control gas jar was less. Hence, lime water did not turn milky. In the case of the experimental jar, there was more CO_2, and hence lime water turned milky. Think, from where did this additional CO_2 in the experimental jar produce?

We can make a guess that it was produced during _____ of the candle.

---

burning

27. You know that this is only our guess. To make sure whether our guess is right or wrong, let us recall the experiment which was done during the lesson 'Oxygen' in chemistry class. We took a jar completely filled with Oxygen and introduced a candle. It burnt brightly, and was put off after sometime. When we tested the gas in the jar with lime water, we noticed lime water turning milky.

We can definitely say that the lime water turned milky because of the _____ gas produced during burning of the candle,

since there was no other gas except oxygen initially.

Carbon-di-oxide

28. Correct. What can we infer from these experiments?

We can infer that _____ is produced burning.

Carbon-di-oxide

29. Let us apply this knowledge to the case of automobile which we had considered in the beginning of the Unit. You know that petrol or diesel is burnt or oxidised in the engine.

From our knowledge of the experiment with the candle we can very well expect the production of _____ gas during oxidation or burning of petrol.

Carbon-di-oxide

30. You are ~~gith~~ right. During oxidation of petrol in the engine of a car, carbon-di-oxide is produced which is thrown out through exhausts. Production of carbon-di-oxide is true of any oxidation process.

We can conclude that _____ gas is produced during oxidation of a substance.

Carbon-di-oxide

31. Recall what you have studied about burning of food in living organisms. You know that it is a slow oxidation process.

From the conclusion which we have arrived at, viz., CO_2 is produced during

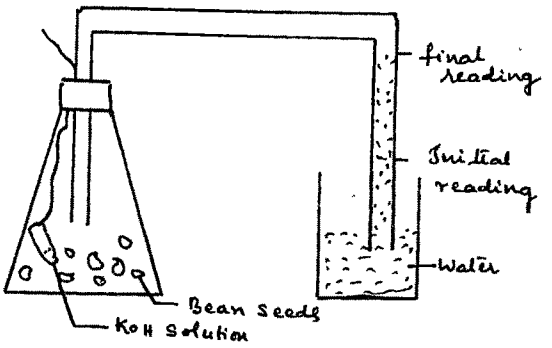
oxidation of a substance, we can hypothesise that carbon-di-oxide is produced during _____ of living organisms.

Respiration 32. Let us confirm the hypothesis by doing an experiment

Your teacher would demonstrate an experiment to show that carbondioxide is produced during respiration of living organisms.

Materials Needed for the Experiment:

1. Conical flask
2. One holed rubber stopper
3. Potassium hydroxide in a small test tube.
4. Beaker containing water
5. Double-bent glass tube
6. Germinating bean seed.



Your teacher will proceed in the following way. Record your observations, and discuss the results with your teacher.

Procedure:

1. A few germinating bean seeds will be taken in a conical flask.
2. A small test-tube containing potassium hydroxide will be introduced into the flask.

3. The flask will be closed with a one-holed rubber stopper carrying a double-bent glass tube.

4. The mouth of the conical flask will be made air tight with the help of paraffin wax.

5. The end of the glass tube will be dipped in a beaker containing water.

Discussion

33. At the beginning of the experiment, you observed no change in the level of water in the bent tube. Think of the reason as to why there was no rise or fall in the level of water in the bent tube.

As students of physics, you may say that since pressure inside and outside the conical flask was _____, there was no change in the level of water in the bent-tube.

(same/different)

If your answer is 'same' go to frame - 35
If your answer is 'different' go to frame-34

---

34. Think once again. If the pressure inside the conical flask was more than outside pressure, then water would have been forced out of the bent-tube. In the same way, if the outside pressure was more than the pressure in the conical flask, water would have rised in the bent-tube.

Since, outside pressure and the pressure inside the conical flask were, _____,

there was no rise or fall in the level of water in the bent tube.

(go to frame - 35).

---

same

35. You are correct. There was no change in the level of water in the bent-tube, since pressure inside and outside the conical flask was same. After sometime, you observed a rise in the level of water. What reason can you think of for this rise in the level of water.

You may say that it was because of the ___ of pressure in the conical flask.

---

fall

36. You are right. Due to fall in the pressure of air in the conical flask, water level rose in the bent tube. Think of the reason as to why there was a fall of pressure in the conical flask.

You may say that germinating bean seeds kept in the Conical flask might have used _____ for respiration, and hence there was a fall of pressure in the conical flask.

Oxygen

37. You are correct in your thinking. The germinating seeds had utilized oxygen present in the conical flask for respiration. Recall the conclusion which we arrived at from the experiments we did to find out whether carbon-di-oxide is produced during burning or oxidation.

We concluded from the experiments that _____ is produced during oxidation.

Carbon-di-oxide

38. Think of respiration. You know that it is essentially an oxidation process.

Hence, we can expect the production of _____ during the process of respiration in the bean seeds.

Carbon-di-oxide

39. You are right in expecting so. But the problem is, if the produced carbon-di-oxide was there in the flask, it would have raised the pressure in the flask and compensated the fall in the pressure due to utilization of oxygen by the germinating bean seeds.

And hence, level of water in the bent tube would n t have changed.

---

not

40. Correct. But, you observed a rise in the level of water due to fall of pressure in the conical flask. Think, what may be the reason?

From your knowledge about the property of potassium hydroxide solution (Potassium hydroxide solution has the property to absorb carbondioxide), you may say that carbon-di-oxide produced during respiration was ab ed by potassium hydroxide solution.

---

absorbed

41. Good. Carbon-di-oxide produced during respiration of seeds was absorbed by the potassium hydroxide solution kept in the conical flask.

Hence, there was a _____ in the pressure inside the Conical flask.

---

fall

42. Now, think, as to what can we conclude from the experiment.

We can conclude from the experiment that _____ is produced during respiration.

---

carbon-di-oxide

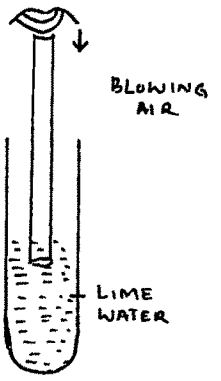
43 You have studied that the process of respiration is same in both plants and animals.

Hence, we can guess that animals also produce _____ during respiration.

---

carbon-di-oxide

44 You know, it is only a guess. Let us find out whether we are correct in our guess. For this, you may have to recall the experiment, 'blowing of air into lime water', which you observed in your chemistry class this year. The diagram will help you to recall the experiment.



		In the experiment you observed lime water turning _____ as you exhaled air into it.
milky	45.	From the experiment, we can say that exhaled air contained sufficient amount of _____to turn lime water milky.
carbon-di-oxide	46.	Correct. But the question is from where did such an amount of carbondioxide produce in our body? You may say that it was produced during _____.
respiration	47.	You are right. What can we conclude from the experiment? We can conclude that carbondioxide is produced during _____of animals.
respiration	48.	Now we know that both animals and plants produce carbon-di-oxide during their respiration. In other words, we can say that _____ is produced during the process of respiration in all living organisms.
Carbon-di-oxide	49	<u>Think it over</u>: 1. Do you think carbon-di-oxide produced during respiration is a waste product. If yes, why do you think so? if no, why you do not think so?

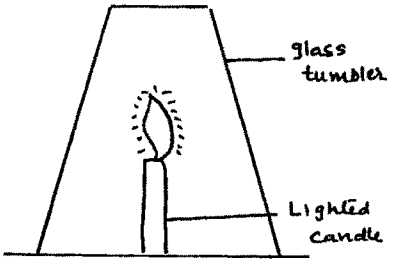
Now you know that one of the end product of respiration is carbondioxide. Let us proceed further and find out the other end products.

Aim:

You may do the following activity to understand that water is produced during oxidation.

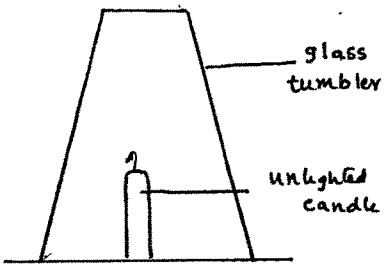
Materials Needed:

1. Two candles
2. Two glass tumblers
3. Match box
4. Wax pencil to mark glass tumblers.



Procedure:

1. Light the candle and allow it to burn for a few seconds.
2. Invert the glass tumbler marked 'experimental' over it as shown in the figure.



3. Mark another tumbler as 'control' and keep it inverted over an unlighted candle (Ref. Fig.)
4. Observe the slides of both the tumblers.
5. Make your observations and proceed with the frames.

49. You observed the candle in the experimental glass tumbler being put-off after sometime.

It was because the burning candle utilized all the O____ present in the tumbler and was put-off when there was no further supply of it.

---

oxygen

50. Correct. Recall what you observed on the sides of the experiment tumbler.

From your observation sheet, you may say that you observed the collection of _____ vapour on the sides of the glass tumbler labelled 'experimental'.

---

water

51. Right. You observed the collection of water vapour on the sides of the experimental glass tumbler. From the experiment, can you say that water vapour is produced during oxidation or burning of the candle. (yes/no)

If 'yes' go to frame.. 52
If 'no' go to frame.. 53

---

52. You know that air contains certain amount of water vapour. What you observed on the sides of the tumbler might be the water vapour present in the air which was inside the tumbler.

Hence, one cannot say definitely that ____ vapour is produced during oxidation or burning. (go to frame..53)

water	53.	You are right if you have written 'No' thinking about the presence of water vapour in the air inside the glass tumbler labelled as 'control'. What change did you observe in the tumbler? From your observation sheet, you may say that there was _____ change in the glass tumbler which was treated as 'control'
'no'	54.	You know that the only difference between the tumblers which were treated as 'experimental' and 'control' was, the experimental jar contained burning candle. Hence, you can say that water vapour on the sides of the experimental tumbler was due to b_____ of the c____.
burning, candle	55	Now apply this conclusion to the process of respiration in living organisms. Since respiration is also an oxidation process, we can guess or hypothesise the production of _____, _____ during the process.
water, vapour	56	You are correct. We can guess or hypothesise that water vapour is produced during respiration or oxidation of food. But you know that it is only a hypothesis or guess. Hence, we have to test it to find out whether we are right in our guess. You can do the following activities to test the hypothesis.

Activity One:

Materials Needed:

1. Two glass tumblers (same size);
2. Germinating bean seeds;
3. Killed bean seeds;
4. Wax pencil.

Procedure:

1. Take a clean and dry glass tumbler and label it as 'experimental'
2. Fill half the experimental tumbler with germinating bean seeds.
3. Take another glass tumbler which is clean and dry, and fill it half with killed bean seeds (you can kill the bean seeds by roasting it on a frying pan).
4. Cover both the tumblers with clean glass plates and keep it in a shady place.
5. Observe the sides of the tumblers after 2 to 3 hours and make your observations. In the mean time, you can perform the Second activity.

Activity Second:

Material Needed:

1. A clean Mirror.

Procedure:

Take deep breaths and every time breath out or exhale air keeping a mirror in front of mouth.

Make your observations. When both the activities are over, you can proceed with the frames.

---

57. Consider the first activity viz., the experiment you did with the germinating bean seeds. Recall what you observed on the sides of the 'experimental' tumbler.

You might have observed collection of w_____ v_____ on the sides of the tumbler.

---

water, vapour

58. Think from where did this water vapour come?

You may say that it might have been present in the a___ which was inside the tumbler.

---

air

59. You are right in thinking so. Think of the other tumbler, which you had kept as 'control'. Recall whether there was any collection of water vapour on the sides of the tumbler.

From your observation sheet, you may say that there was _____ collection of water vapour.

---

no

60 True, you might not have observed water vapour on the sides of the 'control glass tumbler'. Think in what way the two tumblers, viz., 'control' and 'experimental' differ from each other.

You may say that the bean seeds kept in the tumbler labelled 'experimental' were _____, whereas the bean seeds in the control tumbler were _____.

---

living,dead or killed

61. You can also say it in a different way, that is, the bean seeds in the experimental tumbler were re_____, whereas bean seeds in the control tumbler were _____ respiring.

---

respiring, not

62. Think as to what you can infer from this experiment?

You can infer that water vapour is produced during re_____ of the bean seeds.

---

respiration

63 Exactly. We can infer that during the process of respiration in bean seeds, water vapour is produced. This is true of not only bean seeds, but of all plants.

In other words, we can say that during the process of respiration in _____ water vapour is produced.

---

plants

64. Now consider the second activity, you did, viz., exhaling air against a Mirror. Recall what you observed on the mirror when you exhaled air against it.

You might have observed collection _____ _____ on the mirror.

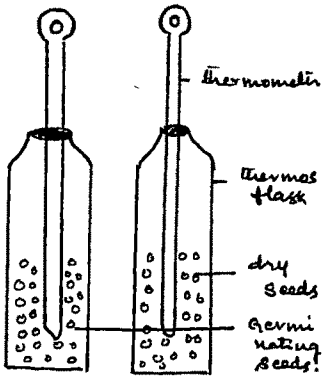
water vapour	65.	Think, from where did this water vapour produce? You may say that it might have been produced during _____ or oxidation of food.
respiration	66.	True. As in plants, in animals also water is produced during oxidation of food. Water produced during the process is thrown out in the form of water vapour during exhalation. Think as to what you can conclude from the above activities. You can conclude that water is produced during respiration of all _____ _____.
living organisms.	67.	Good. We can conclude that water is produced during the process of respiration in all living organisms. In other words we can say that _____ is another end product of respiration.
water		Now you know that CO_2 and water are the two end products of respiration. Recall what you have studied under biochemistry of respiration. You have studied that besides CO_2 and water, during respiration energy is also produced. You know that all the energy that is produced during respiration is not

utilized by the living organisms. Then the question is, what happens to the energy that is not being utilised. Let us do an experiment and find out an answer to this question.

(Your teacher will perform an experiment to show you that unused energy in living organisms is liberated as heat).

Materials Needed:

1. Two thermosflasks
2. Some dry pea seeds
3. Some germinating pea seeds
4. Two thermometers
5. Two one-holed rubber stoppers.



(He will proceed with the experiment in the following way. Record your observations and discuss with your teacher).

Procedure:

1. A few germinating pea seeds will be taken in a thermosflask and the mouth will be fitted with a one-holed rubber stopper. A thermometer will be passed through the rubber stopper, and its initial temperature will be recorded.

2. A few dry pea seeds will be taken in the other flask and it will be fitted with one-holed rubber stopper carrying a thermometer. The initial reading on the thermometer will be noted.

3. The mouths of the thermosflaks will be made air tight using paraffin wax.

4. The temperature in the flasks will be recordéd once again after 2 or 3 hours.

Discussion:

67. Recall what difference did you notice in the readings of the thermometer kept in the flask containing germinating pea seeds. You noticed that the final reading was higher than the initial reading.

In other words, we can say that there was an i____ in the temperature of the thermosflask which contained germinating pea seeds.

---

increase

68. You are right. We noticed an increase in the temperature in the thermosflask in which germinating pea seeds were kept. Think of the other flask which contained dry seeds. You observed no change in the initial and final readings of thermometer kept in that flask.

To put it in a different way, there was no change in the _____ of the thermosflask which contained dry pea seeds.

---

temperature 70. Correct. Temperature in the thermosflask which contained dry pea seeds remained constant. Think what may be the reason for this?

You may say that there was no production of h_____, hence there was no change in temperature.

---

h e a t 71. Good. Since the pea seeds were dry, they did not carry on the process of respiration, and hence there was no production of heat. Think as to why there was a rise in the temperature in the other flask which contained germinating pea seeds.

You can say that it was because of the _____ produced during respiration of the germinating pea seeds.

---

h e a t 72. You are right. What can we conclude from this experiment?

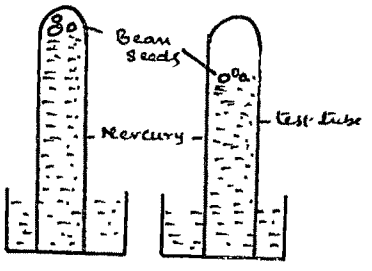
We can conclude that _____ is produced during respiration.

---

h e a t

73. You know that heat is a form of energy. Since living organisms do not utilize all the energy produced during respiration, much of it is released as heat. In plants, this heat is lost by radiation. In animals, this is utilised to maintain the body temperature. You will study more about maintainence of temperature in the Unit 'Excretion'.

Well, now we know the different elements that are used during the process of respiration in living organisms, and the different end-products that are produced during the process. We have noted that oxygen is the main element needed for respiration. Think, can respiration take place even without oxygen? Many of you may say 'no' because it is one of the important element needed for the process of oxidation. Let us not jump to conclusion. We shall do some experiment and find out whether respiration can take place even without oxygen. (Your teacher would demonstrate an experiment to show that respiration can take place in the absence of oxygen).



Materials Needed:

1. One test tube
2. One Beaker
3. Mercury
4. Germinating bean seeds or pea seeds.
5. Pellets of caustic potash.

(He will proceed in the following way. You can record your observations and discuss with him).

Procedure:

1. Germinating bean seeds or pea seeds will be taken and their seed coats will be removed.
2. The test tube will be completely filled with mercury.
3. The test tube containing mercury will be inverted in the beaker containing mercury (Ref. Fig.)
4. Germinating seeds, with their seed coats removed will be passed from below through the open end of the test tube with the help of forceps.
5. The whole apparatus will be kept for one or two days.
6. The gas collected in the test tube will be tested by introducing caustic potash pellets.

Discussion:

74. Recall what you observed with regard to the level of mercury in the test tube. You observed a fall in the mercury level after two days. Think of the reason as to why mercury level fell in the test tube.

You may say that it was due to collection of _____ in the test tube.

---

gas

75. True. Mercury level fell in the test tube due to collection of some gas in the test tube. You may remember that when a pellet of caustic potash was introduced into the test tube, mercury level raised. What reason can you think of for this rise in the mercury level?

You may say that caustic potash which was introduced into the test tube might have a _____ the gas in the test tube. Hence, mercury level raised in the test tube.

---

absorbed

76. You know that caustic potash has the property to absorb carbondioxide. Hence, say that the gas which was produced in the test tube was _____.

---

carbon-di-oxide

77. Correct. The gas which was produced in the test tube was carbondioxide. But, think from where it might have been produced? You may think of the end products of respiration. You know that carbondioxide is one of the end products of respiration.

Can we say that carbondioxide present in the test tube might have been produced during the process of respiration in bean seeds. (yes/no).

If 'yes' go to frame -- 79
if 'no' go to frame -- 78

---

78. Think once again. You know that there was no air in the test tube at the beginning, since it was completely filled with mercury. Further, through experiments we have found out that carbon-di-oxide is produced during respiration.

Because of these two reasons, we can easily say that carbon-di-oxide present in the test tube was produced during the process of _____ in bean seeds.

---

respiration

79. You are right. There was no air or oxygen available for the bean seeds to respire, still seeds could respire. Think how did they respire then?

You may say that the bean seeds might have respired even without _____.

---

oxygen

80. Exactly. Bean seeds in the test tube had respired even without oxygen. What can we conclude from the experiment?

We can conclude that respiration can occur even in the _____ of oxygen.

---

absence

81. You are correct in concluding. So, respiration can take place even in the absence of oxygen. This type of respiration is called as anaerobic respiration.

Ana_____ _____ is a type of respiration, wherein oxygen is not utilized for the process of oxidation of food.

Anaerobic respiration.

82. Recall what you have studied under aerobic respiration. You have studied that it is a type of respiration which can take place only in the presence of oxygen.

So, the difference between anaerobic and aerobic type of respiration is, anaerobic type of respiration takes place in the _____ of oxygen, whereas aerobic take place only in the _____ of oxygen.

---

absence, presence

83. Correct. The difference between anaerobic and aerobic type of respiration is, in anaerobic respiration, oxygen is not utilized, whereas in aerobic respiration oxygen is utilized. Anaerobic type of respiration is seen in fleshy fruits. Castor plants, seed in storage etc.

Since oxygen is not utilized in the process, sugar is not completely oxidised. Hence the formation of carbondioxide and energy is less. On the other hand, certain intermediary products like ethyl alcohol, lactic acid etc., are produced. Anaerobic respiration which results in the formation of alcohol is otherwise known as <u>fermentation</u>. This type of respiration is very common in organisms such as bacteria and yeasts. Hence they are used for fermentation purposes.

If we represent the whole process of anaerobic respiration in the form of an equation, it would be;

$$C_6H_{12}O_6 \text{ ---- } 2CO_2 + 2C_2H_5O_4 + 28$$

(alcohol) Calories of heat

Now you are clear about the mechanism of aerobic and anaerobic respiration, the different end products that are formed in the two types of respirations etc. Let us Summarise what we have studied in this session.

S u m m a r y:

1. - Food forms the main source of energy for all living organisms.

2. - Food is oxidised during respiration in all organisms, and the energy produced during the process is utilized for various life activities.

3. - Respiration or oxidation of food is a very slow process and takes place through a series of steps, and small quantities of energy is released in each step.

4. - The major reactions of respiration are: 1. Glycolysis; and 2. Kreb's cycle.

5. - During glycolysis, food (glucose) is oxidised to pyruvic acid.

6. - During Kreb's cycle the pyruvic acid formed during glycolysis is again oxidised to carbon-di-oxide and water, and during the process 673 calories of energy is released.

7. - The two types of respirations seen among living organisms are (1) aerobic and (2) anaerobic.

Aerobic type:- In aerobic respiration, food is oxidised with the help of free oxygen, i.e., atmospheric oxygen.

Anaerobic type:- In anaerobic respiration, food is oxidised in the absence of oxygen.

8. - The end products of aerobic respiration are (i) Carbon-di-oxide; (ii) Water and 673 calories of energy, whereas in anaerobic respiration the end-products are: carbon-di-oxide, alcohol and 28 calories of energy.

P A R T - III

MECHANISM OF BREATHING

Introduction:

In the Second Part of this Unit, you studied about the mechanism or in other words, the bio-chemistry of respiration. You know that the steps through which glucose is oxidised is same in both plants and animals. They differ only in obtaining oxygen, the main element needed for respiration. You have already studied as to how lower organisms (lower plants and animals) and higher plants take in oxygen from their environment and give out Carbondioxide. In this part, you will be studying how exchange of gases takes place in higher animals. In other words, you would be studying the mechanism of breathing in animals.

This you would be studying in the same way as you studied the "Mechanism of Transportation of Food and Oxygen" (Part I of Unit V), that is, through Projections and Teacher's Explanation*. You may remember that while learning this topic, you answered some questions in the work-booklet after a few projections and teacher's explanation were over. In the same way, here also, you will answer a few questions

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*Transparencies have been presented at the end of "Teacher's Explanation", (Please refer after page no.444).

after learning each idea. These questions are provided mainly to make you understand the idea better.

Hope this will be an another enjoyable experience to you.

1. Before going to the topic proper, let us recall what we have studied in our earlier units about the mechanism of exchange of gases in lower organisms and higher plants.

> What you find in the picture are the diagrams of lower organisms such as chlamydomonas, amoeba and paramaecium. You know that they are unicellular organisms and do not have definite organ systems like higher animals.

2. Recall what you have studied about the mechanism of exchange of gases in them. You have studied that exchange of gases in lower organisms takes place through the process of diffusion.

> Through diffusion, oxygen from the environment enters the organism, and Carbon-di-oxide produced during respiration, passes out.

3. The diagram, viz., 'Section of a Leaf' will enable you to recall what you have learnt about the mechanism of exchange of gases in higher plants.

> In higher plants, oxygen from the atmosphere enters the leaves through the stomata and occupies the air cavities. This is utilized by the cells for oxidising their food and producing energy.

4. As you know already, plants produce oxygen during photo-synthesis. Of the total amount of oxygen produced during photosynthesis, a small part is utilised by plants themselves for respiration, leaving out the rest to the atmosphere. You may think as to what happens to CO_2 produced during respiration?

> You may recall what you have studied about 'Carbon Cycle' in Unit-III. You know that green plants have the ability to utilise CO_2 produced during cellular respiration. Only during night, when green plants cannot manufacture their food, CO_2 is thrown out to the atmosphere.

5. In the case of higher animals, there are definite organs to carry out the process of respiration. These organs constitute the respiratory system.

> For example, in the case of human beings nose, wind pipe, lungs and air sacs constitute the respiratory system. With the help of these organs, we take in oxygen from the atmosphere and give out waste products such as CO_2 and water vapour.

6. We can also say it in a different way, that is, we inhale oxygen, and exhale carbon-di-oxide along with water vapour with the help of respiratory organs. And, this process of inhalation of oxygen and exhalation of carbon-di-oxide is what is known as breathing.

7. Breathing is just a mechanical process and goes on from birth to death. It is one aspect of the whole process of respiration, and is characteristic of all higher animals.

8. Let us consider some examples and try to understand the various ways of exchange of gases or breathing mechanism seen among higher animals.

> First, we shall take the example of earthworms. In the Unit V, viz., transportation and circulation, you have studied that the blood vessels in earthworms branch repeatedly and supply all the organs. The capillaries reach the adjacent sides of almost every cell. Further, the skin of earthworms is always kept moist.

9. If a section of the body wall is taken and observed under microscope, it will be seen that the body cells are separated from the outside environment only by the capillary walls and the skin.

> Hence, oxygen from the atmosphere easily diffuses into the blood through capillary walls and skin. Haemoglobin present in the blood picks up oxygen and forms oxyhaemoglobin. During circulation of the blood, oxyhaemoglobin gives up oxygen to tissues which have a low oxygen concentration.

10. In a similar way, carbon-di-oxide produced during respiration in the body cells is absorbed by the blood. Carbon-di-oxide combines with water of plasma forming carbonic acid. When carbonic acid reaches the capillaries in the skin, it decomposes into CO_2 and water. Carbondioxide diffuses out into the atmosphere through the capillary wall and skin.

11. As in earthworms, in animals like leech, nereis etc., exchange of gases takes place through skin. Since exchange of gases in these animals is affected through skin, this type of exchange of gases is called 'Cutaneous respiration,' or is also called as 'skin breathing'.

12. In the case of Cockroach, with which you are all familiar, exchange of gases takes place through a well developed system of air tubes known as tracheae. With the help of these tubes, air from outside atmosphere is brought into direct contact with the body cells. You may wonder, how such a thing is possible without the intervention of blood, which is the main carrier of oxygen in all higher animals.

13. In the diagram is shown the arrangement of the main tracheae in the body of Cockroach. Tracheae or the air tubes, receive air through breathing pores situated on either side of the body.

14. The main branches of tracheae or air tubes branch repeatedly into fine capillary tubes called as tracheoles, which reach almost every cell to provide oxygen.

15. Air, from the atmosphere, enters the tracheoles through breathing pores and tracheae. From the tracheoles, oxygen diffuses into the body cells which is made use of for burning of food and production of energy. The carbondioxide produced during respiration diffuses back into tracheoles from the cells, from where it passes out through tracheae and breathing pores to the environment.

16. Since exchange of gases in Cockroaches takes place through tracheae, respiration in Cockroaches is called as Tracheal Respiration.

17. So, far we have studied about two types of respiration seen in higher animals, viz., 1. Cutaneous respiration and 2. Tracheal respiration.

> Cutaneous respiration is a type of breathing wherein exchange of oxygen and CO_2 takes place with the help of skin, e.g. earthworms, Nereis, leech.
>
> Tracheal respiration is a type of breathing wherein exchange of oxygen and CO_2 takes place through a system of air tubes called as tracheae.

18. Now let us consider the case of animals which live in water and understand how they breathe in oxygen and breath out carbondioxide. For example, let us consider fish.

You have already learnt the mechanism of exchange of gases in Fish. You would recall that fish takes in oxygen and gives out carbondioxide with the help of gills present on either side of their body.

19. In the diagram is shown the blood supply of gills in fish. When water (taken through the mouth) passes over the gills, oxygen dissolved in water readily diffuses into the blood of the capillaries, since oxygen concentration in the blood will be low.

In the same way, carbondioxide from the blood passes out to the surrounding water through diffusion. You know very well that Fish can utilize only the oxygen dissolved in water and cannot ~~cannot~~ utilize the atmospheric oxygen directly.

20. Since gills are the main organs of breathing in fish, breathing in fish is called as gill breathing. It is characteristic of animals which live in water. Fresh water muscles, prawn, crabs etc., are a few examples for gill breathing.

21. So far, we have studied about three types of breathing, viz., Cutaneous, Tracheal and Gill. Besides these three types, there is one more type which is common among terrestrial vertebrates, and in animals of large size.

These animals, since they are larger in size, require more energy to perform various activities. Naturally they require

more oxygen for the production of energy. Hence, they have well developed organs such as lungs for this purpose. Let us take the example of human beings since they are the highly evolved organisms, and understand the mechanism of breathing.

22. Recall what you have studied about the mechanism of breathing in human beings, in your 7th standard. You would recall that breathing in human beings is done with the help of organs such as nose, tracheae, bronchus and lungs.

23. In lungs, each bronchus divides and subdivides to form bronchioles. Each bronchiole ends in an atrium having air-sacs on its outer surface. To a naked eye, these air-sacs appear like small rounded structures. You can compare it to a bunch of grapes.

24. From the diagram you can make out that each air-sac is surrounded by a net work of capillaries. In other words, we can say that air-sacs are richly supplied with blood. Blood flowing in these capillaries is separated from the air present in the air-sacs only by the thin walls of the air-sacs and capillaries.

25. During inspiration, air from the atmosphere enters the air-sacs through nose, traches, bronchae and bronchioles. Oxygen of air combines with the haemoglobin of blood flowing in the surrounding capillaries of the air-sacs and forms oxyhaemoglobin. Oxygenated blood from the air sacs(lungs) is taken to different parts of the body by blood vessels,where it is utilized by the cells.

26. Carbondioxide produced during burning or oxidation of food combines with water present in plasma of blood and forms carbonic acid. As you have already studied in the earlier unit, viz., Transportation and Circulation, the de-oxygenated blood is brought back to the lungs by pulmonary arteries. In the capillaries surrounding the air sacs, carbonic acid - decomposes into CO_2 and water. Carbondioxide diffuses into air sacs (where concentration of CO_2 is less), from where it is thrown out during expiration.

27. If samples of air are taken during inspiration and expiration and analysed,

> One would find less percentage of oxygen in the expired air, as compared to its percentage in the inhaled air.
>
> From the table, you can clearly make out the percentage composition of oxygen and carbon-di-oxide in the inhaled and exhaled air.

28. Many times, you might have tried to hold your breath. You can probably hold your breath for one or two minutes, but not more than that. Why?

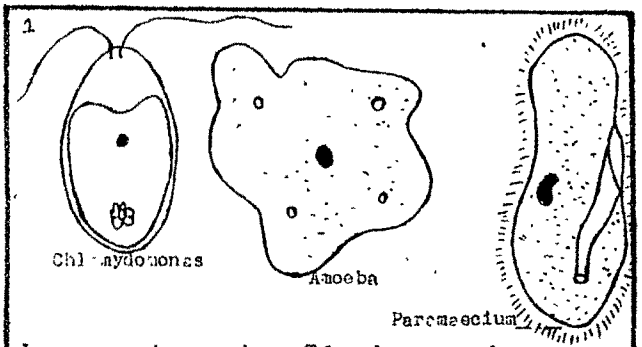
> When we try to hold our breath, carbondioxide gets accumulated in the body. The effect of this accumulation on the respiratory centre is so great that we cannot hold our breath any longer.

29. You might have noticed an increase in your breathing rate when you do exercise, or play. This is because, during the performance of these activities, more energy is produced and naturally carbon-di-oxide production will be more. ~~This will be more~~. This will increase the carbon-di-oxide concentration in the blood. In order to get rid of this carbon-di-oxide, we breathe out fast.

30. Now let us summarise what we have studied about gill breathing and lung breathing.

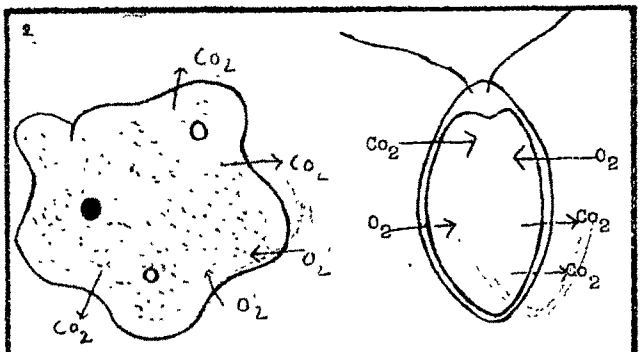
1. gill breathing is usually seen in aquatic animals, and exchange of gases takes place with the help of gills.
2. gills are richly supplied with blood capillaries, and exchange of gases takes place between the surrounding water and blood in the capillaries.
3. Breathing system in human beings are well developed and consists of organs such as Nos; Trachae, Lungs,
4. Blood intervenes in the process of exchange of gases, and is the main carrier of O_2 to different parts.
5. Breathing is controlled by the respiratory centres.

1



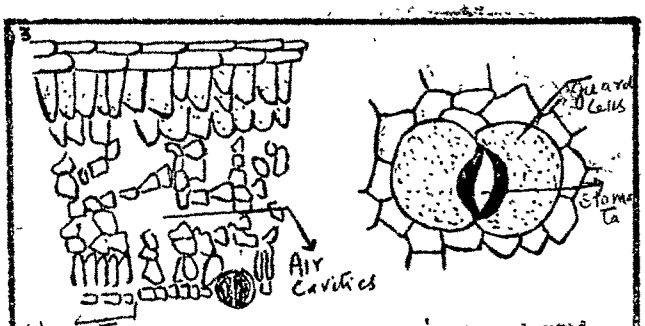
Lower organisms such as Chlamydomonas, and paramoecium are all single celled organisms and do not have definite organ systems.

2



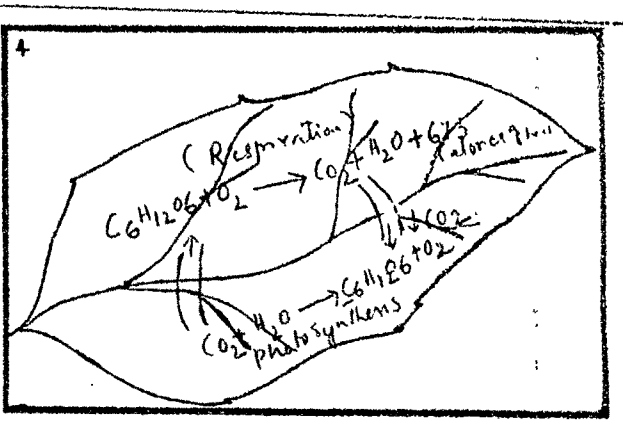
Lower organisms exchange their gases through the process of diffusion.

3



When light falls on the leaf, stomata opens and also enters the leaves and is blocked in air cavities. Oxygen of air is utilized for respiration.

4



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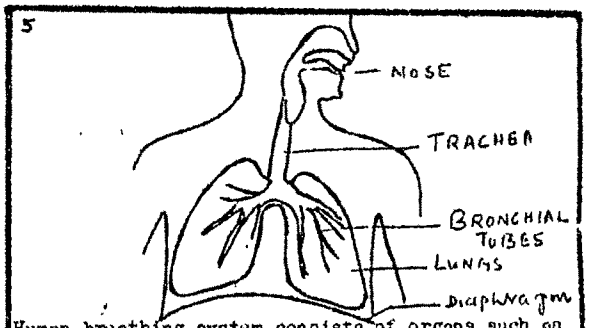
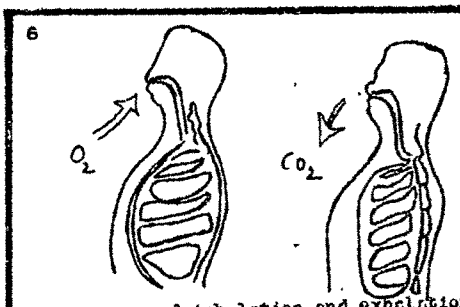


Human breathing system consists of organs such as nose, trachea, bronchial tubes and lungs. They take part in the process of exchange of oxygen and O_2

6

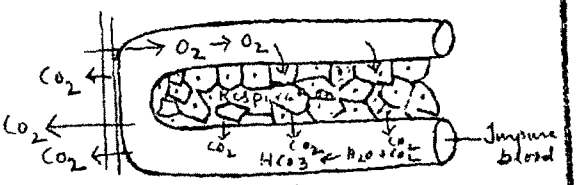


The process of inhalation and exhalation together is called as breathing.

7

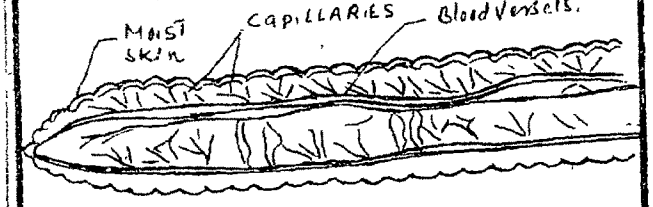
BREATHING IS AN ASPECT OF THE PROCESS RESPIRATION, AND GOES ON FROM BIRTH TO DEATH

10



CO_2 produced during respiration is absorbed by the blood, when CO_2 combines with water of plasma and forms carbonic acid. In the blood vessels of the skin, carbonic acid decomposes into CO_2 and H_2O. CO_2 diffuses out into atmosphere through skin and capillary walls.

8



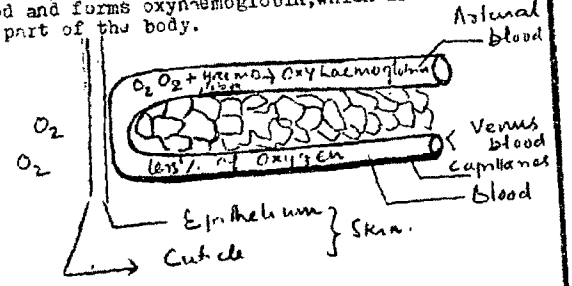
Skin of earthworms is always kept moist and is richly supplied with blood.

11

Exchange of gases through Skin is called as Skin breathing or Cutaneous Respiration

Diffusion of oxygen takes place from the atmosphere into the blood in the capillaries through skin and capillary wall. It combines with haemoglobin of blood and forms oxyhaemoglobin, which is carried to all part of the body.

9



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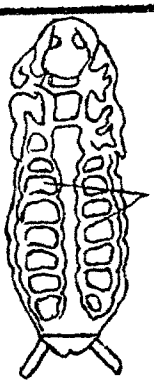
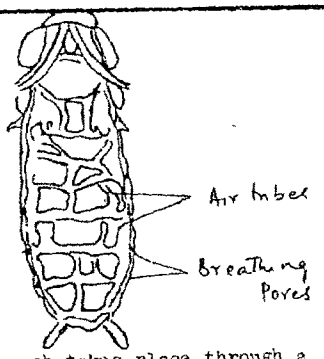


COCKROACH

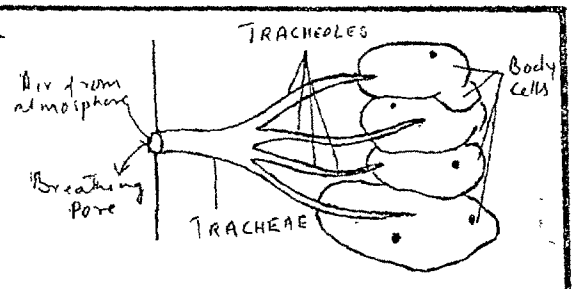
RESPIRATORY OR BREATHING SYSTEMS OF COCKROACH EXPOSED.

13



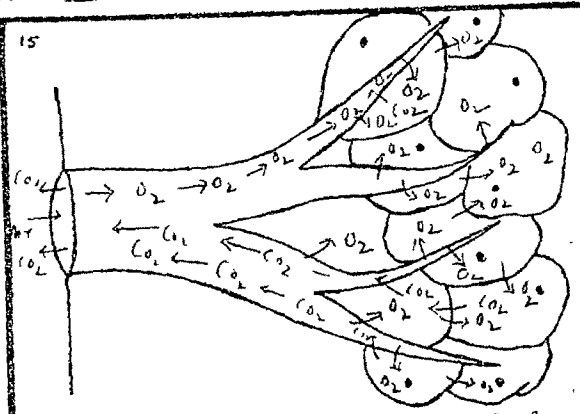
Breathing in Cockroach takes place through a set of tubes known as TRACHEA.

14



Trachae Branch into very fine branches called Tracheoles which supply every cell with O_2

15



Oxygen of air diffuses into the body cells from the tracheoles, and in the same way CO_2 produced during respiration diffuses into tracheoles from cells. From where, it passes out.

16

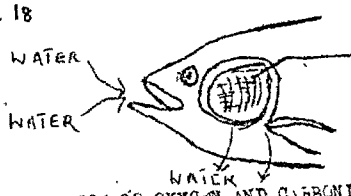
THE MECHANISM OF EXCHANGE OF GASES THROUGH AIR-TUBES OR TRACHAE IS CALLED AS TRACHEAL RESPIRATION.

17

1. CUTANEOUS RESPIRATION IS A TYPE OF BREATHING WHEREIN, EXCHANGE OF GASES TAKES PLACE THROUGH SKIN E.G. EARTHWORMS, LEECH.

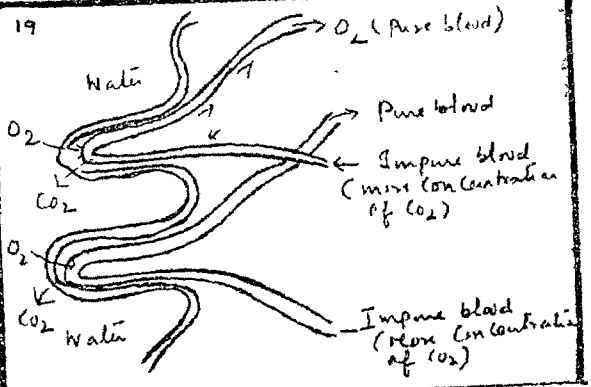
2. THE EXCHANGE OF GASES THROUGH SYSTEM OF AIR-TUBES OR TRACHAE IS CALLED AS TRACHEAL RESPIRATION E.G. COCKROACH.

18



EXCHANGE OF OXYGEN AND CARBONDIOXIDE TAKES PLACE IN FISH WITH THE HELP OF GILLS.

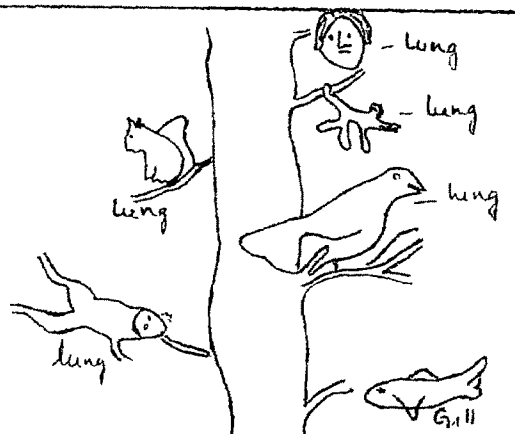
19



20

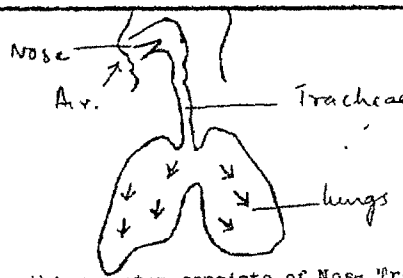
MECHANISM OF EXCHANGE OF GASES IN FISH IS CALLED AS GILL BREATHING, SINCE, GILLS ARE THE MAIN ORGANS OF BREATHING. THIS TYPE OF BREATHING IS SEEN IN AQUATIC ANIMALS

21



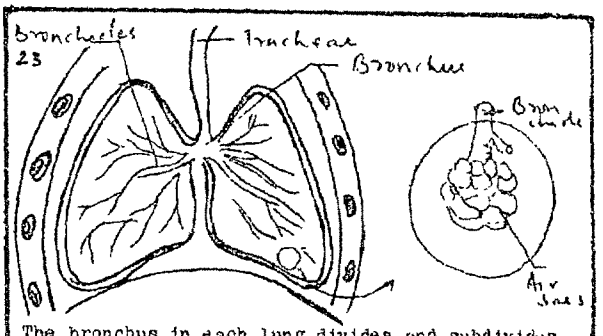
Animals such as Frogs, Birds, Mammals, breathe in and out with the help of Lungs.

22



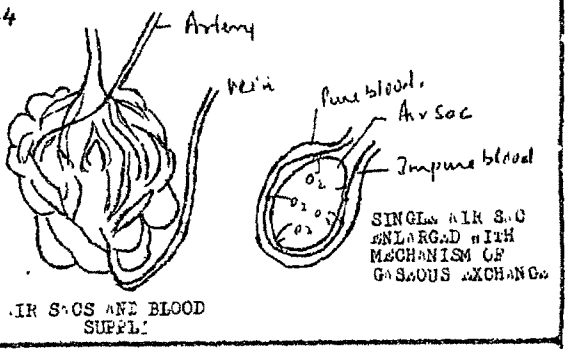
Human breathing system consists of Nose, Trachea and Lungs. These structures are almost seen all the lung breathing animals.

23



The bronchus in each lung divides and subdivides into bronchiole. Each bronchile ends in an airsac, where exchange of gases takes place.

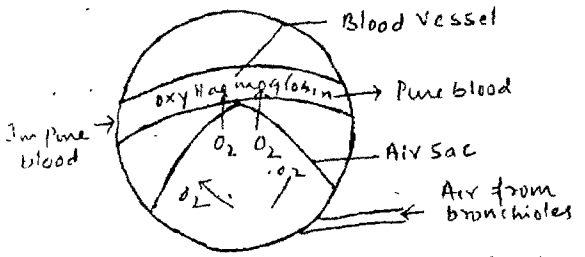
24



SINGLE AIR SAC ENLARGED WITH MECHANISM OF GASEOUS EXCHANGE

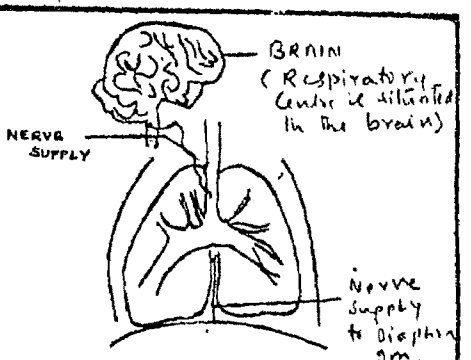
AIR SACS AND BLOOD SUPPLY

25



Impure blood in the vicus absorb 02 from the air Sac. Oxygen combines with haemoglobin of blood and forms oxyhaemoglobin, which dissociates and gives out 02 wherever needed.

28



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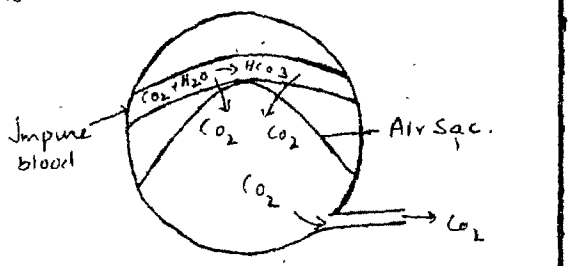

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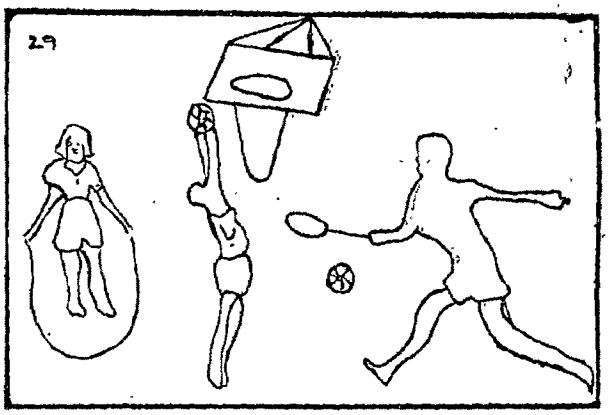


27 HOW AIR IS CHANGED IN LUNGS

Gases in Air	Amount in air breathed in	Amount in air breathed out
NITROGEN	79%	79%
OXYGEN	20%	16%
CARBONDIOXIDE	.04	4
WATER VAPOUR	Varies with Humidity	Saturated
OTHER GASES	Traces	Traces

UNIT TEST VI

Name : _____

I. Fill in the Blanks:

(1) During respiration, _____ of absorbed food takes place and energy is released: K

(a) reduction (c) decomposition

(b) oxidation (d) double-decomposition

(2) The two major steps involved in the process of respiration are _____ and _____. K

(3) Respiration that takes place in the presence of free oxygen is called as _____ respiration (anaerobic, aerobic). K

(4) Here are given a few statements. Some of them applies to the process of respiration and some to photosynthesis. Put 'R' in the blank if it belongs to respiration, and 'P' if it belongs to photosynthesis. C

(a) during _____ plants utilize O_2 and give CO_2

(b) during _____ plants utilize CO_2 and give out O_2.

(c) during _____ organic food is manufactured.

(d) during _____ organic food is utilized.

(e) process of _____ takes place during both day and night.

(f) process of _____ takes place only in sunlight.

(g) process of _____ takes place in all the cells.

(h) process of _____ takes place only in cells having pigment chlorophyll.

21 (5) Here are given a few steps which are related to aerobic and anaerobic types of respiration. Write 'A' in the blank provided, if it belongs to aerobic type, and 'An' if it belongs to anaerobic type of respiration. C

(a) _____ type of respiration can take place in the absence of free oxygen.

(b) _____ type of respiration takes place only in the presence of free oxygen.

(c) In _____ type of respiration, the end product is alcohol.

(d) In _____ type of respiration, 673 Calories of heat is released.

(e) In _____ type of respiration, only 28 Calories of heat is released.

II. Tick (/) the most appropriate answer:

(1) Every organism requires energy: C

(a) for growth (c) for movement

(b) for reproduction (d) for all its life activities.

(2) The structures which are called as 'power houses of cell' are: K

(a) golgi complex (c) vacuoles

(b) mitochondria (d) nucleolus

(3) Anaerobic respiration is a type of respiration which takes place in the: K

(a) presence of O_2

(b) absence of oxygen

(c) presence of CO_2

(4) In lower organisms like amoeba, hydra, etc., exchange of gases takes place through: K

22

(a) gills (c) diffusion

(b) trachese (d) skin

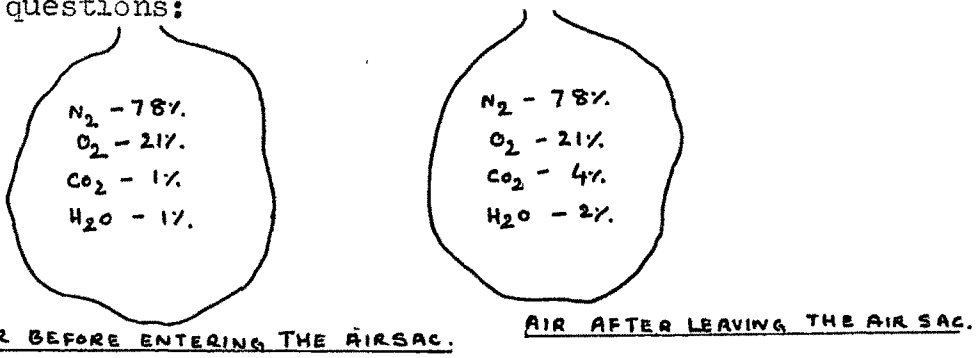
III. $C_6H_{12}O_6 + 6O_2 \text{ ---- } 6\ CO_2 + 6\ H_2O + 673$ Calories of heat (Write in words the end products of respiration).

IV. Here are given two equations. Study them carefully and write which equation represents which type of respiration.

(a) $2\ C_6H_{12}O_6 + 3O_2 \quad 3\ C_4H_6O_5 + 3H_2O$ (Malic acid)

(b) $C_6H_{12}O_6 = 2C_2H_5O_4 + 2CO_2 + 54$ KCal.

V. Observe the diagrams carefully and answer the questions:



(a) What difference you notice in the composition of air?

(b) Reason out the difference in composition.

23. VI. Give your reasons as to why a fish placed in water which is boiled and cooled, dies. A

VII. In the case of liverfluke, an animal, there is no circulatory system and respiratory system. Reason out as to how the animal gets oxygen for respiration.

VIII. A person is made to breathe in the same air which he has breathed out every time. After a short time, there is every possibility for the person to die. Reason out as to why the person dies.

IX. You might have had the experience of eating more food during winter than in summer. Give your reasons for the above.

X. Draw a neat sketch of human respiratory system and label the parts.

24 XI. Match the following:

(Match the organisms under 'A' with the type of respiratory system they have, given under 'B') C

"A"	"B"
(a) amoeba	(a) Cutaneous respiration
(b) earthworm	(b) Simple diffusion
(c) Cockroach	(c) Tracheal
(d) Fishes	(d) Gills
(e) Man	(e) Lungs

XII. With the help of a diagram, describe the experiment 'To show heat is produced during respiration'.

XIII. Draw a neat sketch of the apparatus used in the experiment to demonstrate that 'CO_2 is produced during respiration'.