CO2 is Released During Respiration

Introduction

- Respiration is the biochemical process during which organic food, mainly glucose that is present in the cell, breaks down into simpler substances and liberates carbon dioxide and energy. There are two types of respiration- aerobic and anaerobic respiration.

- **Aerobic Respiration:** This type of respiration requires oxygen, so it is called aerobic respiration. During aerobic respiration, complete oxidation of carbohydrates takes place. Glucose is broken down by oxygen to release energy, while carbon dioxide and water are the by-products of the reaction. The released energy is used to make a special energy molecule called Adenosine triphosphate (ATP). Aerobic respiration occurs in plants as well as animals and takes place in the mitochondria.
- The word equation for aerobic respiration is:
  Glucose + Oxygen → Carbon dioxide + Water + Energy
- The chemical equation is:
  $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$ + 38 ATP (energy)
- Anaerobic Respiration: Sometimes there is not enough oxygen available for animals and plants to respire, but they still need energy to survive, so they carry out respiration in the absence of oxygen/less oxygen to produce the energy they require. As the respiration takes place in the absence of oxygen, incomplete oxidation of food occurs and much less energy is released. This is called anaerobic respiration and the process occurs in the cytoplasm.
- The word equation for anaerobic respiration in plants is:
  Glucose → Ethanol + Carbon dioxide + Energy
- The chemical equation is:
  $C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$ + 2 ATP (energy)
- The word equation for anaerobic respiration in animals is:
  Glucose → Lactic acid + Energy
- The chemical equation is:
  $C_6H_{12}O_6 \rightarrow 2C_3H_6O_3$ + 2 ATP (energy)

Factors Affecting Respiration

Here are some of the few factors that affect the rate of respiration.

- **Temperature:** At a very high temperature, the rate of respiration decreases with time and at very low temperature,
  the respiration rate is insignificant. Optimum temperature for respiration is 20 – 30°C.

- **Carbon dioxide concentration:** Increase in CO_2 concentration and absence of O_2 adversely affects the rate of aerobic respiration.
- **Light:** Light controls respiration by raising the temperature of an organism.
- **Water:** The respiratory rate increases with the increase in water content of the respiring organism.

Science Lab Manual Experiment 3

Aim

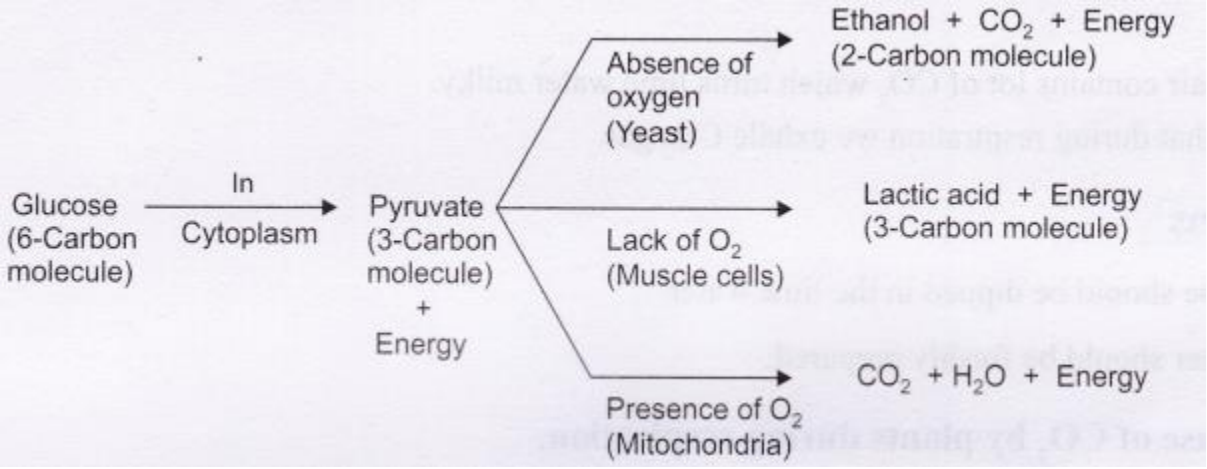
To show experimentally that carbon dioxide is given out during respiration.

Theory

- All living things show respiration.
- It is a chemical process that occurs inside the cell, hence called cellular respiration.
- It involves the breaking down of food to release energy and carbon dioxide.
- Its reaction is the reverse of photosynthesis.

$$\underset{\text{Glucose}}{C_6H_{12}O_6} + 6O_2 \longrightarrow 6CO_2 + 6H_2O + \text{Energy}$$

- There are two types of respiration in animals: Aerobic and anaerobic respiration.
- Aerobic respiration needs oxygen and anaerobic respiration occurs in the absence of oxygen.
- There are three pathways of respiration as shown below:



- The energy released in cellular respiration is immediately used to synthesise a molecule called ATP.
- Plants also release CO_2 during respiration.
- The exchange of gases during respiration takes place through small pores on the leaf called stomata.
- Carbon dioxide can be tested by lime water test.

- A freshly prepared lime water is $Ca(OH)_2$ When CO_2 is allowed to pass through it an insoluble compound called $CaCO_3$ is formed which makes the lime water milky.

$$\underset{\text{Lime water}}{Ca(OH)_2} + CO_2 \longrightarrow \underset{\text{(Milky ppt.)}}{CaCO_3} + H_2O$$

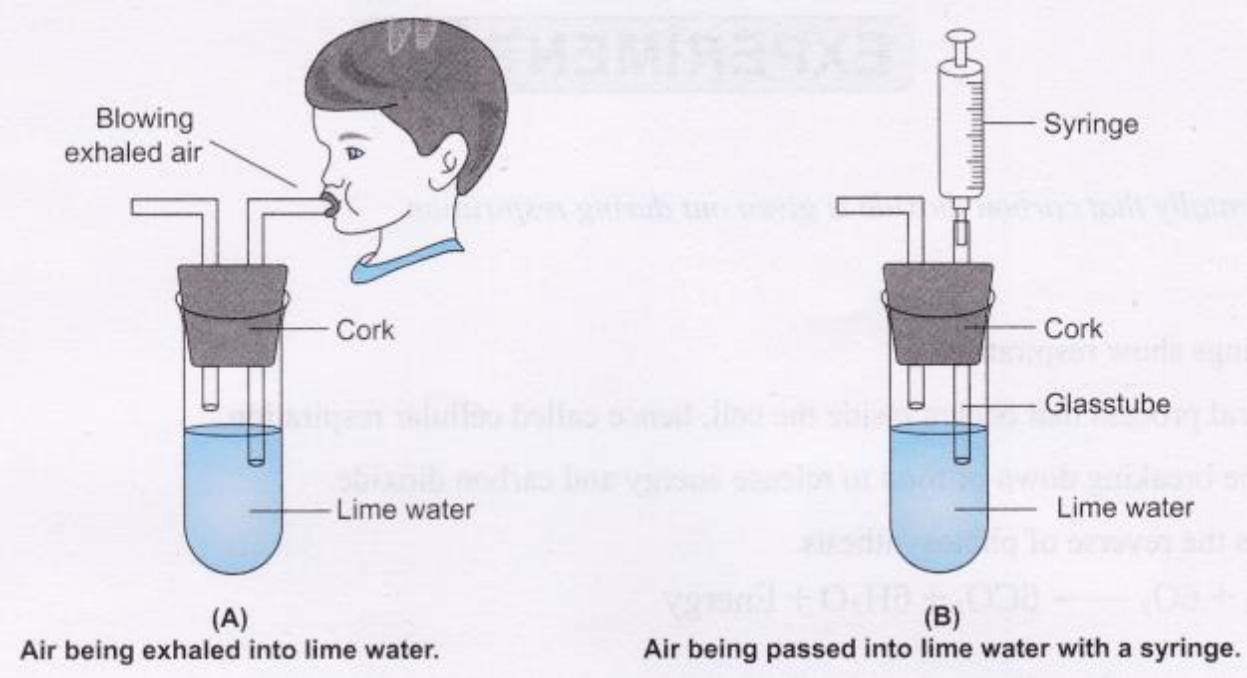
(A) Test for release of CO_2 during respiration in animals.

Materials Required

Two test tubes, a cork with two holes, two glass tubes, syringe, lime water.

Procedure

1. Take some freshly prepared lime water in two test tubes.
2. Fit cork with two holes in test tubes A and B.
3. Fix two glass tubes in this cork of test tube A as shown in the figure.
4. Exhale air into the tube and record your observations.
5. In another test tube B, which has lime water, pass air through syringe and record your observations.



Observation

- In test tube A, the lime water turns milky sooner than in test tube B.

Conclusion

1. The exhaled air contains lot of CO_2 which turns lime water milky.
2. This proves that during respiration we exhale CO_2 gas.

Precautions

1. The glass tube should be dipped in the lime water.
2. The lime water should be freshly prepared.

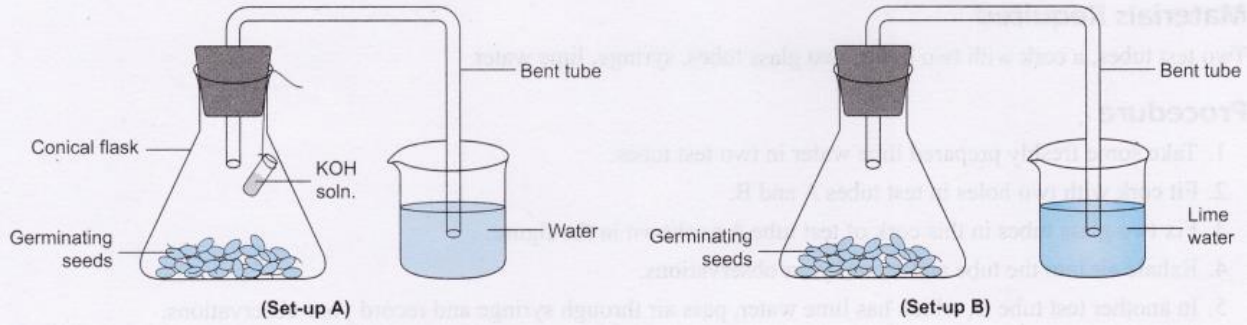
(B) To test release of C02 by plants during respiration.

Materials Required

A conical flask, small test tube, cork, thread, germinating seeds, a bent tube, a beaker, water and freshly prepared lime water.

Procedure

1. Take two conical flasks, add germinating seeds with little water sprinkled over it.
2. Fix the mouth of conical flasks with cork in which a bent tube is fixed.
3. Suspend a small test tube containing KOH solution in it with the help of a thread in conical flask A.
4. Allow the mouth of the bent tube to be immersed in water in set-up A and in lime water in set-up B as shown below.
5. Record your observations after few hours.



Observations

1. In set-up A, the water level in the bent tube dipped in beaker increases after few hours.
   This is because the oxygen present in the conical flask is taken up by germinating seeds and CO_2released due to respiration is absorbed by KOH present in small tube. Hence, the air pressure in the flask reduces and water level rises.
2. In set-up B, the freshly prepared lime water turns milky. This is due to excess CO_2 released into the test tube during respiration of germinating seeds.

Conclusion

This shows that CO_2 is given out during respiration.

Precautions

1. Lime water should be freshly prepared.
2. KOH solution should be freshly prepared.
3. Germinating seeds should have lot of moisture in them.

Science Lab Manual Viva Voce

Question 1:
Name the parts of the plant through which exchange of gases takes place.
Answer:
Stomata and lenticles.

Question 2:
Is respiration a physical or chemical process?
Answer:
Respiration is a chemical process. It takes place in cells.

Question 3:
Name the part of cell in which final breaking down of food takes place and energy is released
Answer:
Mitochondria

Question 4:
Name two organisms that respire in absence of oxygen.
Answer:
Bacteria and yeast.

Question 5:
What are the end products of anaerobic respiration?
Answer:
It is ethanol, carbon dioxide and energy.

Question 6:
Name the energy currency for most of the cellular processes.
Answer:
ATP, i.e., Adenosine tri phosphate.

Science Lab Manual Practical Based Questions

Question 1:
State two types of respiration.
Answer:
Aerobic (in presence of oxygen) and anaerobic respiration (in absence of oxygen).

Question 2:
What are the end products of respiration that takes place in lack of oxygen?

Answer:
In lack of oxygen, lactic acid and energy is released.

Question 3:
On passing CO_2 gas through freshly prepared lime water why does it turn milky?
Answer:
The freshly prepared lime water is $Ca(OH)_2$ and when CO_2 is passed through it, the compound formed is $CaCO_3$ which forms insoluble precipitate that is white in colour.

Question 4:
If you insert a thermometer in a sealed beaker containing germinating seeds, the temperature of thermometer increases. Why?
Answer:
The germinating seeds respire and release CO_2 gas alongwith heat energy. It is due to this heat energy the temperature of thermometer increases.

Science Lab Manual Questions

Question 1:
What is the role of KOH in this experiment?
Answer:
KOH is used to absorb the carbon dioxide released during respiration of germinating seeds which creates a vacuum in the flask.

Question 2:
When we say that plants and animals respire, where exactly is the process occurring?
Answer:
Respiration is a chemical process and occurs in mitochondria.

Question 3:
Why do we use germinating seeds in this experiment?
Answer:
The rate of respiration in germinating seeds is faster and the results are visible in less time.

Science Lab Manual Multiple Choice Questions (MCQs)

Questions based on Procedural and Manipulative Skills
Question 1:
When respiration occurs in presence of oxygen, the end products are
(a) $CO_2 + H_2O$
(b) C_2H_5OH + energy
(c) $C_2H_5OH + CO_2$ + energy
(d) $CO_2 + H_2O$ + energy.

Question 2:
The end products of anaerobic respiration is
(a) C_2H_5OH + energy
(b) $C_2H_5OH + CO_2$
(c) $C_2H_5OH + CO_2$ + energy
(d) $C_2H_5OH + H_2O + CO_2$

Question 3:
Cellular respiration occurs in
(a) cytoplasm
(b) mitochondria
(c) nucleus
(d) cytoplasm and mitochondria

Question 4:
Plants exchange gases through
(a) stomata
(b) lenticles
(c) both (a) and (b)
(d) none of these

Question 5:
To test the release of CO_2 gas during respiration, the chemical used is
(a) lime
(b) lime water
(c) calcium carbonate
(d) marble

Question 6:
Fermentation is the process used by yeast/bacteria. The end product is released and used in the following except for one.
(a) idli dough
(b) bread dough
(c) pakoda
(d) dosa dough.

Question 7:
To study the release of CO_2 by plants we should use
(a) a potted plant
(b) germinating seeds
(c) dry seeds
(d) boiled seeds.

Question 8:
If a thermometer is kept in a conical flask containing germinating seeds, the temperature of thermometer will
(a) increase
(b) decrease
(c) remain the same
(d) first increases then decrease.

Question 9:
At levels of atmospheric O_2 below 1%, the amount of CO_2 released is relatively high. This is probably because
(a) The Krebs cycle is very active.
(b) O_2 is being converted to H_2O.
(c) Alcohol fermentation is occuring.
(d) photosynthesis cannot function at night.

Question 10:
In the experiment demonstrating respiration in germinating seeds, KOH is used to
(a) absorb carbon dioxide produced by the seeds
(b) absorb oxygen present in the flask
(c) absorb water vapour released by the seeds
(d) liberate oxygen to be used by the seeds.

Question 11:
Why is some KOH placed in a small test tube in the flask with germinating seeds in the experiment to demonstrate the occurrence of respiration in germinating seeds?'
(a) To provide oxygen required by the seeds for respiration.
(b) To absorb carbon dioxide and create partial vacuum in the flask.
(c) To absorb water from the seeds to make them dry.
(d) To make the air present in the flask alkaline.

Question 12:
In the experiment to show that CO, is given out during respiration, the student uses:
(a) Lime water
(b) Alcohol
(c) KOH solution
(d) Iodine solution.

Question 13:
Seeds that are taken in the flask during respiration experiment must be
(a) just wet
(b) boiled
(c) dry
(d) germinating

Questions based on Observational Skills

Question 14:

A student sets up the apparatus for the experiment to show that CO, is released during respiration by germinating seeds. After 2 hours, he would observe.

(a) KOH turning milky

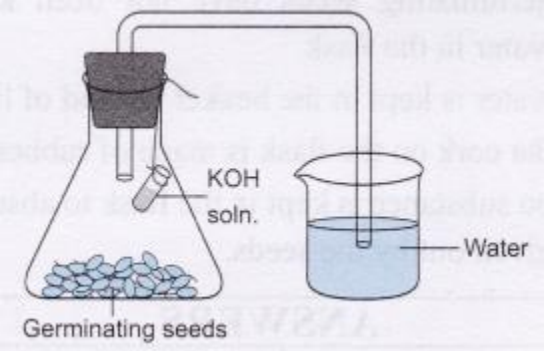
(b) Water level rising in the bent tube in the beaker.

(c) Water level decreasing in the bent tube in the beaker.

(d) Water turning turbid in the beaker.

Question 15:

In the following set-up which shows that “carbon dioxide is given out during respiration” the KOH kept in the flask



(a) makes the air in the flask alkaline

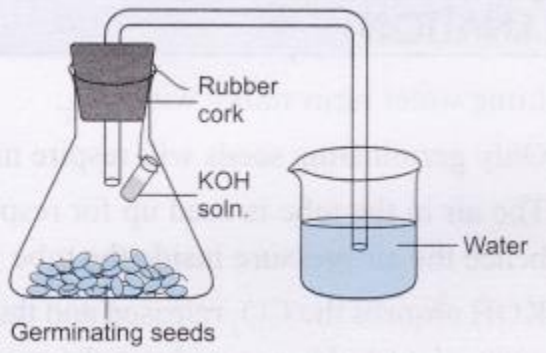
(b) creates partial vacuum in the flask

(c) absorbs moisture present in the flask.

(d) provides oxygen for respiration to the germinating seeds.

Question 16:

What is the use of KOH solution in this experiment?



(a) Absorb CO_2 released by germinating seeds

(b) Absorb O_2 released by germinating seeds

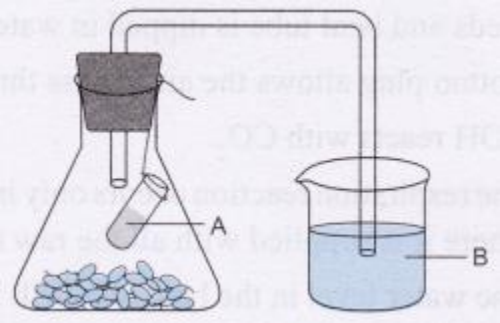
(c) Absorb moisture released by the seeds.

(d) None of these.

Question 17:

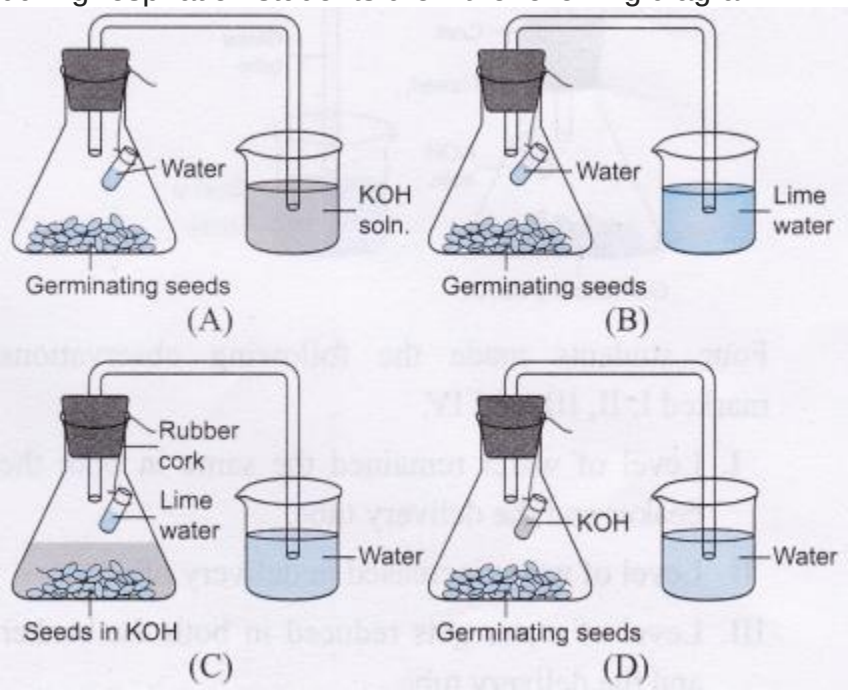
In the following experimental set-up to show that CO_2 is evolved during respiration,

substances A and B are:



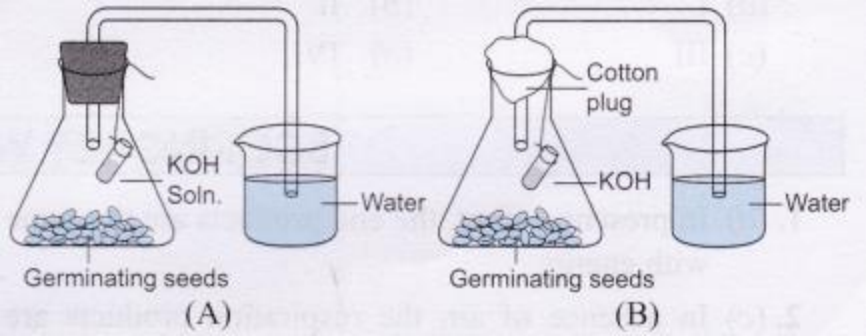
(a) A is water and B is lime water
(b) A is lime water and B is water
(c) A is $CaSO_4$ crystals and B is water
(d) A is KOH solution and B is water

Question 18:
After performing the experiment to show that germinating seeds give out carbon dioxide during respiration students drew the following diagram.



The correct labelled diagram is (a) A (b) B (c) C (d) D

Question 19:
The following experimental set-ups were kept in the laboratory to show CO_2 is given out during respiration



After two hours, students observed that water rises in the delivery tube
(a) only in set-up (A)
(b) only in set-up (B)
(c) in both (A) and (B)
(d) neither in (A) and nor in (B)

Questions based on Reporting and Interpretation Skills

Question 20:

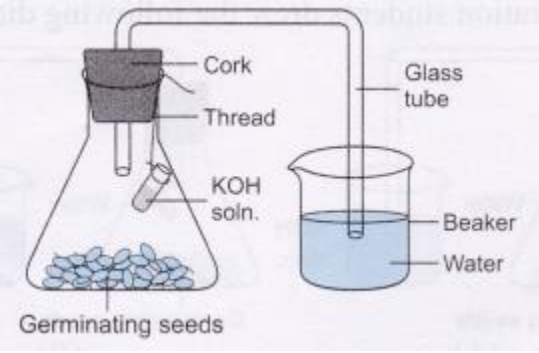
The function of KOH in the experimental set-up to show that CO_2 is released during respiration is
(a) to enhance respiration
(b) to release oxygen for respiration
(c) to absorb CO_2 released by germinating seeds.
(d) to remove water vapour from the flask.

Question 21:

Respiration occurs only in living cells like germinating seeds because
(a) living cells need ATP
(b) living cells have glucose
(c) living cells have O_2
(d) all of these

Question 22:

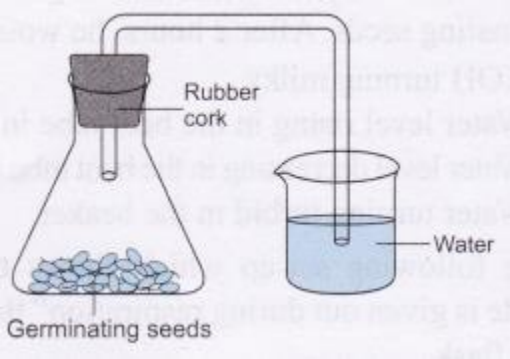
An experimental set-up is given below to demonstrate that CO_2 is given out during respiration.



Four students made the following observations marked I, II, III, and IV.
I. Level of water remained the same in both the beaker and the delivery tube.

II. Level of water increased in delivery tube.
III. Level of water gets reduced in both the beaker and the delivery tube.
IV. Water ascends into the delivery tube and again descends.
Which one of the above is correct observation?
(a) I
(b) II
(c) III
(d) IV

Question 23:
The following experiment was set up to show that a gas is given out during respiration. But there was no rise in the level of water. This was because



(a) germinating seeds have not been kept under water in the flask
(b) water is kept in the beaker instead of lime water
(c) the cork on the flask is made of rubber
(d) no substance is kept in the flask to absorb the gas given out by the seeds.

Answers:

1. (d)	2. (c)	3. (d)	4. (c)	5. (b)
6. (c)	7. (b)	8. (a)	9. (c)	10. (a)
11. (b)	12. (a)	13. (d)	14. (b)	15. (b)
16. (a)	17. (d)	18. (d)	19. (a)	20. (c)
21. (d)	22. (b)	23. (d)		

Science Lab Manual Scoring Key With Explanation

1. (d) In presence of air, the end products are the same with energy.
2. (c) In absence of air, the respiration products are ethanol, CO_2 and less energy.
3. (d) Respiration in cells occur in cytoplasm and mitochondria.
4. (c) Both stomata on leaf and lenticels on stem/root helps in exchange of gases.
5. (b) Lime water test helps in identifying the CO_2 gas, by turning milky.
6. (c) Yeast grows in all except pakora.
7. (b) Germinating seeds respire more to release CO_2.
8. (a) The release of CO_2 is co-related with the release of heat energy.

9. (c) When O_2 is absent (or very low), anaerobic respiration (alcohol fermentation) is initiated. Alcohol fermentation releases CO_2. Photosynthesis, which would consume CO_2 to produce glucose, is obviously not occurring.
10. (a) KOH absorbs CO_2 from the air.
11. (b) To study the rise of water level in the bent tube, CO_2 needs to be absorbed.
12. (a) Lime water turns milky with CO_2.
13. (d) Only germinating seeds will respire more.
14. (b) The air in the tube is used up for respiration and hence the air pressure inside the tube is reduced.
15. (b) KOH absorbs the CO_2 released and the O_2 is used up by plant and hence, reduces the pressure in the bent tube.
16. (a) KOH combines with CO_2.
17. (d) KOH is kept near germinating seeds and the bent tube is dipped in water.
18. (d) KOH tube is kept in a flask with germinating seeds and bent tube is dipped in water.
19. (a) Cotton plug allows the air to pass through it.
20. (c) KOH reacts with CO_2.
21. (d) The respiration reaction occurs only in living cells where it is supplied with all the raw materials.
22. (b) The water level in the bent tube will rise because the pressure inside the tube is reduced.
23. (d) The gases exchanged remains in the tube and in the flask and hence the pressure will not change.