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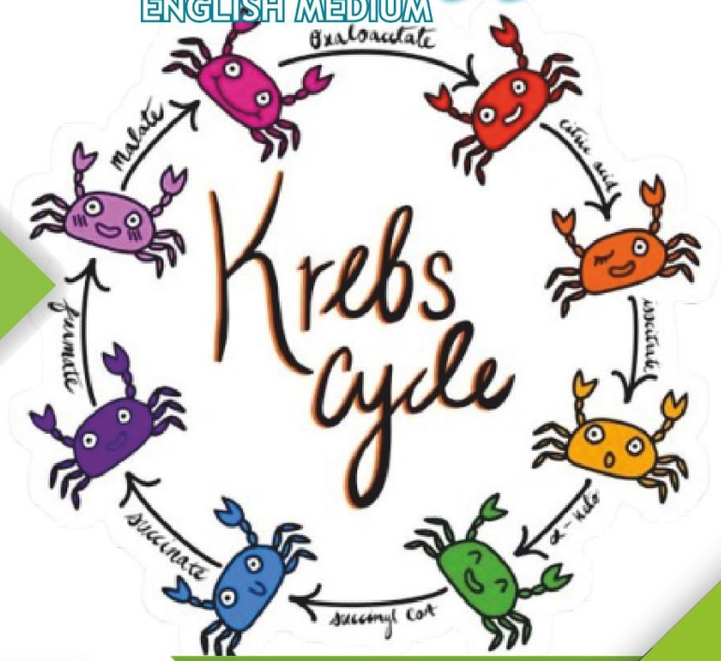

UNIT 02

Energy Relationships in Metabolic Processes

Cellular Respiration

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Cellular Respiration as a Process of Obtaining Energy

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Cellular respiration is divided as

a) Aerobic respiration

b) Anaerobic respiration

Aerobic respiration

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Glucose is found to be the major respiratory substrate in living cells. The aerobic respiration of glucose molecules can be represented by the following balanced chemical equation.

$$C_6H_{12}O_6 + 6O_2\,(g) \rightarrow 6CO_2\,(g) + 6H_2O + \text{Energy (ATP+ heat)}$$

This process consists three main steps. They are;

a) Glycolysis

b) Pyruvate oxidation and citric acid cycle (Kreb's cycle)

c) oxidative phosphorylation (Electron transport chain)

Glycolysis

It takes place in the ..... of the cell, because all enzymes that catalyze reactions of the glycolysis are found in the cytosol of the cell. This process does not depend on O_2. During the above process a six carbon (6C) ..... molecule is broken down ..... by ..... into two three-carbon (3C) pyruvate molecules.

Two ATP molecules are used up to initiate the process.

Four Hydrogen ions and electrons released from one molecule of glucose breakdown reduce ....and produce two NADH. At the end of glycolysis there will be four ATP molecules produced. Since two ATP molecules were used up for the initiative step, the net yield will be two ATP molecules.

Only when O_2 is present. the ..... molecules will enter the ..... and further steps will take place.

29. These numbers should be doubled when the yield of one glucose molecule is considered.
30. Electron transport chain takes place in the inner membrane (cristae) of mitochondria and
31. synthesize ATP
32. by oxidation of reduced co-enzymes / NADH and FADH2 .
33. This process is oxidative phosphorylation.
34. Electrons (of reduced co-enzymes) pass through a series of proteins and non-protein molecules
35. and are finally accepted by molecular oxygen/O_2 /is the final electron acceptor.
36. One (molecule of) NADH produces 2.5 molecules of ATP.
37. One (molecule of) $FADH_2$ produces 1.5 molecules of ATP.
38. Total number of ATP molecules produced in the electron transport chain is 28.
39. Thus the total number of ATP molecules produced for one molecule of glucose is 32 (during aerobic respiration in the liver cell).

Any 37 x 4 = 148 marks

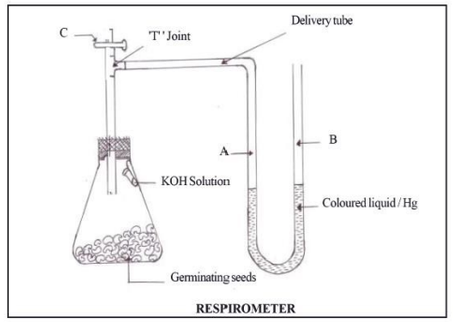
If > 37 points are correct + 2 marks

Total = 150 marks

Essay 04:

Explain how to determine the respiratory quotient of germinating green gram seeds.

1. Germinate the green gram seeds,
2. by soaking in water for at least 8 hours
3. and to spread it on wet paper for one day.
4. Set up two respirometers
5. according to the diagram given below.
6. Add equal weights (25 g) of germinating seeds to each.
7. Insert an ignition tube
8. with KOH solution
9. Make the apparatus airtight.
10. Keep the flask of the respirometer in a water bath.
11. Level the coloured liquid columns in A and B by using C stopper.
12. Note the initial positions of the water column in each of the tubes.
13. Start the stop watch.
14. Observe and record changes
15. in the water column after two hours.
16. Calculate the volume of O_2 intake
17. by unit mass of seeds
18. during unit time period .
19. Volume of O2 = Volume change with KOH (h1)
20. Calculate the volume of CO_2 released
21. by unit mass of seeds
22. during unit time period .
23. Volume of CO2 = Volume with KOH (h1) —Volume without KOH (h2)
24. RQ = Volume of CO2/ Volume of O_2



RESPIROMETER

- Diagram (Marks 4 x 18 + Diagram 28)

18. Krebs cycle takes place in matrix (of mitochondria) and
19. electron transport chain takes place in inner membrane /cristae (of mitochondria)
20. Pyruvate / pyruvic acid
21. which is the end product of oxidation of glucose
22. in glycolysis
23. enters to mitochondrial matrix.
24. In the presence of oxygen
25. it is converted to acetyle co-enzyme A
26. by enzymes in the matrix
27. producing two NADH molecules and
28. two CO_2 molecules.
29. Acetyle Co-A reacts with Oxaloacetic acid
30. which is a 4C compound
31. to form Citric acid
32. which is a 6C compound
33. by a series of enzymes.
34. Most of the Kreb cycle enzymes are located in the matrix.
35. Citric acid regenerates to oxaloacetic acid
36. producing H^+ / electrons.
37. Those H+/electrons are accepted by NAD and
38. FAD
39. to produce 6NADH and
40. 2 $FADH_2$ molecules respectively.
41. Two ATP molecules are produced
42. by substrate level phosphorylation in the matrix of mitochondria.
43. Reduced co-enzymes/ NADH and
44. $FADH_2$ are oxidized
45. to release ATP by electron transport chain.
46. 34 ATP molecules are produced(in electron transport chain)
47. by (a process known as) oxidative phosphorylation.
48. H^+/electrons in reduced co-enzymes/ NADH and $FADH_2$ are finally accepted by molecular oxygen
49. to form water

Any 48 x 3 = 144
Diagram = 08
Total = 152
Maximum = 150

Essay 03:

Describe the process of aerobic respiration that occurs in liver cells of man using glucose as the substrate.

1. Three main steps
2. Glycolysis
3. Pyruvate oxidation and citric acid cycle /Krebs cycle / TCA cycle
4. Oxidative phosphorylation /Electron transport chain
5. Glycolysis takes place in the cytosol (of a cell),
6. Does not depend on oxygen/oxygen is not involved.
7. (one) Glucose (6C) molecule is oxidized (broken down) into two (3C) pyruvate molecules.
8. Two ATP (molecules) are utilized (to initiate the process) and
9. four H+ and electrons are produced.
10. Electrons/H+ are accepted by two NAD+ (molecules) and
11. two NADH (molecules) are produced.
12. In later steps of glycolysis) four ATP (molecules) are produced
13. by substrate level phosphorylation.
14. The net gain of ATP (molecules) in glycolysis is 2 ATP (as two ATP molecules are used up).
15. Two pyruvate (molecules) enter mitochondria
16. by active transport.
17. Pyruvate is converted to acetyl group by releasing $2CO_2$ (molecules),
18. in the matrix of mitochondria.
19. Acetyl group combines with co-enzyme A to produce Acetyl Co-enzyme A.
20. (In this reaction) two NAD+ (molecules) are converted to two NADH (molecules).
21. Citric acid cycle/ Krebs cycle/ TCA cycle takes place in the matrix of mitochondria (using specific enzymes).
22. Acetyl Co-enzyme A is combined with (4C) oxaloacetic acid/oxaloacetate and produce (6C) citric acid/ citrate.
23. Citric acid/citrate undergoes a series of reactions to regenerate oxaloacetic acid/oxaloacetate
24. by releasing two (molecules of) CO; (decarboxylation)
25. and one ATP molecule
26. by substrate level phosphorylation.
27. One FADH2 (molecule) and
28. three (molecules of) NADH are produced (for one cycle/for one molecule of acetyl co_A)

Oxidation of Pyruvate/ Link reaction

These two pyruvate molecules enter mitochondrion by active transport through the membrane. In the matrix of mitochondria, Pyruvate is converted to …… group by releasing two CO_2 molecules. Then this acetyl group combines with co-enzyme A to produce Acetyl co-A. In this reaction two NAD^+ is converted to two NADH molecules. Therefore this step can be represented as follows.

2 $C_3H_4O_3$ (Pyruvate) + 2CoA + 2NAD^+ → 2 Acetyl Co-A + 2CO_2 + 2NADH

Oxidation of pyruvate is a linking reaction of glycolysis and citric acid cycle. Acetyl Co-A will feed its acetyl group for citric acid cycle.

Citric acid cycle

……
……
……
……
……

Hence, it is named as Kreb's cycle. Citric acid contains three carboxylic acid groups. This cycle is also known as …… …… cycle or …… cycle. In the citric acid cycle 4C compound …… combines with 2C compound acetyl Co -A to form 6C compound, citric acid. Then citric acid undergoes a series of enzyme catalyzed reactions to regenerate oxaloacetate by releasing two CO_2 molecules by decarboxylation reaction. One ATP molecule is produced by substrate level phosphorylation. …… $FADH_2$ and three NADH will be generated as a result of oxidation reactions. These are the products of a single acetyl group led into citric acid cycle and hence these numbers should …… when the yield for a glucose molecule is considered.

Electron transport chain

This step is taken place across the inner membrane (cristae) of mitochondria. The …… of cristae increases surface area for oxidative phosphorylation. NADH and $FADH_2$ products in the early stages of aerobic respiration are oxidized by transferring electrons, through the electron transport chain and finally to molecular oxygen (O_2). The electron transport chain is located in the inner membrane of mitochondrion and composed of series of protein and non-protein molecules involving in the movement of electrons and protons across cristae. Therefore, the Molecular oxygen (O_2) is the final electron acceptor in aerobic respiration.

Essay 01 : Answer

(a) What is understood by the term respiration

1. Occurs in living cells
2. Complex organic food molecules are
3. Broken-down/oxidization by
4. Series of enzymes to
5. Release energy

(b) What are major steps of aerobic respiration

7. Glycolysis
8. Pyruvate oxidation and Krebs cycle
9. Electron transport chain

(c) Explain the major biochemical reactions that take place in each of the steps you mentioned and how energy is produced in the form of ATP when one molecule of glucose is subject in to aerobic respiration.

10. Glucose is converted to pyruvic acid by glycolysis.
11. By specialized set of enzymes.
12. Occurs in cytoplasm
13. first ATP used in phosphorylation.
14. Later ATP produced by
15. Substrate level phosphorylation.
16. 2 net ATP
17. 2 NADH production occurs.
18. During Krebs cycle pyruvate enters in to the mitochondrion.
19. Pyruvate converts to Acetyl CoA.
20. Decarboxylation occurs
21. produce 1 molecule of NADH.
22. During this dehydrogenation process
23. acetyl CoA combines with OAA to
24. form citrate.
25. Citrate undergoes many enzyme catalyzed reactions
26. To results CO2 by decarboxylation
27. and oxidation.
28. OAA is regenerated to complete the cycle., As a result of this process
29. 1 ATP
30. 3 NADH
31. 1 $FADH_2$
32. forms for 1 molecule of pyruvate.
33. Occurs in mitochondrial matrix.
34. During electron transport chain all reduces coenzymes pass through electron acceptors.
35. Finally they joined with O_2 to form water.
36. Using energy ATP forms.
37. By oxidative phosphorylation.
38. Occurs on mitochondrial inner membrane.
39. One NADH molecule forms 2.5 ATP molecule
40. and 1.5 $FADH_2$ molecule.
41. Aerobic respiration of one glucose molecule forms 30/32 molecules of ATP

Essay 02:

a) Describe the fine structure of a mitochondrion using a fully labeled diagram

1. Double membrane structure/ is bounded by two membranes/ envelopes
2. Rod/sausage/tubular shaped.
3. Outer membrane is smooth,
4. Inner membrane is folded inwards
5. forming a number of cristae.
6. Stalked particles are
7. attached on cristae/ are found on the matrix side of the inner membrane
8. The cristae of the inner membrane effectively increase its surface areal and
9. contain enzymes of electron transport system.
10. Inter membranal space is present (between membrane).
11. Internal area is called matrix
12. which contains circular DNA,
13. 70s ribosomes and
14. Enzymes of the Krebs cycle.

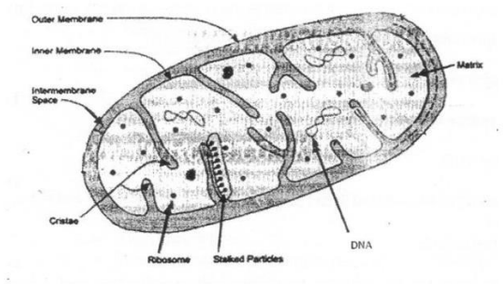


Diagram 1x 8 = 08

b) Explain the role of mitochondria in cellular respiration

15. Mitochondria is the major organelle in which generation of cellular energy and
16. where Krebs cycle reactions and
17. electron transport chain take place.

1.(2)	2.(1)	3. (3)	4.(4)	5.(2)	6.(4)	7.(AC)	8.(1)	9.(ABD)	10.(5)
11.(4)	12.(AB)	13.(1)	14.(3)	15.(1)	16.(3)	17.(4)	18.(2)	19.(2)	20.(2)
21.(4)	22.(1)	23.(1)	24.(2)	25.(2)	26.(4)	27.(4)	28.(3)	29.(3)	30.(3)
31.(2)	32.(4)	33.(3)	34.(3)	35.(5)	36.(CD)	37.(3)	38.(3)	39.(5)	40.(2)
41.(2)	42.(3)								

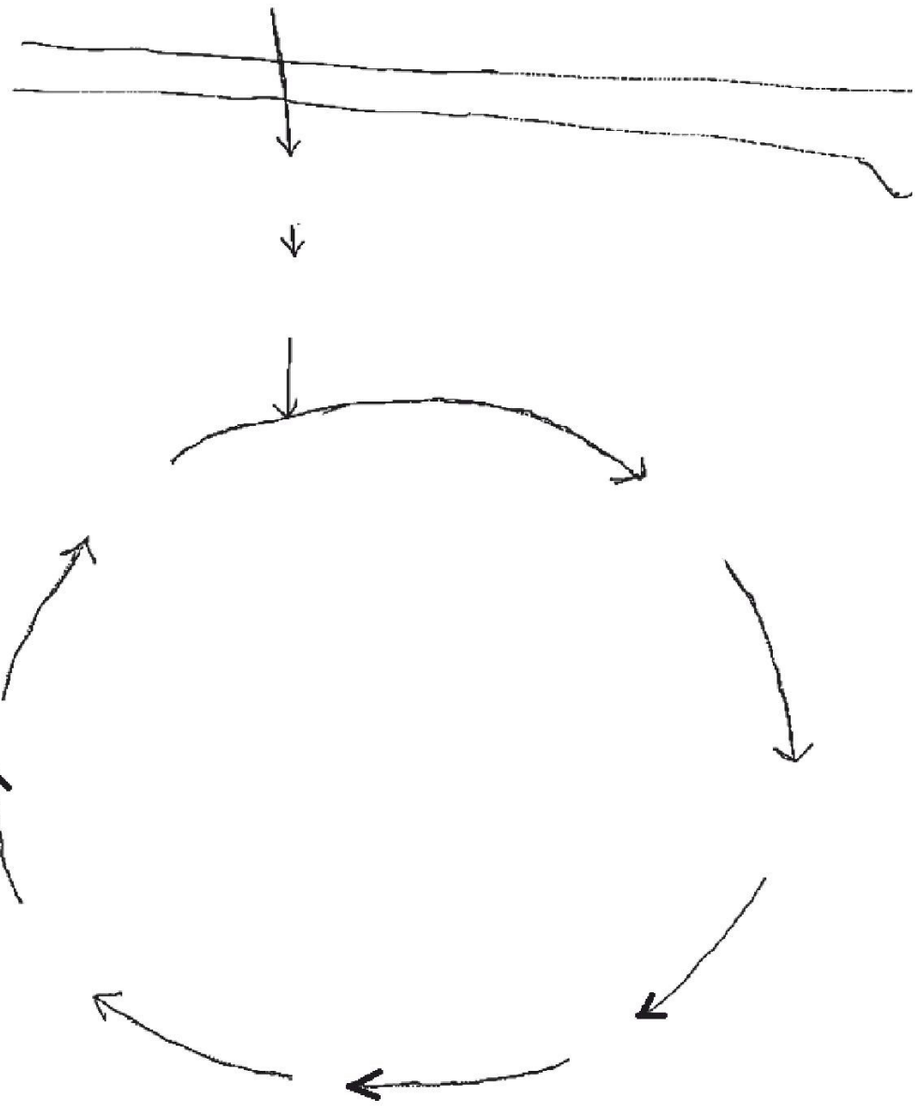
Question 1: i) glucose ii) pyruvate iii) Process 2 (leading to lactic acid) and process 3 iv) oxaloacetate v) Sites in eukaryotic cell: a) Cytosol b) Matrix of mitochondria c) Inner membrane (cristae) of mitochondria

Question 2: (i) Set up a respirometer with 25g germinating seeds/Fill one ignition tube with water (not KOH)/Insert the tube into the respirometer and make it airtight using Vaseline/clay/Place the flask in a water bath to maintain constant temperature/Level the colored liquid columns using C stopper/Note initial position of water column/After two hours, observe and record the change in water column/The movement indicates oxygen consumption by the seeds
(ii) Set up a second identical respirometer with 25g germinating seeds/Fill ignition tube with KOH solution/KOH absorbs CO2 produced by seeds/Note initial position of water column/After two hours, observe changes/Difference between readings of two respirometers (with and without KOH) indicates CO2 production
(iii) Calculate volume of O2 used from first respirometer/Calculate volume of CO2 released from difference between two respirometers/Use formula: RQ = Volume of CO2 evolved / Volume of O2 consumed/ This gives respiratory quotient for the germinating seeds
(iv) Expected RQ would be 1.0/This is because green gram seeds primarily use carbohydrates as respiratory substrate/When carbohydrates are metabolized, the volume of CO2 produced equals O2 consumed
(v) For germinating castor seeds: Expected RQ would be 0.7/Castor seeds contain high fat content/Fats require more oxygen for complete oxidation/Hence CO2 produced is less than O2 consumed, giving RQ of 0.7

Question 3: (i) Glycolysis, Net 2ATP/Pyruvate oxidation and Citric acid cycle (Kreb's cycle), 2ATP/ Electron transport chain, 28 ATP (ii) Starch (ii) Glycogen (iii) Amylase

Question 4: i) Stage 1- Glycolysis - Cytosol - 2 net ATP + 2NADH + 2 Pyruvate /Stage 2 - pyruvate oxidation and citric acid cycle - Mitochondrial matrix - 2 ATP + 8NADH + 2FADH2 /Stage 3 Electron transport chain - Inner mitochondrial membrane - 28 ATP + H2O

Question 5: i) Process A is Glycolysis/Process B is pyruvate oxidation and Citric acid cycle (Kreb's cycle)/ Process C is Electron transport chain/ii) Locations: A occurs in cytosol B occurs in mitochondrial matrix C occurs in inner mitochondrial membrane (cristae)/iii) ATP molecules formed: In A (Glycolysis): 2 net ATP/ In C (ETC): 28 ATP/iv) Three electron carriers in process C: NADH, FADH2, and molecular oxygen (O2)/v) Two products formed from pyruvate in absence of O2: Ethyl alcohol (ethanol), Lactic acid



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(ii) Where do processes A, B, and C occur in the living cell?

……..

……..

……..

(iii) How many ATP molecules are formed in stages A and C in the respiration of one glucose molecule

……..

……..

(iv) Name three electron carriers taking part in biochemical reactions of process C

……..

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……..

(v) Name the two products that maybe formed from pyruvate in the absence of O2.

……..

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Essay Aid

Essay 01: 1999/Bot

(a) What is understood by the term respiration

(b) What are major steps of aerobic respiration

(c) Explain the major biochemical reactions that take place in each of the steps you mentioned and how energy is produced in the form of ATP when one molecule of glucose is subject in to aerobic respiration.

Essay 02: 2015 AL

a) Describe the fine structure of a mitochondrion using a fully labeled diagram

b) Explain the role of mitochondria in cellular respiration

Essay 03: 2020 AL

Describe the process of aerobic respiration that occurs in liver cells of man using glucose as the substrate.

Essay 04: Model

Explain how to determine the respiratory quotient of germinating green gram seeds.

(a) Seeds - .....

(b) Liver - .....

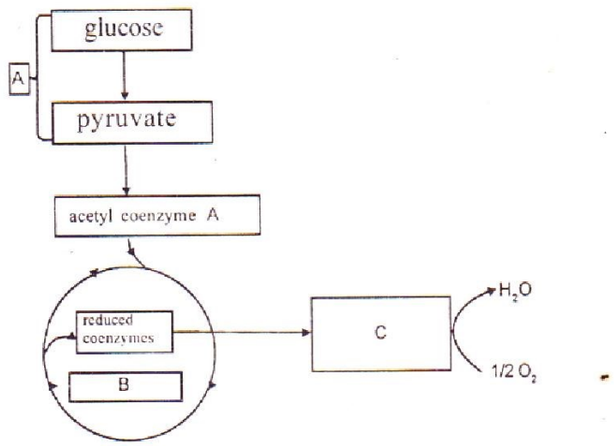
(iii) Name an enzyme which converts the storage carbohydrates in to 6C sugar in plants.

.....

4. (i) In the table given below write in column A the three major stages of aerobic respiration in correct sequence and indicate in column B the end products of each of the three major stages you mentioned, when glucose is the respiratory substrate.
Indicate in columns *C* and *D* respectively the sites in a prokaryotic cell and a eukaryotic cell where the above three stages take place.

(A) Major stages of aerobic respiration	(B) End products	(C) Site in prokaryotic cell	(D) Site in eukaryotic cell
1			
2			
3			

5.Questions (i)- (iv) are based on the following diagram showing outline of aerobic respiration.



(i) Name the processes shown as A, B, and C.

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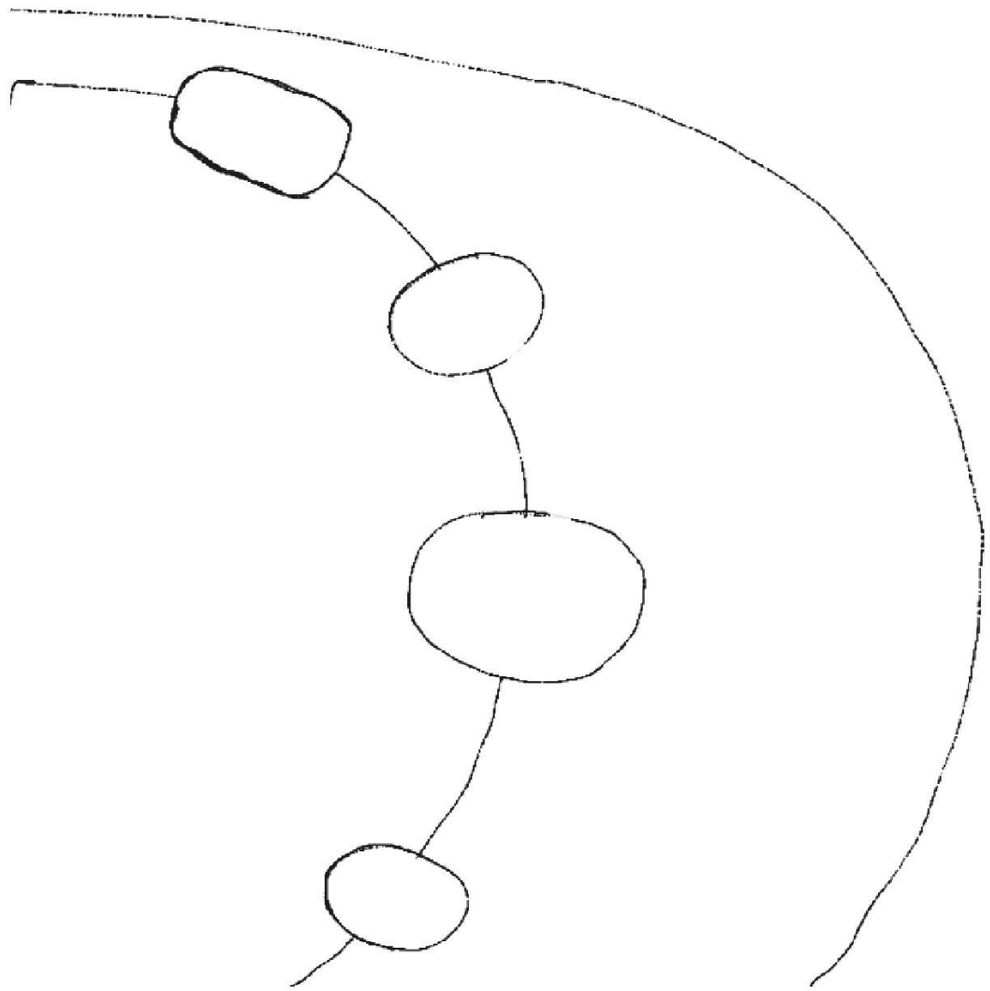

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(v) If the seed used in the above experiment were germinating castor seeds what will be the expected respiratory quotient? Explain the answer,

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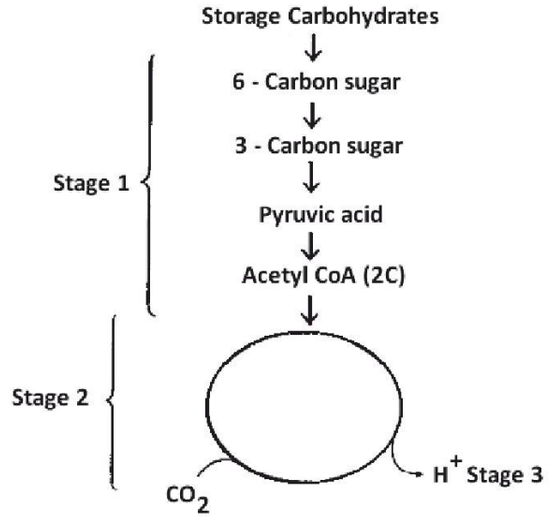
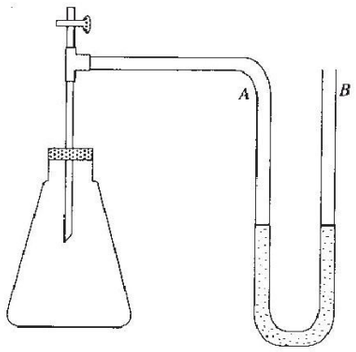
3. The following diagram outlines the major stages of aerobic respiration in cells.

(i) Name the processes labeled as stages 1, 2 and 3 in the diagram and indicate the sites they occur in the cell and the number of ATP molecules produced at each stage.

Process	**Site**	**Number of ATP molecules produced**
Stage 1	.....	
Stage 2	.....	
Stage 3	.....	



(ii) Name the storage carbohydrate commonly found in each of the following.



(i) Explain how this apparatus can be used to determine the rate of oxygen uptake of the germinating seeds.

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(ii) Explain how this apparatus can be used to determine the rate of carbon dioxide release from the same sample of germinating seeds.

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(iii) Explain how respiratory quotient of the germinating seeds could be calculated using the measurements made in (i) and (ii).

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(iv) If the seed used in the above experiment were germinating green gram seeds what will be the expected respiratory quotient? Explain the answer.

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In the electron transport chain, ATP is synthesized by …….. phosphorylation. In this electron transport chain, …….. is released ……. from NADH and $FADH_2$ and that energy is used to synthesize ATP. When one molecule of NADH is oxidized in the electron transport chain. …….. molecules of ATP in average are generated due to oxidative phosphorylation. When one molecule of $FADH_2$ is oxidized ……. molecules of ATP in average are produced due to oxidative phosphorylation. Total number of ATP that is produced in this step is …….. This is true in the active cells such as …….. cells and …….. muscle cells but not in other cells where two ATP produced in glycolysis is used to ……. 2 NADH from cytosol to …… ……..... In those cells total number of ATP produced by one molecule of glucose is (32-2) = …….. ATP

Total number of ATP molecules produced from one molecule of glucose. during aerobic respiration.

In glycolysis;

As ATP	⟶	2 ATP (substrate phosphorylation)
From 2NADH	⟶	5 ATP (oxidative phosphorylation)

In pyruvate oxidation;

From 2NADH	⟶	5 ATP (oxidative phosphorylation)

In Citric acid cycle;

As ATP	⟶	2 ATP (substrate level phosphorylation)
From 6 NADH	⟶	15 ATP (oxidative phosphorylation)
From 2 $FADH_2$	⟶	3 ATP (oxidative phosphorylation)
Total Number of ATP	=	32 ATP

Anaerobic respiration

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In the absence of molecular oxygen pyruvate molecules cannot be broken down further. ATP generated is utilized to fulfill energy requirements. However, NADH produced during glycolysis cannot be utilized. Since, NAD^+ is limited, it is essential for the cell to recycle NADH to enhance the availability of NAD^+.

Fermentation

Fermentation is a method of production of ATP in the absence of O_2.

There are many types of fermentation, differing from end products formed by pyruvate.

The two common types are;

1. Ethyl alcohol fermentation
2. Lactic acid fermentation

Ethyl alcohol fermentation

- Like in aerobic respiration, the first step of this is also Glycolysis.
- Therefore one molecule of glucose is converted to 2 molecules of pyruvate giving 2 molecules of ATP and two molecules of NADH
- Then this pyruvate involve in two steps. In the 1st step pyruvate is converted in to Acetaldehyde, releasing a molecule of CO_2 In the second step acetyldehyde is reduced to ethanol using NADH that is produced in Glycolysis. Therefore final hydrogen acceptor in ethyl alcohol fermentation is acetylaldehyde (organic compound)
- Many bacteria carry out ethyl alcohol fermentation. The most common organism which carries out ethyl alcohol fermentation is yeast.

Lactic acid fermentation

- As in ethyl alcohol fermentation, Glycolysis takes place as the first step of lactic acid fermentation.
- Therefore one molecule of glucose produces two molecules of pyruvate, two molecules of ATP and two molecules of NADH.
- Then pyruvate is reduced directly by NADH for lactic acid as an end product with no release of CO_2, therefore final H acceptor is pyrurate.
- Certain fungi and bacteria carryout lactic acid fermentation but the most common organisms are lactic acid bacteria involved in formation of yoghurt and curd.

Respiratory quotient

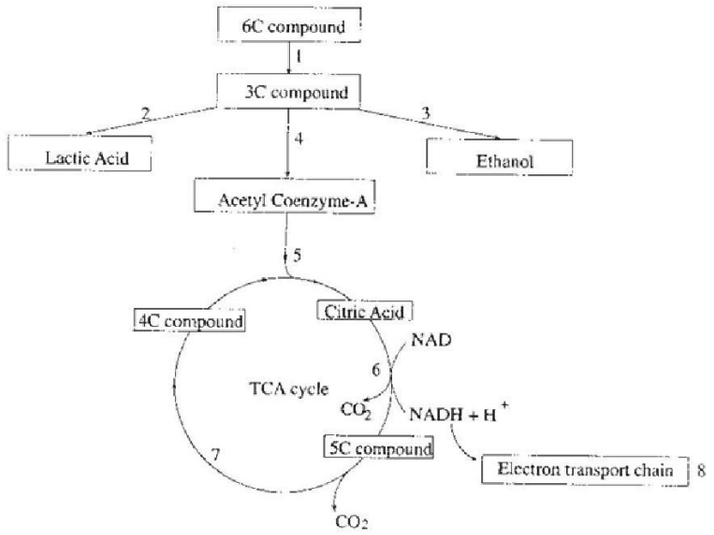
It is the ratio of CO_2 evolved and the volume of O_2 consumed in a given time for the respiratory substrate.

$RQ = VCO_2/VO_2$

RQ of respiration of carbohydrates, fats and proteins are 1.0, 0.7 and 0.8 respectively.

Structured Essay

1. Some of the processes of cellular respiration are given in the diagram. Labeled 1-8.



(i) What is the 6C compound usually used in process 1?

.....

(ii) Name the 3C compound formed by process 1.

.....

(iii) Which of the above processes take place only under anaerobic conditions?

.....

(iv) What is the 4C compound regenerated in the TCA cycle which combines with Acetyl Coenzyme A to form citric acid?

.....

(v)Name the sites in an eukaryotic cell which the following processes take place.

(a) Glycolysis .....

(b) TCA cycle .....

(c) Electron transport chain .....

2. The diagram below shows a simple respirometer that can be used to determine the rate of respiration in germinating seeds.

31. Certain instances green plants also show the capability of anaerobic respiration. Aerobic respiration is beneficial to green plants, because it produce more,
1) CO_2 2) Energy 3) Water required for metabolic reactions 4) Pyruvic acids
5) Water and CO_2

32. What is the sentence always correct regarding anaerobic respiration?
1) Ethyl alcohol is a final product 2) Final hydrogen acceptor is an organic compound
3) Molecular oxygen involved in the process 4) ATP produces as a final result
5) Respiratory quotient is less than one

33. Pyruvate produce in the glycolysis converts to
1) Oxaloacetic acid 2) Malate 3) Acetyl Co A 4) Citrate 5) Fumarate

34. What is the name of the scientist whom became popular due to invention of biochemical process of respiration?
1) Robert Hook 2) Melvin Calvin 3) Hans Krebs 4) Charles Darwin 5) Robert Koch

35. Which of the following statement is incorrect regarding the glycolysis?
1) Happens in all green plants 2) Utilizes ATP 3) Results pyruvic acid 4) O_2 is not required
5) Happens within mitochondria

36. Which of the following sentence is incorrect regarding glycolysis?
A) Happens within the cytoplasm B) Pyruvic acid is the end product
C) Ethanol form as the end product D) Released CO_2 E) Produce ATP

37. Which sentence is correct regarding respiration?
1) Mitochondria is essential for aerobic respiration 2) Carbohydrate is the only substrate used in higher plants
3) Respiration is not the only process provide energy required for life
4) The ratio of CO_2 to O_2 released during respiration is 1:1 5) ATP released only in glycolysis

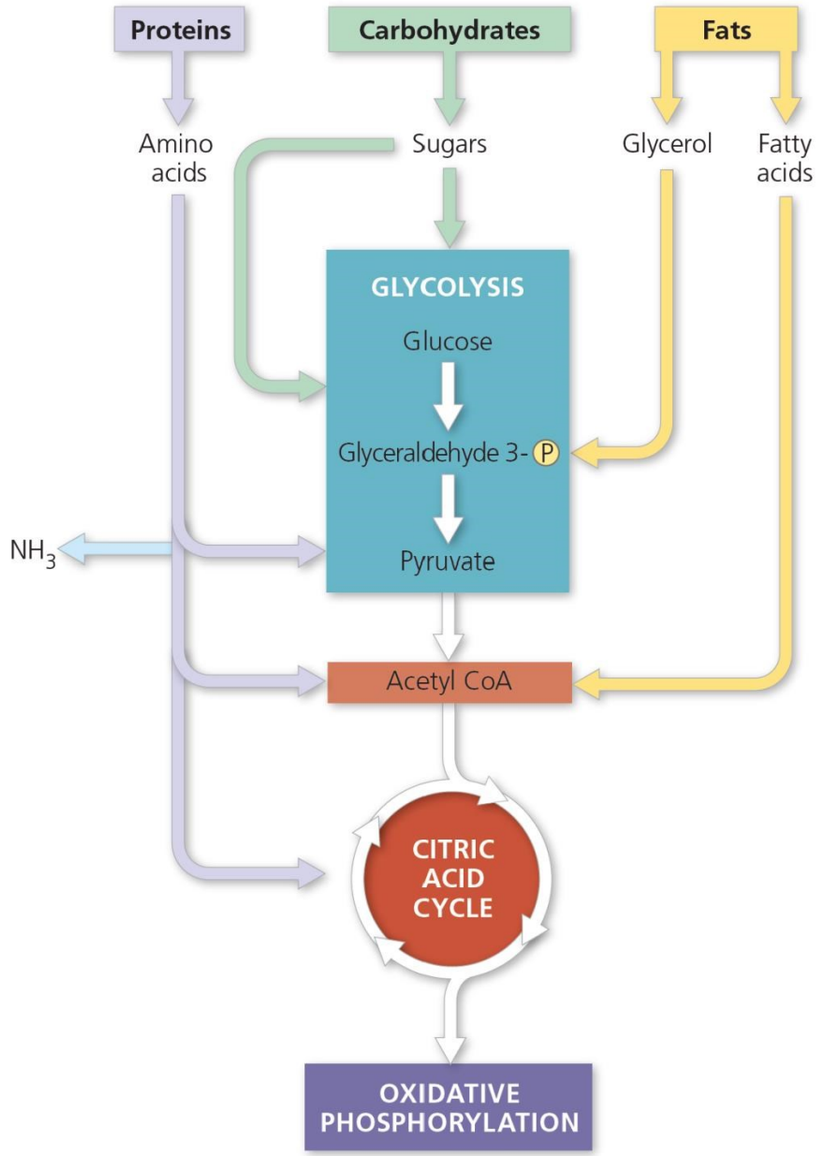
38. Number of ATP molecules produce during fermentation is comparatively less to that of aerobic respiration. Because,
1) CO_2 is produce during fermentation 2) More number of ATP molecules needed to start fermentation
3) Fermentation produces partially oxidized end products 4) Fermentation happens outside the mitochondria
5) Fermentation need low amount of energy

39. Which of the following is not use as a substrate in respiration?
1) Starch 2) Protein 3) Fat 4) Sucrose 5) ATP

40. How many carbon atoms present in one glyceraldehyde phosphate molecule?
1) Two 2) Three 3) Four 4) Five 5) Six

41. How many net ATP molecules are produce from one glucose molecule at the end of glycolysis?
1) 1 2) 2 3) 4 4) 36 5) 38

42. Which of the following statements is incorrect regarding respiration?
1) Respiration is a stepwise process
2) The main respiratory substrate of plant tissues are glucose
3) If O_2 containing O^{18} isotope is given to plant tissues, then the resulting CO_2 will contain O^{18}
4) Respiratory quotient is the ratio between the released CO_2 volume and the absorb O_2 volume.
5) Respiration of plant tissues doubles when the temperature increases from 20^0C to 30^0C

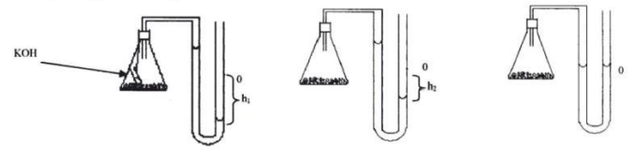


20. Which of the following cellular processes produces ATP from glucose in the absence of oxygen?
(1) Krebs cycle (2) Glycolysis (3) Electron transport chain (4) Photophosphorylation
(5) CO_2 fixation (AL 2014)

21. Which of the following processes take place in the inner membrane of mitochondria?
(1) Conversion of pyruvate to acetyl co-enzyme A (2) Production of NADH
(3) Ethanol fermentation (4) Oxidative phosphorylation (5) Release of CO_2 (AL 2015)

22. Which of the following is common to lactic acid fermentation, alcoholic fermentation and aerobic respiration?
(1) Glycolysis (2) Krebs cycle (3) Electron transport chain (4) Production of acetyl co-enzyme A from pyruvate (5) Oxidation of glucose to CO_2 and water (AL 2016)

23 - 25 questions are based on the following explanation.
The apparatus shown below was fixed to study respiration. At the beginning of the experiment the height of the manometer was h_0 in all three setups. Hour after, the height of the manometer fluid was h_1, h_2 and h_0 respectively.



23. Which of the following show the volume of O_2 taken by the germinating seeds?
1) h_1 2) h_2 3) $h_1 - h_2$ 4) $h_2 - h_1$ 5) $h_1 + h_2$

24. Which of the following show the respiratory quotient (RQ)?
1) $h_1 / (h_2-h_1)$ 2) $(h_1-h_2) / h_1$ 3) $h_1 / (h_1-h_2)$ 4) $(h_2-h_1) / h_2$ 5) $(h_1+h_2) / h_2$

25. Which of the following can expect if the respiratory substrate is lipid?
1) $h_1 = O$ 2) $h_1 > h_2$ 3) $h_2 > h_1$ 4) $h_2 = h_1$ 5) $h_2 = O$

26. Which of the following statements is correct regarding the respiration quotient of castor seeds?
1) Less than 1 at the initial period of germination and then become 1 at later stage
2) Higher than 1 at the initial period of germination and then become 1 at later stage
3) Value stays at 1 during whole germination process
4) Value is less than 1 during whole germination process
5) Value is more than one during whole germination process

27. Which of the following statement is correct regarding respiration?
1) Mitochondria are need for respiration of all organisms
2) Fat and proteins are converted to carbohydrates before enter in to respiration
3) Ratio between released CO_2 and absorb O_2 is 1 : 1
4) Respiration rates of different tissue of the same plant are different
5) ATP is synthesized only using the reduce energy

28. Which of the following process is considered as the most important reaction in respiration?
1) O_2 uptake 2) Release of CO_2 3) ATP synthesis 4) Electron transfer chain
5) Breakdown of organic products

29. What is the final hydrogen acceptor in fermentation in Yeast?
1) Cytochromes 2) Pyruvic acid 3) Acetaldehyde 4) Ethyl alcohol 5) Oxygen

30. Respiratory quotient do not deviate from 1 when,
1) A substrate other than carbohydrate is oxidized
2) When respiratory substrates are partially oxidized
3) When atmospheric pressure and temperature change
4) Absorbed O^2 is used for a process other than respiration
5) When CO_2 is used up for other cellular processes

9. In a plant cell, ATP synthesis can occur in the
(A) cytoplasm. (B) cell membrane. (C) chloroplast (D) mitochondria (E) endoplasmic reticulum

10. Which one of the following statements of comparison between cellular respiration and photorespiration is incorrect?
(1) Cellular respiration is a useful process while photorespiration is a wasteful process.
(2) In both processes, carbohydrate is oxidized by O_2.
(3) Both processes need mitochondria.
(4) Cellular respiration occurs in all plants but photo respiration only in some plants.
(5) PGA is an intermediate in both processes. (AL 2009)

11. Which of the following statements of comparisons between photophosphorylation and oxidative phosphorylation is incorrect?
(1) Photophosphorylation takes place in chloroplasts while oxidative phosphorylation takes place mitochondria.
(2) Photophosphorylation may be accompanied by release of O_2 while oxidative phosphorylation is accompanied by utilization of O_2.
(3) Photophosphorylation may be accompanied by reduction of co-enzymes while oxidative phosphorylation is accompanied by oxidation reduced co-enzymes.
(4) Both processes use ADP as an electron acceptor.
(5) Photophosphorylation can take place only in the presence of light while oxidative phosphorylation can take place at any time. (AL 2009)

12. Which of the following process/ process require/ requires ATP?
(A) Glycolysis in aerobic respiration (B) Calvin cycle in photosynthesis.
(C) Photolysis in photosynthesis. (D) Electron transport system in aerobic respiration.
(E) Krebs cycle in aerobic respiration. (AL2009)

13. Most of the CO2 liberated during respiration of glucose arise from the reactions of
(1) Krebs cycle (2) Glycolysis (3) Alcohol fermentation (4) Oxidative phosphorylation
(5) lactic acid fermentation (AL 2010)

14. Which one of the following metabolic processes is exergonic?
(1) $ADP + P_i \rightarrow ATP + H_2O$ (2) $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$
(3) $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$ (4) Amino acids $\rightarrow$ Protein
(5) Glycerol + Fatty acids $\rightarrow$ Fat (AL 2011)

15. Which of the following acts as the final electron acceptor in ethanol fermentation?
(1) Acetaldehyde (2) Pyruvate (3) Acetyl coenzyme-A (4) Molecular oxygen (5) Glucose
(AL 2012)

16. Approximately what percentage of ATP is produced by the electron transport system in cellular aerobic respiration of glucose?
(1) 63% (2) 58% (3) 87.5 % (4) 11% (5) 79% (AL 2013)

17. Which of the following is incorrect regarding glycolysis?
(1) ATP is produced. (2) ATP is utilized. (3) NADH is produced. (4) CO_2 is released.
(5) Occurs in the cytosol. (AL 2013)

18. Which of the following final products are formed during anaerobic respiration of glucose in yeast?
(1) Ethanol and water (2) Ethanol and CO_2 (3) Pyruvic acid and CO_2 (4) Lactic acid and CO_2
(5) CO_2 and water (AL 2014)

19. Which one of the following is the final electron acceptor in the electron transport chain in animal respiration?
(1) NAD (2) Oxygen (3) Cytochrome (4) Water (5) NADP (AL 2014)

PRACTICAL NO. 08

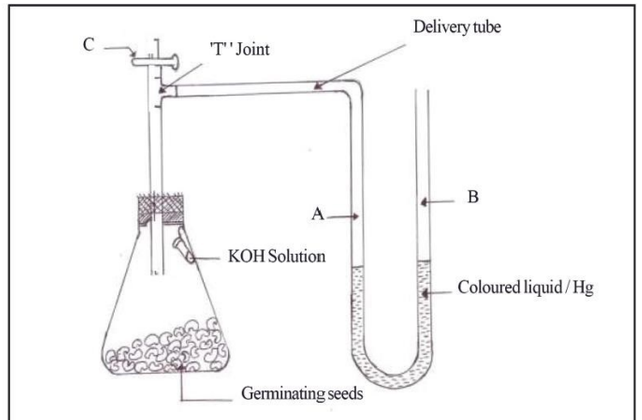
Determination of rate of respiration and respiratory quotient using germinating seeds

Objectives

- Students should be able to set up the apparatus to determine the rate of respiration of germinating seeds,
- make accurate observations and measurements,
- determine the rate of respiration by measuring the volume of oxygen used or the volume of carbon dioxide released,
- determine the respiratory quotient.

Materials and equipment

- Green gram seeds
- Two respire meters
- KOH solution
- Ignition tubes
- Stop watches
- Balances
- Water bath
- Vaseline/clay Instructions



RESPIROMETER

Instructions

- Guide the students to germinate the green gram seeds, by soaking in water for at least 8 hours and spreading on a wet paper for one day.
- Guide the students to set up two respire meters (appendix II) and to follow the instructions given below.
- Add equal weights (25g) of germinating seeds to each.
- Fill one ignition tube with KOH solution and the other one with equal volume of water.
- Insert these ignition tubes into the two respire meters separately.
- Make the apparatus as airtight using Vaseline or clay.
- Keep the flasks of the respire meters in a water bath.
- Level the coloured liquid columns in A and B using C stopper.
- Note the initial positions of the water column in each of the tubes.
- Start the stop watch.
- Observe and record changes in the water column after two hours.
- Calculate the volume of O_2 used and the volume of CO_2 released and determine the rate of respiration and the respiratory quotient.

MCQ

1. Which of the following biological conversions taking place in the cell yield the highest amount of energy in the form of ATP?
   (1) Glucose → pyruvic acid (2) Glucose → lactic acid (3) Glucose → $CO_2 + H_2O$
   (4) Glucose → ethyl alcohol (5) CO_2 →Glucose (AL 2000)
2. Which one of the following metabolic pathways is common to both fermentation and aerobic respiration?
   (1) Glycolysis (2) Conversion of pyruvate to alcohol (3) Electron transport chain
   (4) Kreb's cycle (5) Synthesis of acetyl Co-A from pyruvate (AL 2001)
3. Which of the following statements is incorrect regarding ATP?
   (1) ATP is a nucleotide. (2) ATP is produced during photosynthesis.
   (3) In aerobic respiration most ATP per molecule of glucose is produced during Kreb 's cycle.
   (4) ATP ' is used in muscle contraction.
   (5) ATP is utilized in both respiration and photosynthesis. (AL 2001)
4. The incorrect statement regarding ATP is
   (1) ATP is a nucleotide. (2) ATP is required to synthesize macro molecules.
   (3) ATP is required to convert glucose to pyruvic acid during glycolysis (AL 2002)
   (4) ATP contains 3 high energy phosphate bonds.
   (5) A greater amount of ATP is produced during aerobic respiration than in fermentation.
5. Which one of the following biological processes does **not** require energy in the form of ATP?
   (1) Conversion of glucose to pyruvic acid in glycolysis
   (2) Conversion of starch to sugar during seed germination
   (3) Conversion of carbon dioxide to sugar in photosynthesis
   (4) Conversion of amino acids to proteins during protein synthesis (AL 2004)
   (5) Transport of sugar from mesophyll cells to sieve tube elements in phloem translocation
6. Which of the statements in the following comparison between Calvin's cycle and Kreb's cycle is incorrect?

Calvin cycle	**Kreb's cycle**
(1) CO_2 is absorbed	CO_2 is released
(2) PGA is n intermediate produce	PGA is not an intermediate produce
(3) ATP is used	ATP is product
(4) Light is necessary	Light is not necessary
(5) Takes place in the stroma of chloroplast	Take place in the matrix of mitochondria

(AL 2005)

7. Which of the following biochemical processes require/requires ATP?
   (A)Conversion of glucose to pyruvic acid in glycolysis.
   (B) Photolysis of water in photosynthesis.
   (C) Absorption of K+ into root hair cells from soil solution.
   (D) Diffusion of O_2 into living cells through cell membrane.
   (E) Transport of water in plant body. (AL 2007)
8. Which of the following statement is incorrect regarding respiration'?
   1) Glycolysis produces more ATP under aerobic conditions than under anaerobic conditions.
   2) Growth rate of yeast under aerobic conditions is higher than that under anaerobic conditions.
   3) Glycolysis of muscle cells under aerobic conditions does not yield lactic acid.
   4) The net ATP production during aerobic respiration of glucose is less than 32 molecules per molecule of glucose in some cells.
   5) Carbohydrates, lipids and proteins can act as respiratory substrates in aerobic respiration (AL 2008)