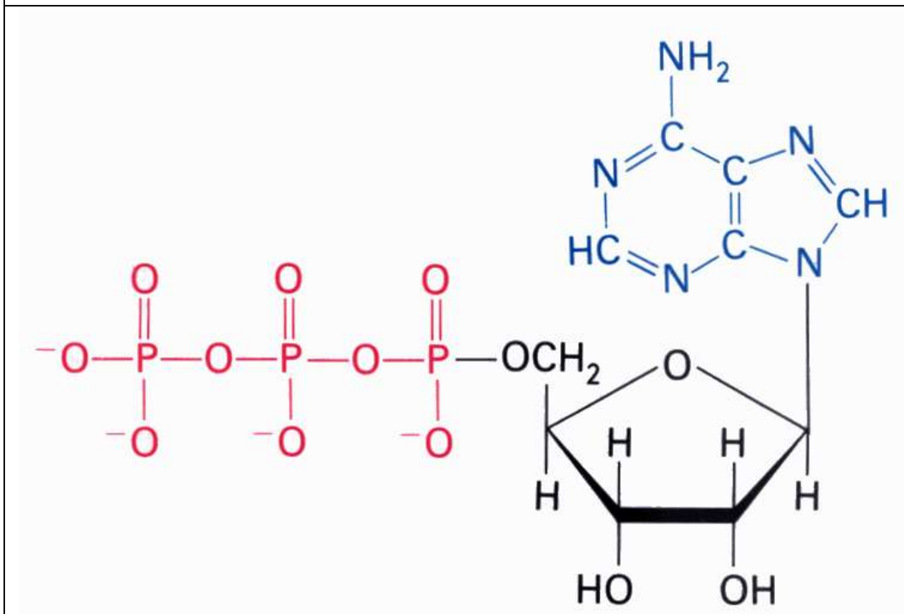
Energy and respiration

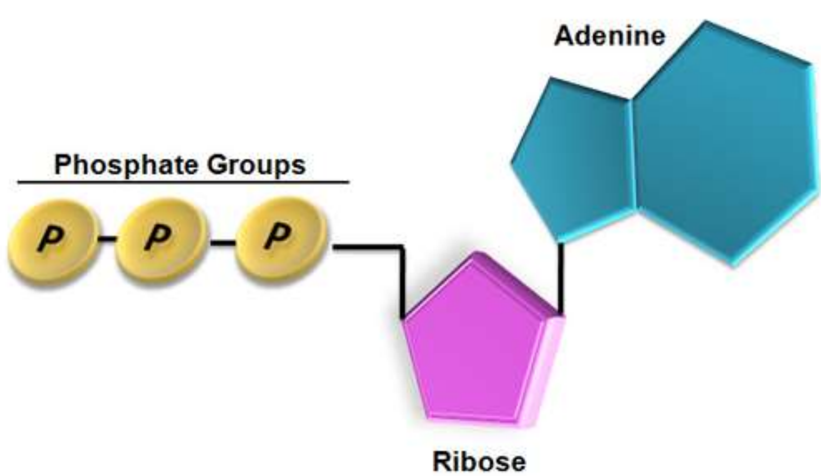
Energy in living organisms

ATP

- **Adenosine triphosphate.**

• a double phosphorylated nucleotide
• Circle nucleotide in the diagram below
• has a similar structure to the nucleotides that make up RNA. However, it has ______ phosphate groups attached to it instead of one.





- ATP is used as the energy currency in every living cell.
- Upon hydrolysis releases 35.5 Kj of energy
- Small molecule
- Water soluble
- Found in all living things
- Single step hydrolysis
- Energy released during hydrolysis used for living activities of a cell
- Energy released during respiration can be used to make ATP again

ADP +P --------------→ATP

Cells use energy for many different purposes. These include:

- Synthetic processes.
- Name a synthetic process

- Active transport of ions and molecules
- State Active transport, and name two ions and a molecule transported by active transport

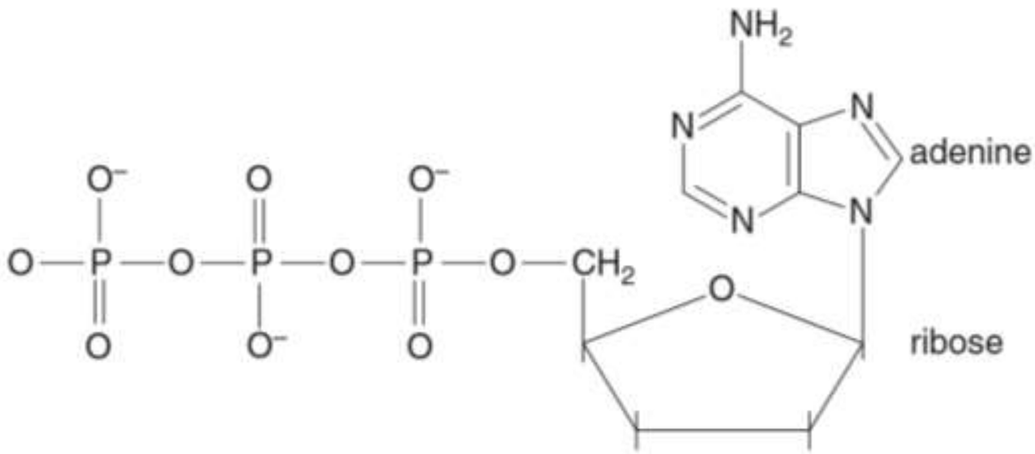
1.
2.
3.

- For the transmission of nerve impulses
- Describe the use of ATP in transmission of nerve impulses

- For muscle contraction
- Describe the use of ATP in transmission of nerve impulses

- Maintenance of body temperature

Structure of ATP



Name the sugar found in ATP
Name the nitrogen base found in ATP
State the number of phosphate groups found in ATP
State the amount of energy released in KJ when first, second and third phosphate group is removed by hydrolysis.
State hydrolysis of ATP
Draw structure of an ATP molecule below

Question 1

Describe the structure and synthesis of ATP and its universal role as the energy currency in all living organisms. [8]

Q9(b); 9700/41/O/N/09

1. nucleotide ;
2. adenine + ribose / pentose + three phosphates ;
3. loss of phosphate leads to energy release / hydrolysis releases 30.5 kJ ;
4. ADP + Pi ↔ ATP (reversible reaction) ;
5. synthesised during, glycolysis / Krebs cycle / substrate level phosphorylation ;
6. synthesised, using electron carriers / oxidative phosphorylation / photophosphorylation;
7. in, mitochondria / chloroplasts ;
8. ATP synthase / ATP synthetase ;
9. chemiosmosis / description;
10. used by cells as immediate energy donor ;
11. link between energy yielding and energy requiring reactions / AW ;
12. active transport / muscle contraction / Calvin cycle / protein synthesis ;

Your Answer here below

USES OF ATP

Question 2

Explain the role of ATP in active transport of ions and in named anabolic reactions. [7]

Q9(a); 9700/42/M/J/12

Active transport or anabolic reactions

1. ATP provides energy (linked to either) ;   ignore ref. to energy currency alone
   active transport
2. movement against concentration gradient ;
3. carrier / transport, protein (in membrane) ;   ignore pump
4. binds to (specific) ion ;
5. protein changes shape ;
   anabolic reactions
6. synthesis of complex substances from simpler ones ;
7. starch / cellulose / glycogen, from, monosaccharides / named monosaccharides / named sugar ;
8. glycosidic bonds ;
9. lipid / triglyceride, from fatty acids and glycerol ;
10. ester bonds ;
11. polypeptides / proteins, from amino acids ;
12. peptide bonds ;
13. other named polymer from suitable monomer ;
14. appropriate named bond ;   [7 max]

Your Answer here below

Respiration

Summary Of Respiration

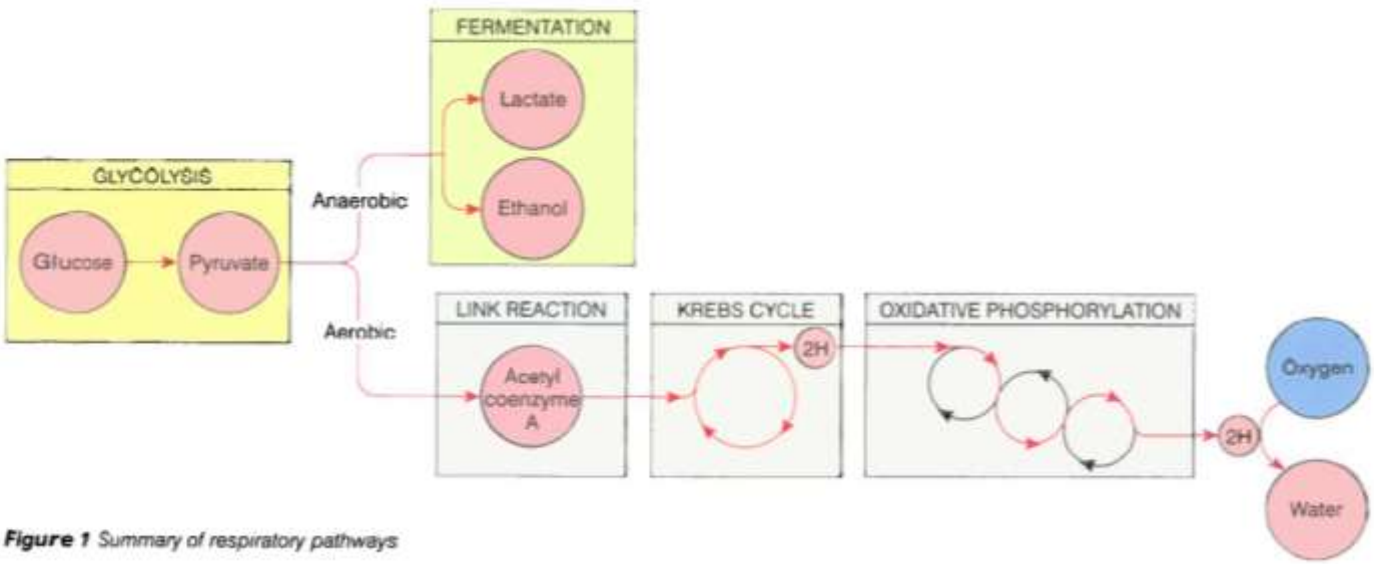


Figure 1 *Summary of respiratory pathways*

- Respiration is the oxidation of energy-containing organic molecules, such as glucose. These are known as respiratory substrates. The energy released from this process is used to combine ADP with inorganic phosphate to make ATP.

Definition
A process which transfers energy from complex organic substances to ATP

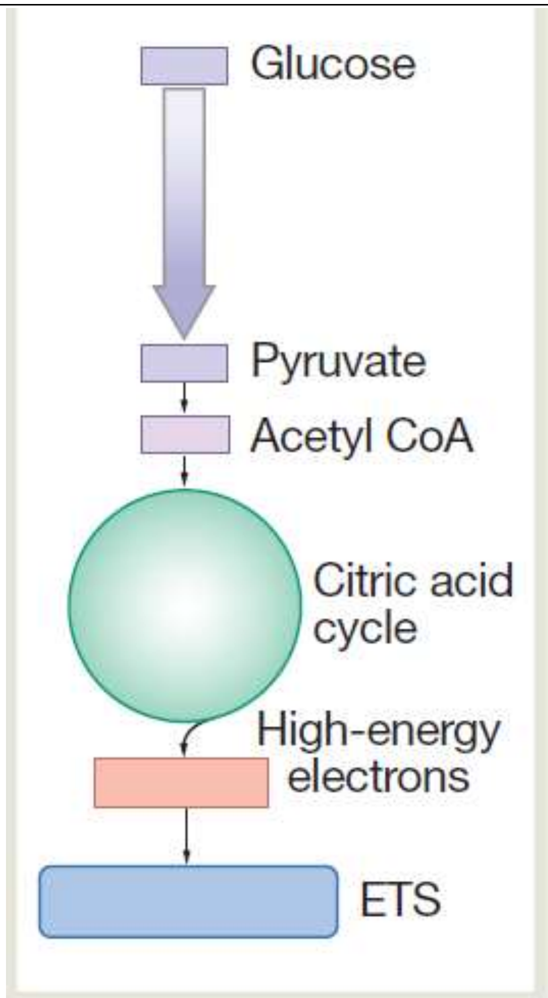
- Respiration may be aerobic or anaerobic.
- Tick the correct choice in each column to compare Aerobic and Anaerobic Respiration

Feature	Aerobic	Anaerobic
Oxygen	Used/Not Used	Used/Not Used
Energy released	More/Less	More/Less
Oxidation of glucose	Complete/Partial	Complete/Partial

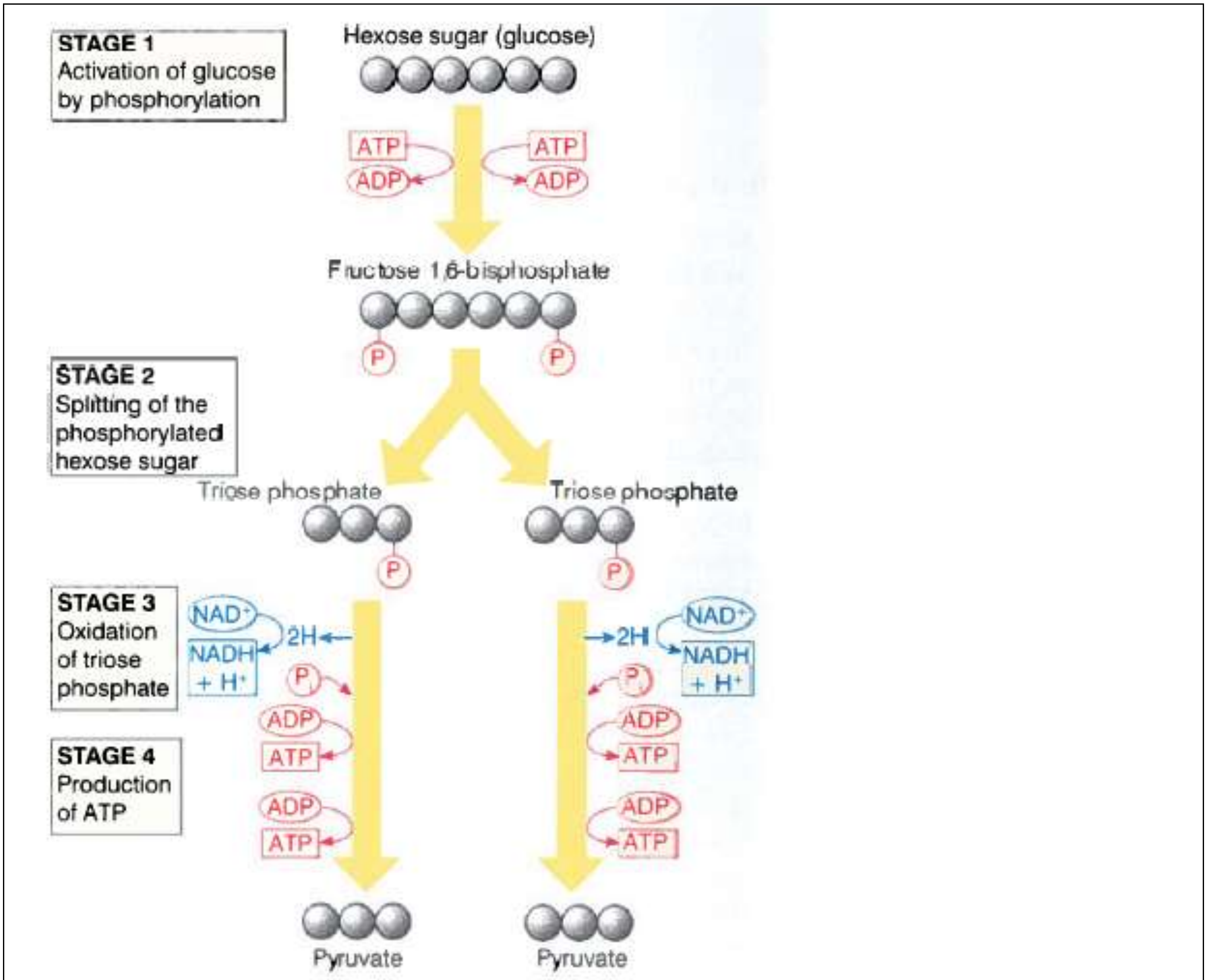
Coenzymes

- Respiration involves coenzymes called NAD and FAD.
- A coenzyme is a molecule required for an enzyme to be able to catalyse a reaction.
- These coenzymes are reduced during respiration.
- The term ‘reduce’ means to add hydrogen, so reduced NAD has had hydrogen added to it.

Aerobic Respiration

A series of reactions divided into following stages
Define Aerobic Respiration
State main steps involved in Aerobic Respiration


Glycolysis



Define Glycolysis
State where does glycolysis take place in a cell
State the number of stages, glycolysis is divided into
Name the initial substrate used in glycolysis
Name the products of glycolysis.

Glycolysis is the first stage of respiration. It takes place in the cytoplasm.

• Stage 1	
	Name the stage 1
	State the ATP molecules used during Stage 1
	State the importance of this stage
	Name the molecule produced at the end of Stage 1
• A glucose (or other hexose sugar) molecule is phosphrylated, as two ATPs donate phosphate to it.	
• Stage 2	
	Name the stage 2
	Describe the process of Stage 2
	Name the molecule made at the end of stage 2
	State the number of carbon in each molecule made at the end of stage 2
• This produces a hexose bisphosphate molecule, which splits into two triose phosphate molecules.	
• Stage 3	
	Name the process that takes place in stage 3
	Define Oxidation
	Define dehydrogenation
	Describe the role of NAD in this step
• Each triose phosphate is converted to a pyruvate molecule. This involves the removal of hydrogens, which are taken up by the coenzyme NAD. The removal of hydrogens is an oxidation reaction. It can also be referred to as dehydrogenation. This produces reduced NAD. During this step, the phosphate groups from the triose phosphates are added to ADP to produce a small yield of ATP.	
• Stage 4	
	Describe substrate level phosphorylation
• Overall, two molecules of ATP are used and four are made during glycolysis of one glucose molecule, making a net gain of two ATPs per glucose.	
	State the total number of ATP made at the end of Glycolysis
	State the Net number of ATP made at the end of Glycolysis
	Sate the number of ATP used during glycolysis

GLYCOLYSIS

Question 5

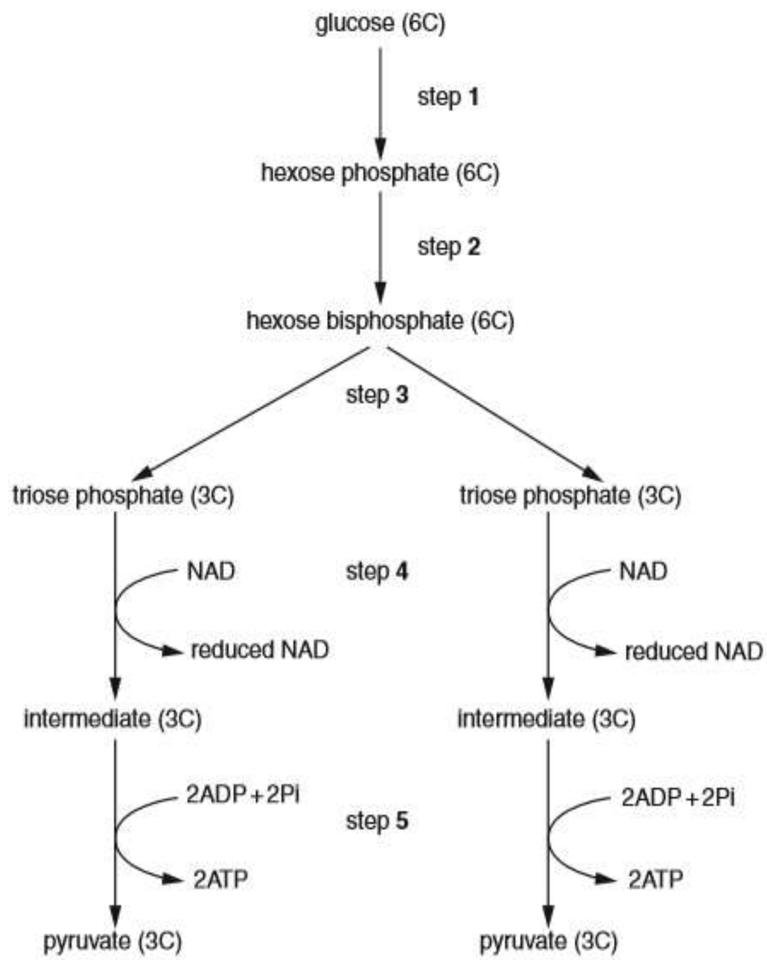
Outline the process of glycolysis. [6]

Q9(a); 9700/42/M/J/16

1. (glucose) phosphorylated by ATP ;
2. raises energy level / overcomes activation energy ;
3. hexose bisphosphate ;
4. lysis / splitting, of, glucose / hexose ; R sugar splitting
5. breaks down to two TP ; A GALP / GADP / G3P / PGAL
6. 6C $\rightarrow$ 2 x 3C ;
7. dehydrogenation / description ;
8. 2 NAD reduced formed (from each TP to pyruvate formed) ;
9. 4 ATP produced / net gain of 2 ATP ;
10. pyruvate produced ;
11. reduced NAD $\rightarrow$ oxidative phosphorylation / redox ; accept flow diagram

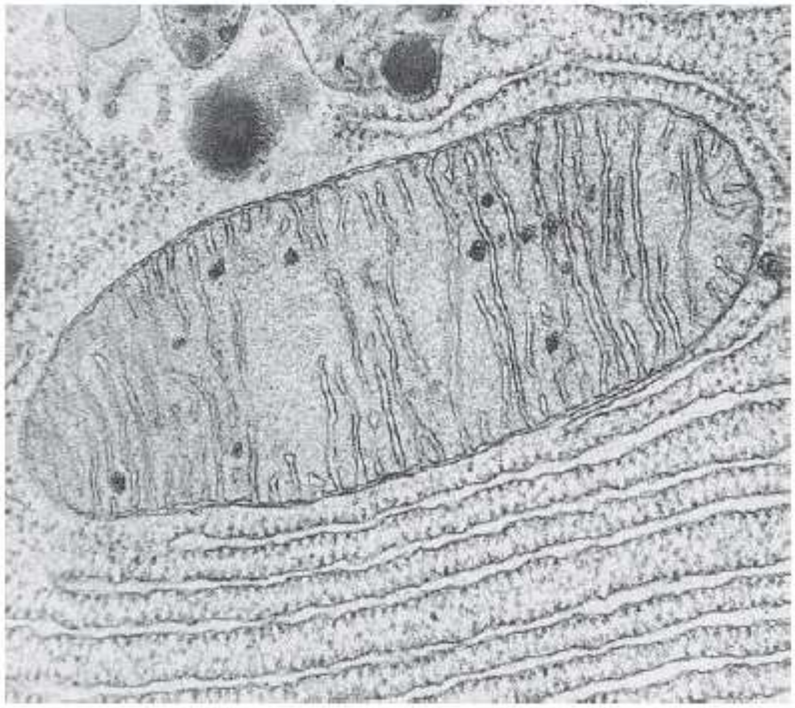
Your Answer here below

Glycolyis



Name each step on the flow diagram	
Where ATP is used	
Where dehydrogenation occurs	
Name Coenzyme involved in this process	
State the role of NAD as a coenzyme	

A mitochondrion



Draw a mitochondrion below

MITOCHONDRIAL STRUCTURE AND FUNCTIONS

Describe how the structure of a mitochondrion is related to its function. [8]

Q9(a); 9700/42/O/N/17© UCLES 2017

eight from:

1 double membrane ;

inner membrane

2 folded / cristae ;

3 increased / large, surface area ;

4 has, ATP synthase / stalked particles ;

5 has, carrier (proteins) / cytochromes ;

6 (site of) ETC / oxidative phosphorylation / chemiosmosis ;

intermembrane space

7 has low pH / high concentration of protons ;

8 accepts protons from ETC / AW ;

9 proton gradient between intermembrane space and matrix or protons move from intermembrane space to matrix ;

10 ref. to ATP synthesis ;

matrix

11 contains enzymes ;

12 site of, link reaction / the Krebs cycle ;

outer membrane

13 presence of carriers for, pyruvate / reduced NAD ;

14 AVP ; e.g. ribosomes / DNA, plus function [8]

Suggest the functions of the DNA and ribosomes in a mitochondrion.[3]

Q8(a); 9700/43/M/J/14

(DNA for) transcription/codes for mRNA ;

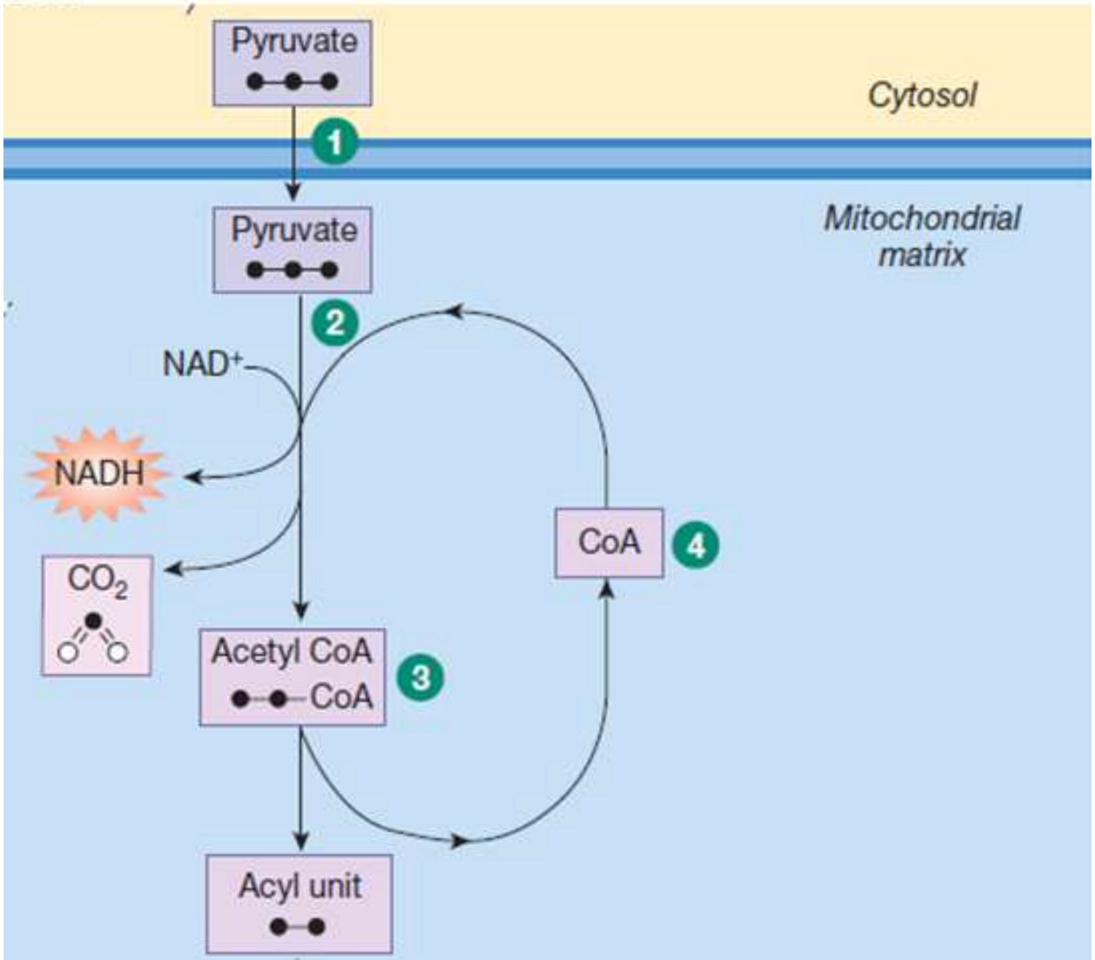
(ribosomes for) translation ;

synthesis of, respiratory enzymes/named enzyme/inner membrane proteins ;

[max 3]

Your Answer

The link reaction



Outline the process of link reaction

1.	**.**
2.	**.**
3.	**.**
4.	**.**

The overall reaction of link reaction

$$\text{pyruvate} + NAD^{+} + \text{CoA} \rightarrow \text{acetyl CoA} + \text{reduced NAD} + CO_2$$

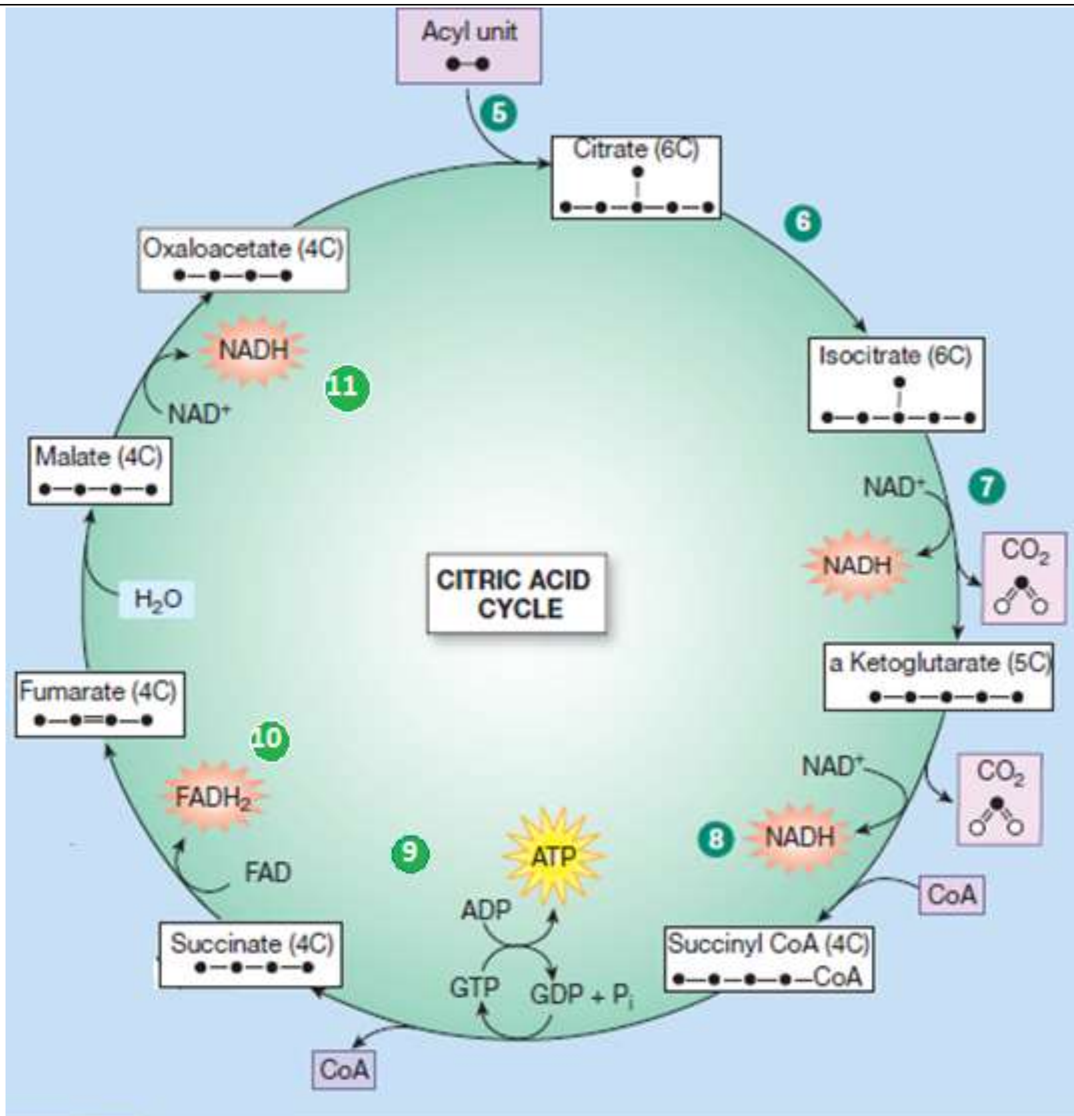
If oxygen is available, each pyruvate now moves into a mitochondrion, where the link reaction and the krebs cycle take place. During these processes, the glucose is completely oxidized.

Link reaction involves

1. decarboxylation of pyruvate by pyruvate decarboxylase enzyme which produces a two carbon molecule Acetyl which combines with Coenzyme A to make Acetyle Co.A
2. oxidation of pyruvate by dehydrogenase enzyme which reduces NAD to NADH

Define Decarboxylation
Define Oxidation
Name coenzymes involved in this step
Name the products of link reaction
Is there any ATP made during this step
State where link reaction occurs in eukaryotic cells
State the reason why link reaction and krebs cycle do not take place in prokaryotic cells.
Explain when oxygen is available only then link reaction takes place

The Krebs Cycle



Outline the Krebs's cycle

5. .
6. .
7. .
8. .
9. .
10. .
11. .

Acetyl coenzyme A has two carbon atoms. It combines with a four-carbon compound called oxaloacetate to produce a six-carbon compound, citrate. The citrate is gradually converted to the four-carbon compound again through a series of enzyme-controlled steps. These steps all take place in the matrix of the mitochondrion, and each is controlled by specific enzymes.

During this process:

- More carbon dioxide is released (decarboxylation) and diffuses out of the mitochondrion and out of the cell.
- More hydrogens are released (dehydrogenation) and picked up by NAD and another coenzyme called FAD. This produces reduced NAD and reduced FAD.

• Put D on the Krebs cycle where decarboxylation occurs
• State the number of carbondioxide molecules made during krebs cycle for one glucose.
• Put N where NAD is reduced on the cycle
• Put F where FAD is reduced on the cycle

Question 6

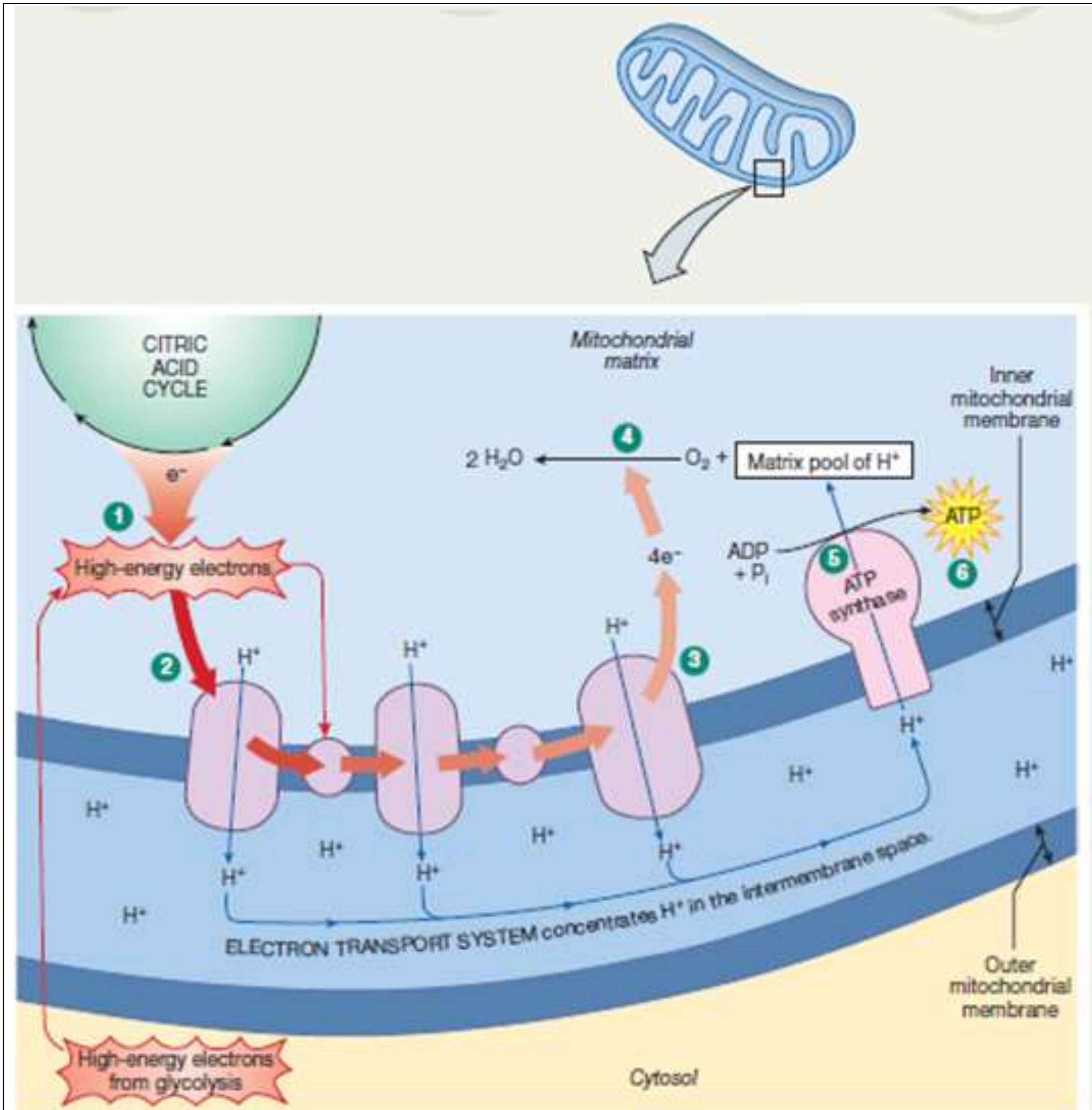
Outline the main features of the Krebs cycle. [9]

Q9(a); 9700/42/O/N/09

1. acetyl CoA combines with oxaloacetate ;
2. to form citrate ;
3. 4C to 6C ;
4. decarboxylation / CO2 released ;
5. dehydrogenation / oxidation / release of hydrogen ;
6. reduced NAD produced / NAD accepts hydrogen ;
7. reduced FAD produced / FAD accepts hydrogen ;
8. ATP produced ;
9. substrate level phosphorylation ;
10. series of, steps / intermediates ;   A many named steps off a diagram
11. enzyme catalysed reactions ;
12. oxaloacaetate regenerated ;
13. occurs in mitochondrial matrix ; accept diagram

your Answer here below

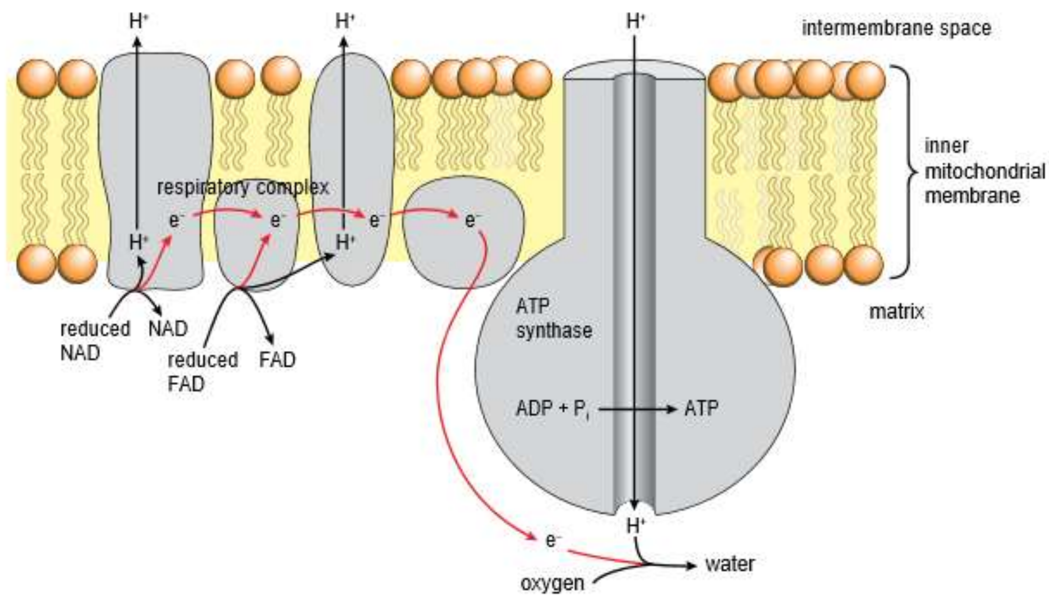
Oxidative phosphorylation



Outline oxidative phosphorylation

1.	**.**
2.	**.**
3.	**.**
4.	**.**
5.	**.**
6.	**.**

- NADH and FADH bind with receptors on ETC
- The hydrogen picked up by NAD and FAD are now split into electrons and protons.
- The electrons are passed along the electron transport chain, on the inner membrane of the mitochondrion.
- As the electrons move along the chain, they lose energy. This energy is used to actively transport hydrogen ions from the matrix of the mitochondrion, across the inner membrane and into the space between the inner and outer membranes. This builds up a high concentration of hydrogen ions in the intermembrane space
- The hydrogen ions are allowed to diffuse back into the matrix through special channel proteins that work as ATP synthases. The movement of the hydrogen ions through the ATP synthases provides enough energy to cause ADP and inorganic phosphate to combine to make ATP.
- At the end of the chain, the electrons reunite with the protons from which they they were originally split. They combine with oxygen to produce water. This is why oxygen is required in aerobic respiration – it acts as the final acceptor for the hydrogens removed from the respiratory substrate during glycolysis, the link reaction and the Krb's cycle.



Name the substances where the H is removed from during Oxidative phosphorylation
State what happens to H removed from NADH and FADH during this process
State what happens to the Hydrogen ions during this process
State what happens to e during the process
State metabolic water
State the role of oxygen in oxidative phosphorylation
State the number of ATP made when one NADH is oxidized to NAD

Question 7

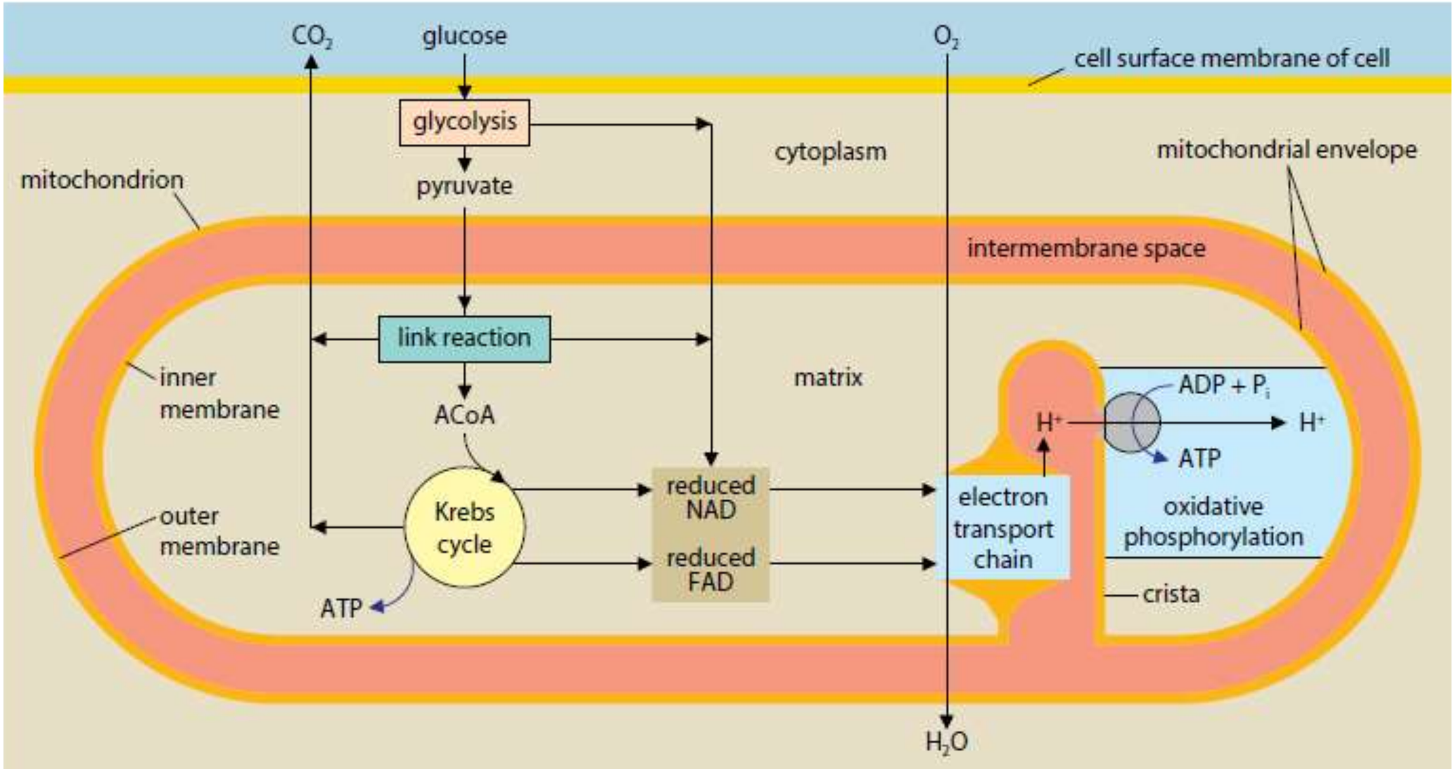
Outline how ATP is synthesized by oxidative phosphorylation. [8]

Q9(a); 9700/43/M/J/16

accept proton/hydrogen ion/H+ /H ion as equivalent throughout

1. reduced, NAD/FAD ; A NADH/NADH2/NADH + H+ for reduced NAD
2. passed to ETC ;
3. inner membrane /cristae ;
4. hydrogen released (from reduced, NAD/FAD) ; R H_2
5. split into electrons and protons ; A released as electron and proton
6. electrons pass along, carriers / cytochromes ; A electrons pass along proteins of, ETC / carrier chain
7. energy released pumps protons into intermembrane space ;
8. proton gradient is set up ; A concentration gradient of protons is created A full description
9. protons diffuse, (back) through membrane / down gradient ; A protons diffuse into matrix
10. ATP synthase / stalked particles / protein channels ; A ATP Synthetase R ATPase
11. (ATP produced from) ADP and (inorganic) phosphate ; A context for 'final'
12. idea of oxygen as final electron acceptor ;
13. addition of proton (to oxygen) to form water / (oxygen) reduced to water ; [max 8]

Your Answer here below



Write a summary of the processes shown in this diagram

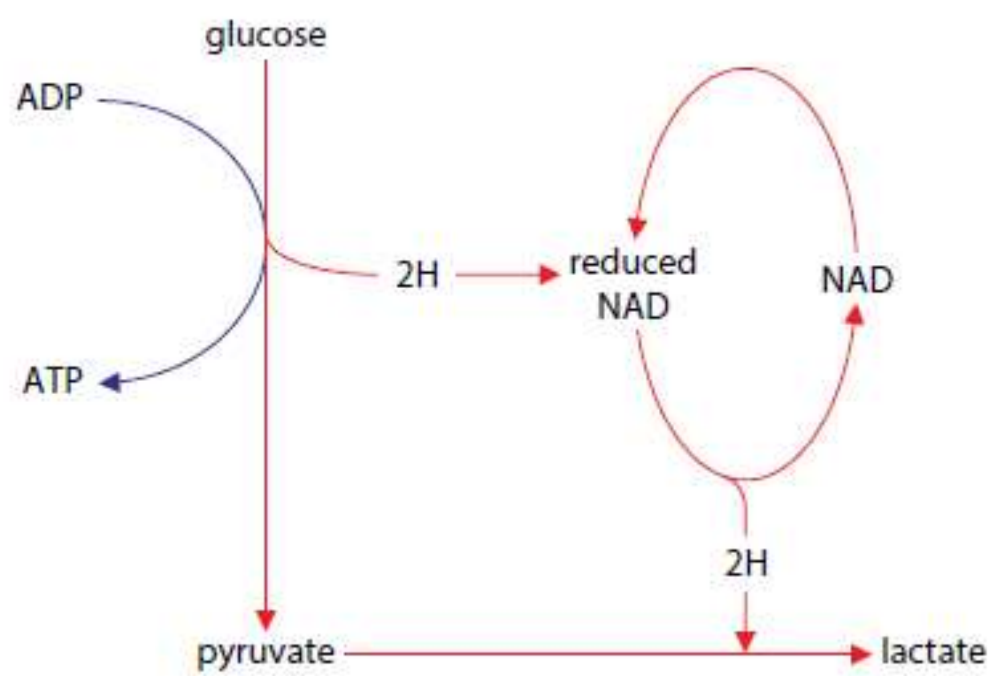
Anaerobic respiration

If oxygen which is final electron acceptor is not available, oxidative phosphorylation cannot take place, as there is no oxygen to accept the electrons and protons at the end of the electron transport chain. This means that reduced NAD is not reoxidised, so the mitochondrion quickly runs out of NAD or FAD that can accept hydrogens from the Krebs Cycle reactions. The Krebs Cycle and the link reaction therefore come to halt.

Glycolysis, however, can still continue, so long as the pyruvate produced at the end of it can be removed and the reduced NAD can be converted back to NAD.

The lactate pathway

In mammals, the pyruvate is removed by converting it to lactate.

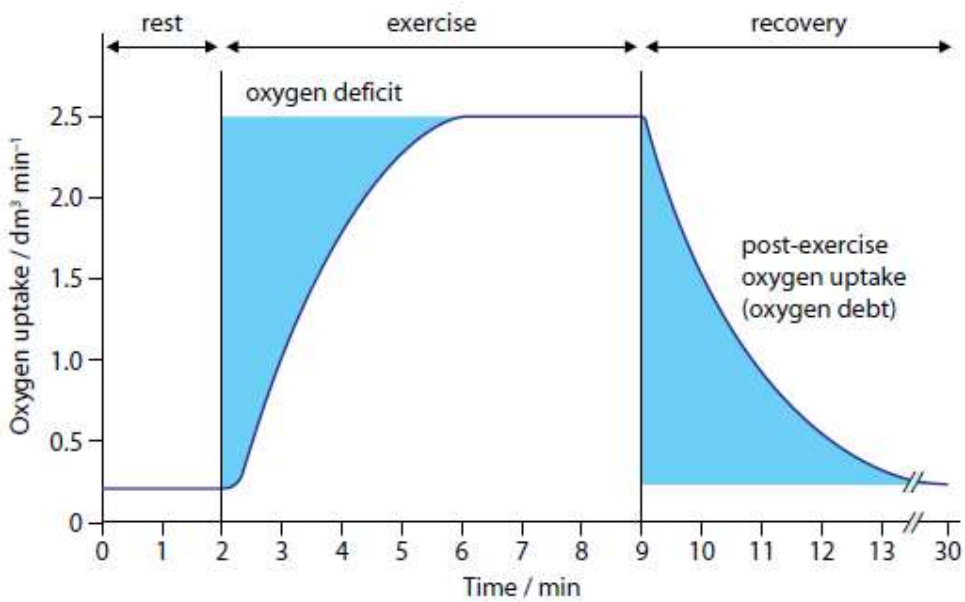


The lactate pathway

Oxygen Debt

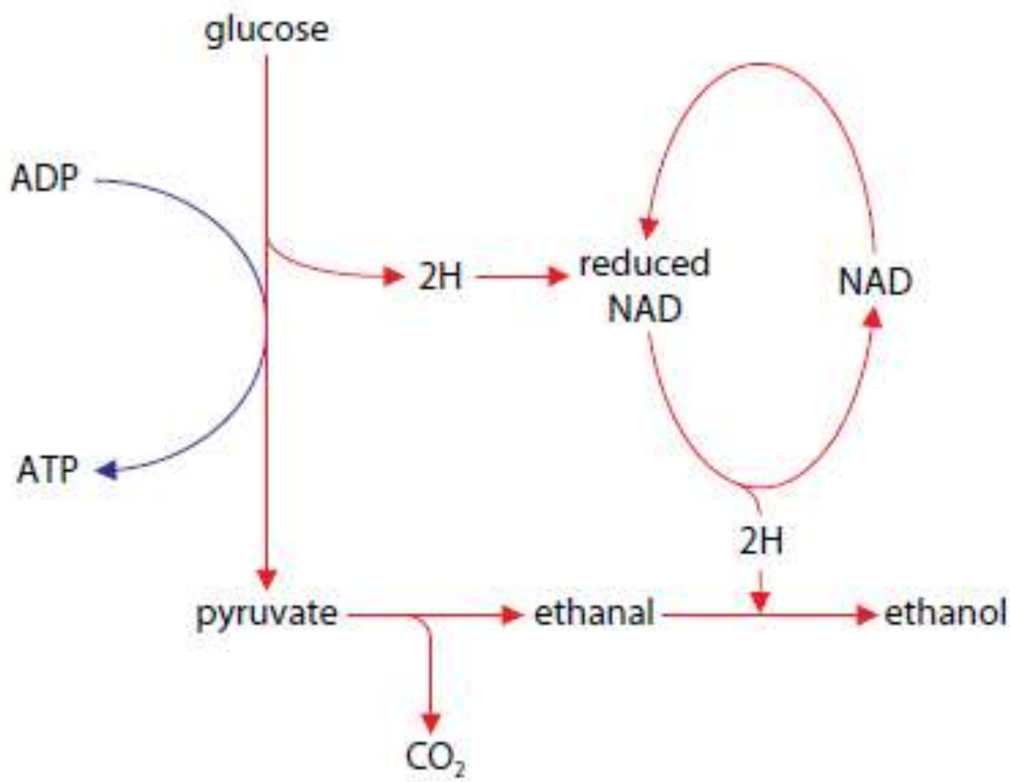
The lactate that is produced (usually in muscles) diffuses into the blood and is carried in solution in the blood plasma to liver. Here liver cells convert it back to pyruvate. This requires oxygen, so extra oxygen is required after exercise has finished. The extra oxygen is known as the oxygen debt. Later, when the exercise has finished and

Oxygen is available again, some of the pyruvate in the liver cells is oxidized through the link reaction, the Krebs cycle and the electron transport chain. Some of the pyruvate is reconverted to glucose in the liver cells. The glucose may be released into the blood or converted to glycogen and stored.



Define oxygen debt	
State oxygen uptake during rest	
State oxygen uptake during exercise	
State demand of oxygen during exercise	
State oxygen debt	

The ethanol pathway
In yeast and in plants, the pyruvate is removed by converting it to ethanol.



The ethanol pathway

Differences

Feature	**Acidic fermentation**	**Alcoholic fermentation**
Decarboxylation		
Single step		
Reversible		
Cell in which occurs		

RESPIRATION WITHOUT OXYGEN

Question 8

Describe respiration in yeast cells in anaerobic conditions. [7]

Q9(b); 9700/41/M/J/16

1. pyruvate formed by glycolysis ;
2. reduced NAD formed by glycolysis ;
3. pyruvate decarboxylated / AW ;
4. ethanal produced ;
5. pyruvate decarboxylase ;
6. ethanal is, hydrogen acceptor / reduced ; A gains H or gains H^+ and e^-
7. from / by, reduced NAD ;
8. ethanol formed ;
9. ethanol / alcohol, dehydrogenase ;
10. not reversible reaction ;
11. NAD, regenerated / can now accept hydrogen atoms ; A reduced NAD oxidised
12. so glycolysis can continue ; [max 7]

your answer

Question 9

Describe respiration in anaerobic conditions in mammalian muscle cells and describe how this differs in yeast cells. [7]

Q9(b); 9700/42/O/N/17

seven from:

liver cells (max 6)

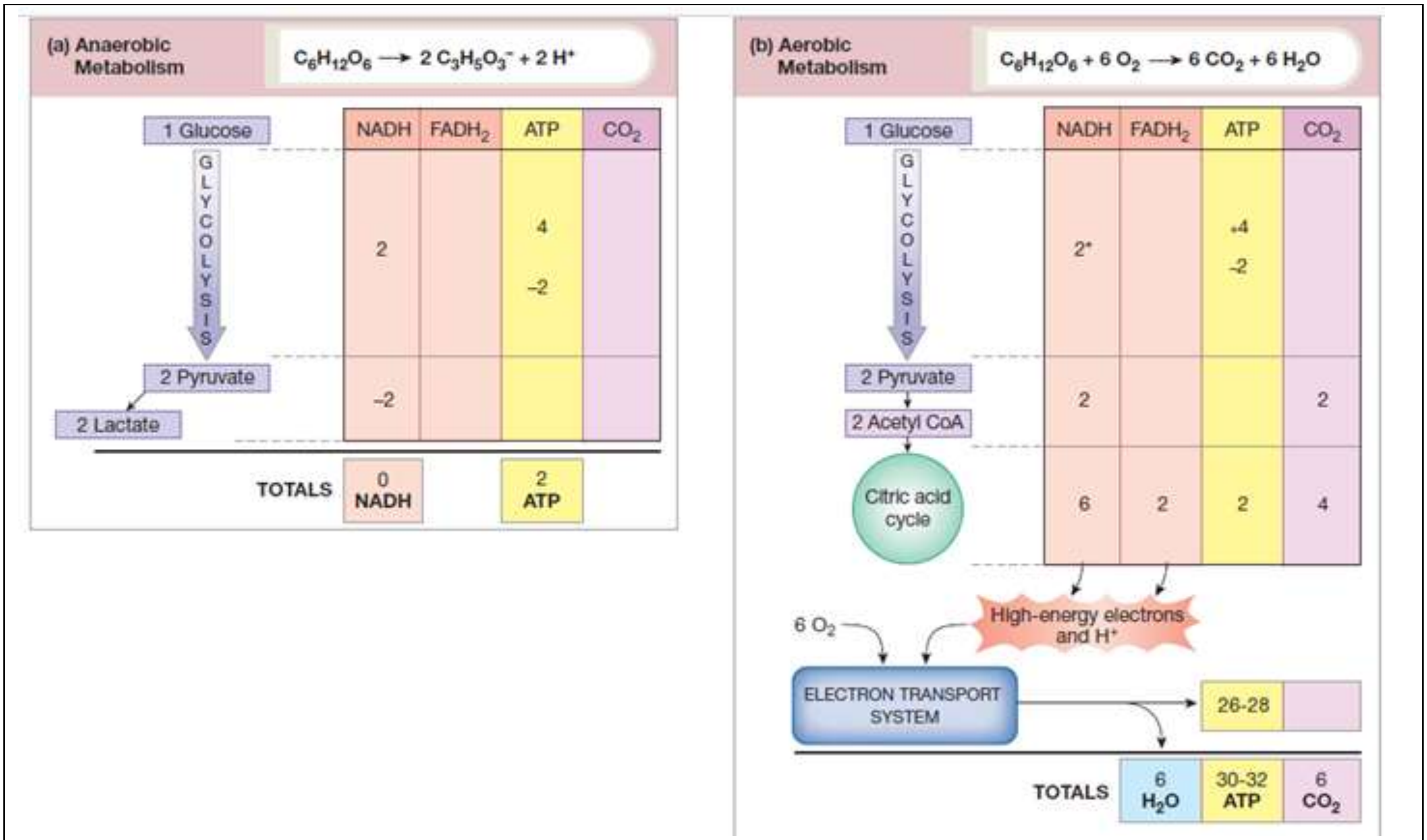
1. only glycolysis occurs ;
2. pyruvate, cannot enter mitochondrion / remains in the cytoplasm ;
3. (pyruvate) becomes, hydrogen acceptor / reduced ;
4. by reduced NAD (from glycolysis) ;
5. lactate produced ;
6. lactate dehydrogenase ;
7. production of, 4 ATP / 2 ATP / small amount of ATP ;
8. allows glycolysis to continue ;

yeast cells

9. decarboxylation / CO2 removed ;
10. ethanal becomes, hydrogen acceptor / reduced ;
11. two steps (instead of one) ;
12. irreversible reaction (instead of reversible) ;
13. ethanol dehydrogenase ;
14. ethanol produced ;

Your Answer

ATP yield in aerobic and anaerobic respiration



Describe why only very small amounts of ATP are produced during anaerobic respiration
Only small amounts of ATP are produced when one glucose molecule undergoes anaerobic respiration. This is because only glycolysis is completed. The glucose molecule is partially oxidized during anaerobic respiration. The Krebs cycle and oxidative phosphorylation, which produce most ATP, do not take place.
The precise number of molecules of ATP produced in aerobic respiration of one glucose molecule varies between different organisms and different cells, but is usually between 30 and 32 molecules.

	ATP used	ATP made	Net gain in ATP
glycolysis	–2	4	+2
link reaction	0	0	0
Krebs cycle	0	2	+2
oxidative phosphorylation	0	28	+28
Total	**–2**	**34**	**+32**

Calculate percentage efficiency of both aerobic and anaerobic respiration

Aerobic respiration

30.5 X 32/2870 *100 33.0 %

Anaerobic respiration

30.5 X 2 /2870 *100 2.0 %

Respiratory substrates

Glucose is not the only respiratory substrate. All carbohydrates, lipids and proteins can also be used as respiratory substrates.

Energy values of different respiratory substrates

Respiratory substrate	Energy released/KJg^{-1}
Carbohydrate	16
Lipid	39
Protein	17

You can see that lipid provides more than twice as much energy per gram as carbohydrate or protein. This is because a lipid molecule contains relatively more hydrogen atoms (in comparison with carbon or oxygen atoms) than carbohydrate or protein molecules do. You have seen that it is hydrogen atoms that are used to generate ATP via the electron transport chain.

Many cells in the human body are able to use a range of different respiratory substrates. However, brain cells can only use glucose. Heart muscles preferentially use fatty acids.

RESPIRATORY SUBSTRATES

Question 10

Explain the different energy values of carbohydrate, lipid and protein as respiratory substrates. [6]

Q10(b); 9700/41/O/N/10

1. idea of lipid > protein > carbohydrate / AW ; A lipid has more energy than either protein or carbohydrate
2. comparative figures ; e.g. 39.4, 17.0 and 15.8 accept any two kJ g-1 / per unit mass ;
3. more hydrogen atoms in molecule, more energy ;
4. lipid have more, hydrogen atoms / C-H bonds ;
5. (most) energy comes from oxidation of hydrogen to water ;
6. using reduced, NAD / FAD ;
7. in ETC ;
8. detail of ETC ;
9. ATP production

[6 max]

Your Answer

Respiratory quotients

It is possible to get a good idea of which respiratory substrate the cells in an organism are using by measuring the volume of oxygen it is taking in and the volume of carbon dioxide it is giving out.

The respiratory quotient, RQ is $\frac{\text{Volume of } CO_2 \text{ given out}}{\text{voluem of } O_2 \text{taken in}}$

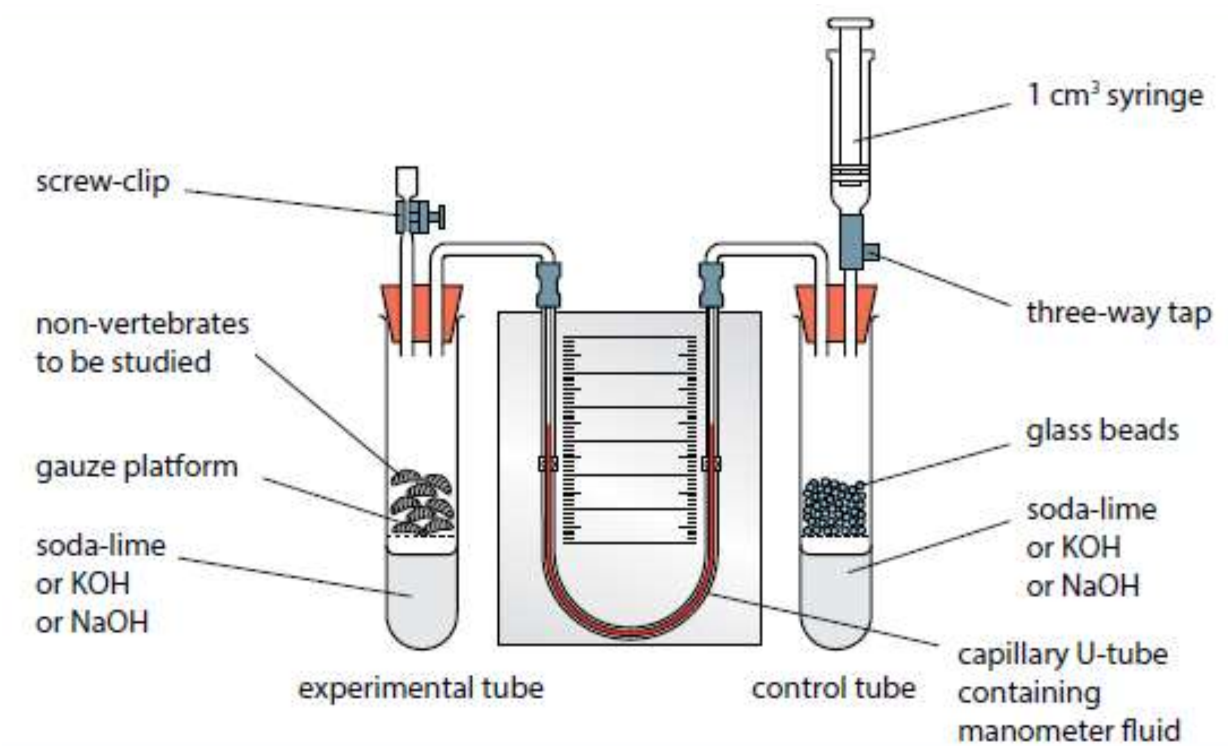
RQs for different substrates undergoing aerobic respiration

Respiratory substrate	**RQ**
Carbohydrate	1.0
Lipid	0.7
Protein	0.9

The values in the table are for aerobic respiration. If a cell or an organism is respiring anaerobically, then no oxygen is being used. The RQ is therefore infinity (∞).

Using respirometers

There are various different types of respirometer. One type is shown in the diagram.



Using a respirometer to measure the rate of uptake of oxygen

- The organism to be investigated are paced in one tube, and non-living material of the same mass in the other tube.
- Soda lime is placed in each tube, to absorb all carbon dioxide. Cotton wool prevents contact of the Soda lime with the organisms.
- Coloured fluid is poured into the reservoir of each manometer and allowed to flow into the capillary tube. It is essential that there are not air bubbles. You must end up with exactly the same quantity of fluid in the two manometers.
- Two rubber bungs are now taken, fitted with tubes as shown in the diagram. Close the spring clips. Attach the manometers to the bent glass tubing, ensuring an airtight connection. Next, place the bungs into the tops of the tubes.
- Open the screw clips. (this allows the pressure throughout the apparatus to equilibrate with atmospheric pressure). Note the level of the manometer fluid in each tube. Close the clips. Each minute, record the level of the fluid in each tube.
- As the organism respire, they take oxygen from the air around them and give out carbon dioxide. The removal of oxygen from the air inside the tube reduces the volume and pressure, causing the manometer fluid to move towards the organisms. The carbon dioxide given out is absorbed by the soda lime. The distance moved by the fluid is therefore affected only by the oxygen taken up and not by the carbon dioxide given out.

- You would not expect the manometer fluid in the tube with no organisms to move. But it may do so because of temperature changes. This allows you to control for this variable, by subtracting the distance moved by the fluid in the control manometer from the distance moved in the experimental manometer (connected to the living organisms), to give you an adjusted distance moved.
- Calculate the mean (adjusted) distance moved by the manometer fluid per minute. If you know the diameter of the capillary tube, you can convert the distance moved to volume:
- Volume of liquid = length × πr^2
  This gives you a value for the volume of oxygen absorbed by the organisms per minute.

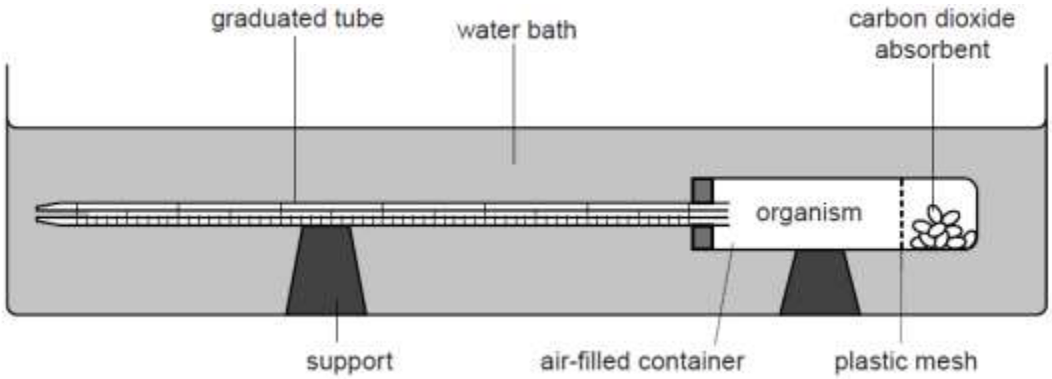
Question 11 Paper 5 question

A student used the respirometer shown in Fig. 1.1 to compare the rate of respiration in:

• germinating seeds

• insect larvae

• single celled green algae living in water.



After putting the germinating seeds into the air-filled container and attaching the graduated tube, the respirometer was lowered into a water bath. The seeds respired using oxygen and water moved into the graduated tube. The procedure was repeated for the other two organisms.

(a) (i) Suggest a hypothesis about the respiration of the different organisms that the student could test using this apparatus.

.... [1]

(ii) Identify the independent and dependent variables in this investigation.

independent variable ....

....

dependent variable

....

.... [2]

(iii) Describe a method, using the respirometer in Fig. 1.1, that the student could use to compare the rates of respiration of germinating seeds, insect larvae and a single celled green algae living in water.

Your method should be detailed enough for another person to use.

Your Answer

8 marks

(b) The student calculated the rate of respiration as oxygen used per unit mass of the organisms. Explain how this rate of respiration was calculated.

....

....

....

....

....

.... [3]

(c) The student determined the respiratory quotient (RQ) for each of the organisms. To do this the student needed to measure the rate of carbon dioxide production.

Outline how the student should use the respirometer to find the rate of carbon dioxide production.

....

....

....

....

....

.... [2]

(d) Table 1.1 shows the student's results.

	mean volume of oxygen used per unit mass per unit time	mean volume of carbon dioxide produced per unit mass per unit time	RQ
germinating seeds	0.74	0.53	0.72
insect larvae	1.23	0.98	
single-celled green algae	0.35	0.34	

(i) Complete Table 1.1 by writing in the RQ values for the insect larvae and the single celled green algae.

(ii) With reference to the RQ values in Table 1.1, what conclusions can be drawn about the type of substrate respired by each of the organisms tested?

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.... [3]

[Total 20]

Using a respirometer to investigate the effect of temperature on the rate of respiration

1 (a) Fig. 1.1 shows a simple respirometer that can be used to measure the rate of respiration by measuring oxygen uptake.

For Examiner's Use

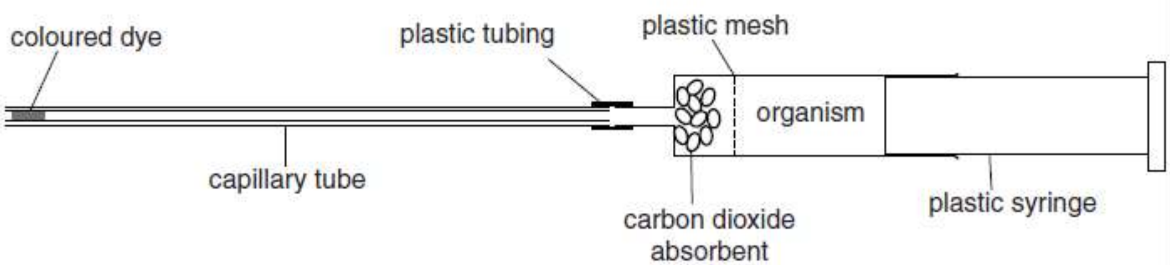

Fig. 1.1

A student used this apparatus to test the hypothesis:

The rate of respiration will double for every 10 °C rise in temperature.

(i) Identify the independent and dependent variables in this investigation.

independent variable ....

....

....

dependent variable..

.... [2]

(ii) Sketch a graph to show the expected results **if the student's hypothesis is correct**.

[2]

(iii) Describe how the student could use the apparatus in Fig. 1.1 to test this hypothesis using germinating seeds.

Your method should be detailed enough for another person to use.

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For Examiner's Use

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.... [8]

For Examiner's Use

(b) The student calculated the rate of respiration as volume of oxygen taken up per unit mass of the germinating seeds.

Explain how this rate of respiration was calculated.

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.... [3]

(c) Outline how the student could use the apparatus in Fig. 1.1 to find the optimum temperature for respiration in the germinating seeds.

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.... [2]

(d) In a different investigation the student measured the effect of external temperature on the oxygen uptake of a small mammal.

Careful attention was paid to the welfare of the mammal during the investigation.

Table 1.1 shows the results of this investigation.

Table 1.1

environmental temperature / °C	oxygen uptake / arbitrary units				
	trial 1	trial 2	trial 3	trial 4	mean
5	52	36	48	45	45.3
10	42	32	35	36	36.3
15	35	25	29	24	28.3
20	28	15	17	22	20.5
25	17	10	11	9	11.8
30	14	11	13	10	12.0
35	12	10	11	11	11.0

For Examiner's Use

(i) State why the student decided that the results from trial 1 were anomalous.

....

....[1]

(ii) Suggest a reason for the cause of these anomalous results in trial 1.

....

....[1]

(iii) Suggest an explanation for the higher rates of oxygen uptake of the small mammal at the low temperatures.

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....[2]

[Total: 21]

Adaptations of rice for wet fields

- Can respond to flooding by growing taller; always has parts such as leaves and flowers above water
- Contains loosely packed aerenchyma cells in the cortex of stems (formed by cell death) allowing diffusion for oxygen to be transported easily to areas deprived
- Contains ridges to trap oxygen underwater
- Can tolerate high levels of ethanol
- Produce more alcohol dehydrogenase which breaks down ethanol
- Ethanol stimulates gibberellin, which in turn stimulates cell division hence increasing length

ADAPTATIONS OF RICE FOR WET ENVIRONMENT

Question

Explain how rice is adapted to growing in flooded fields. [8]

Q10(b); 9700/42/M/J/13

1. ethene (in plant);
2. stimulates production of gibberellin;
3. gibberellin stimulates, cell division / cell elongation / increase in stem length;
4. leaves / flowers, above water;
5. (so) photosynthesis can occur;
6. (so) sexual reproduction / pollination, can occur;
7. aerenchyma / description;
8. assists gas diffusion (within plant);
9. air can be trapped by specialised underwater leaves;
10. (submerged parts of plant) carry out anaerobic respiration;
11. produce ethanol;
12. can tolerate high concentrations of ethanol;
13. produce a lot of ethanol dehydrogenase; [8 max]

Your Answer

CS of stem and a leaf of a rice plant