Lesson Element

Aerobic and Anaerobic Respiration

Instructions and answers for teachers

These instructions cover the learner activity section which can be found on page 12. This Lesson Element supports OCR GCSE (9–1) Gateway Science Biology A and the Twenty First Century Science Biology B qualifications.

When distributing the activity section to the learners either as a printed copy or as a Word file you will need to remove the teacher instructions section.

Mapping to specification level (Learning outcomes)

GCSE (9–1) Gateway Science Biology A/Combined Science A

B1.3c compare the processes of aerobic respiration and anaerobic respiration

GCSE (9–1) Twenty First Century Science Biology B/Combined Science B

B4.1 What happens during cellular respiration?

B4.1.1 compare the processes of aerobic and anaerobic respiration, including conditions under which they occur, the inputs and outputs, and comparative yields of ATP

B4.1.2 explain why cellular respiration occurs continuously in all living cells

B4.1.3 explain how mitochondria in eukaryotic cells (plants and animals) are related to cellular respiration

B4.1.4 describe cellular respiration as an exothermic process

B4.1.5 a) describe practical investigations into the effect of different substrates on the rate of respiration in yeast

b) carry out rate calculations for chemical reactions in the context of cellular respiration

M1a, M1c

Introduction

This topic area addresses the differences between aerobic and anaerobic respiration along with differences in anaerobic respiration in animals and microorganisms. This is a topic that can prove difficult for learners as they often have a basic understanding of cellular respiration but with a number of misconceptions.

Learners can develop their understanding and enjoyment of the content through a number of fun activities.

A number of learners believe that respiration is breathing. This common misconception should be addressed early on by highlighting that 'ventilation' is breathing and respiration is the release of energy.

A common misconception is that anaerobic respiration in humans releases carbon dioxide. The activities included in this lesson element allow learners to discover that whilst this is true for yeast in alcohol fermentation and humans in aerobic respiration, the only product of anaerobic respiration in humans is lactate. It may be useful to ask the learners 'where does the carbon dioxide come from that is breathed out in anaerobic respiration?' This will allow learners to make the link to aerobic respiration that occurs prior to and following anaerobic respiration.

Supporting information

Task 1 – the learners could be asked to cut out and assemble or the teacher may prefer to save time during the activity and the teacher could pre-cut (and maybe laminate) the cards. To save paper learners could draw out the table in their books. The teacher may choose to demonstrate the practical investigation to the learners or allow them to work in small groups/pairs.

Learners can cut out the Task 1 cards and use them with the table provided. Here learners can place the cards into the aerobic respiration, anaerobic respiration or both columns.

Learners can then use the Task 1 cards with Tasks 2a, 2b and 2c to complete the equations for aerobic respiration, anaerobic respiration in microorganisms and anaerobic respiration in mammals.

After the card sorting activities learners can use their knowledge to complete Task 3 which is the extension questions. The use of additional resources may be of benefit for less able learners.

Learners can practically investigate aerobic and anaerobic respiration using Task 4. The task has been designed to allow learners to work in small groups to qualitatively assess the CO_2 production.

Prior knowledge

Learners should be aware of the processes of aerobic and anaerobic respiration in humans and microorganisms along with word summaries for aerobic respiration and anaerobic respiration. They should also be aware of the differences between aerobic and anaerobic respiration in terms of the reactants, the products formed and the implications for the organism.

Running the activity

Learners could work individually or in pairs.

Task 1

Learners should cut out the task cards and arrange them in the table below. Depending on how the activity is delivered (either a revision task or a learning aid) learners could either use their notes to help or use guided discussion with their partner or teacher to help place the cards.

Anaerobic Respiration	Both	Aerobic Respiration
Ethanol	Glucose	H_2O
Fermentation	CO_2	O_2
Lactate	Exothermic	Water
	ATP	
	ADP and Pi	
	$C_6H_{12}O_6$	

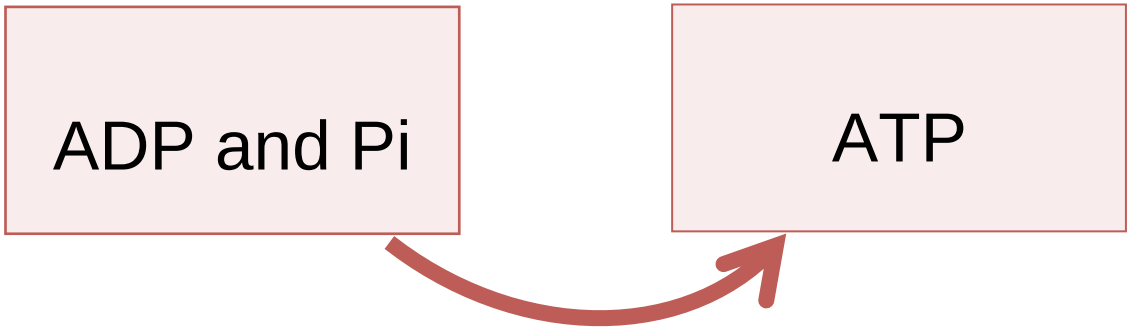
Task 2 a, b, c and 3

Once Task 1 is complete, learners should then use the cards from Task 1. The cards should be arranged on the blank equations in Task 2 a, b and c. Learners can then consolidate their learning using Task 3. If this is an introductory lesson learners may need additional resources such as textbooks or access to the Internet.

Task 2a

Use your cards to complete the following equations. How would you balance this equation?

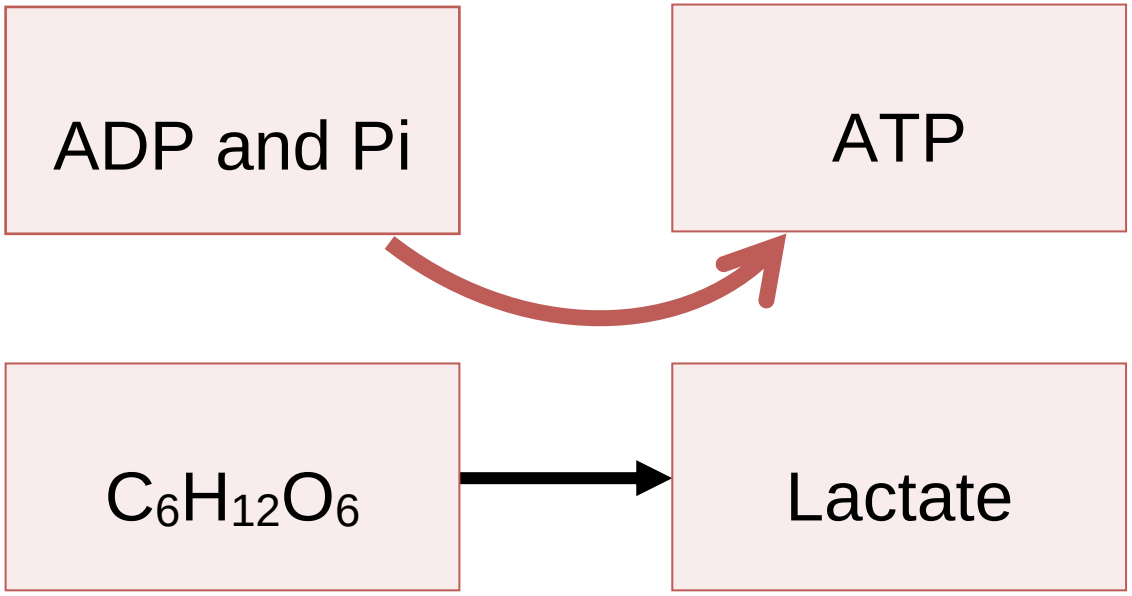
Aerobic Respiration



$C_6H_{12}O_6 + 6O_2 \rightarrow 6H_2O + 6CO_2$

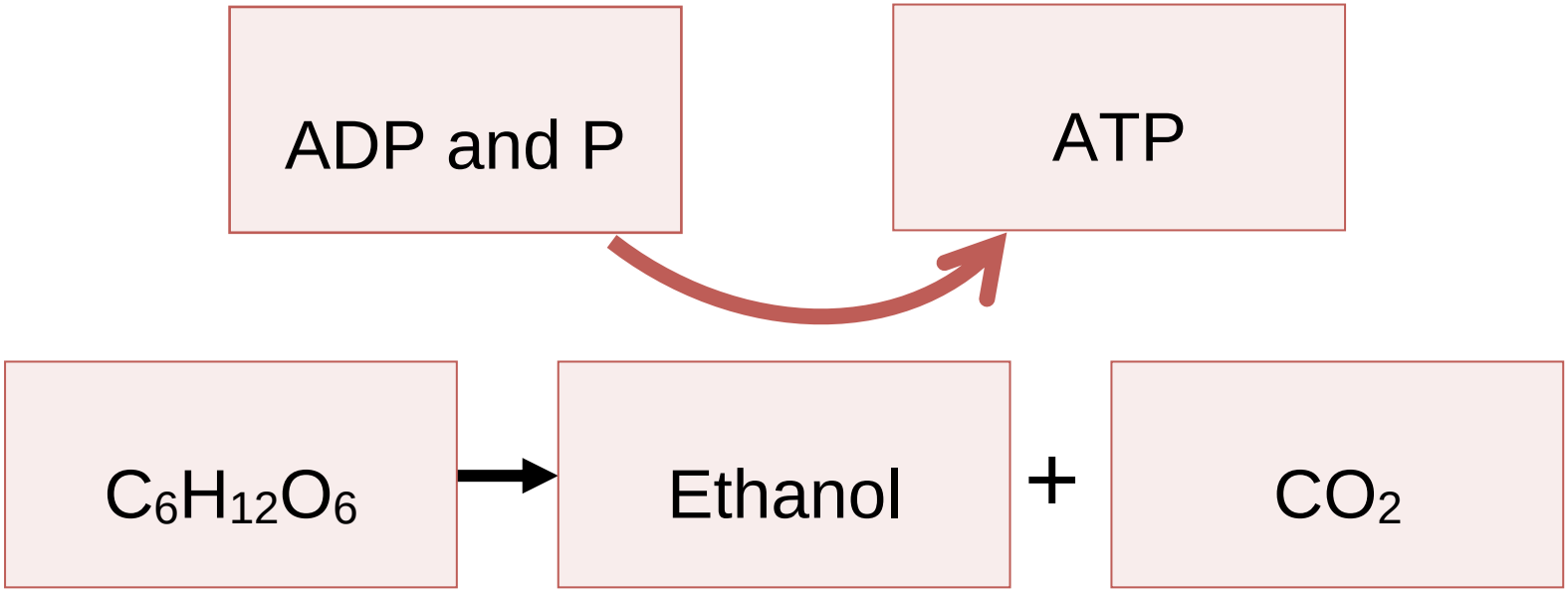
Task 2b

Anaerobic Respiration in animals



Task 2c

Anaerobic Respiration in micro-organisms



Task 3 – Extension questions

1. State 3 uses of ATP.

    1. Muscle contraction
    2. Active transport
    3. Keeping warm

2. Where do aerobic and anaerobic respiration occur?

    Aerobic – Mitochondria

    Anaerobic – Cytoplasm

3. Which 3 organ systems are required to aerobically respire?

    1. Respiratory system (oxygen)
    2. Cardiovascular system (blood supply)
    3. Digestive system (glucose)

4. For each of the statements below state if they are true or false.

    1. Respiration is breathing. TRUE / **FALSE**
    2. Respiration occurs in all living cells. **TRUE** / FALSE
    3. All types of respiration give out CO_2. TRUE / **FALSE**
    4. Respiration is an exothermic process. **TRUE** / FALSE
    5. Aerobic respiration requires oxygen. **TRUE** / FALSE
    6. Respiration stops when we are asleep. TRUE / **FALSE**

5. Red blood cells have no mitochondria. What does this suggest about the way they respire?

    They respire anaerobically so produce small amounts of ATP.

6. State the name of a cell and a tissue that undergo a lot of aerobic respiration.

Example of cell - sperm cell (spermatozoa)

Example of tissue - muscle

7. Males require more energy from their diet than females. Suggest why.

Males normally have more muscle than females
Muscle contains many mitochondria
Mitochondria produce ATP

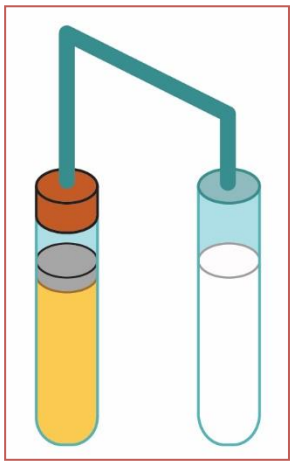
Task 4

Practically investigating Aerobic and Anaerobic Respiration

Apparatus

- 4 x boiling tubes
- 2 x bung with delivery tube
- 5% glucose
- 15% yeast solution
- Liquid paraffin
- Lime water
- 2 x 10ml syringe
- 1 x 2ml syringe
- 5ml syringe
- Glass rod

Diagram



Method

1. Use the 5 cm^3 syringe to add 5 cm^3 of lime water to a boiling tube.
2. Label another boiling tube ‘A’.
3. Use a 10 cm^3 syringe to place 20 cm^3 of glucose into test tube ‘A’.
4. Use a second 10 cm^3 syringe to place 10 cm^3 of yeast solution into test tube ‘A’.
5. Stir the contents of test tube ‘A’ with the glass rod.
6. Add 2 cm^3 of liquid paraffin to test tube ‘A’ using the 2 cm^3 syringe.
7. Attach a bung with delivery tube to tube ‘A’ and place the delivery tube into the test tube of lime water as shown in the diagram.
8. Record your initial observation of the test tube containing lime water in the table below and repeat every 5 minutes for 15 minutes.
9. Repeat the whole procedure without liquid paraffin (step 6) and label the test tube ‘B’.

Results table

Time (minutes)	Observation of test tube containing lime water	
	Test tube A (containing paraffin)	Test tube B
0	**Clear**	**Clear**
5	**Almost clear**	**Slightly cloudy**
10	**Very slightly cloudy**	**Almost cloudy**
15	**Slightly cloudy**	**Cloudy**

Sample results are shown below

Questions

1. In this investigation what is:

   a. the dependent variable?

   Observation of test tube

   b. the independent variable?

   Time (minutes)

2. State two variables that are not controlled in this investigation.

   1) **Temperature**

   2) **pH**

3. What type of respiration is occurring in

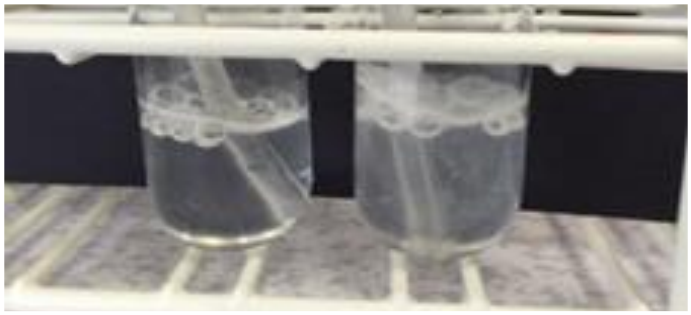
   a. Tube A? **Anaerobic**

   b. Tube B? **Aerobic**

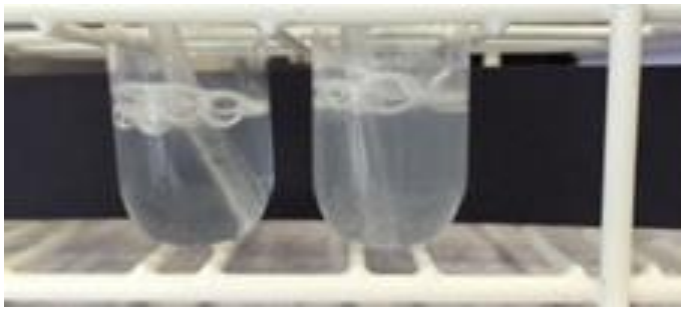
4. Investigations of this type are described as qualitative. Qualitative data is descriptive. Suggest a limitation of using qualitative data.

   ***Idea that* everyone describes observations in different ways.**

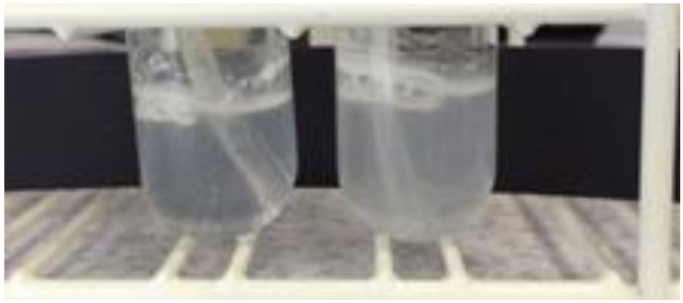
Observation after 5 minutes



Observation after 10 minutes



Observation after 15 minutes



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Lesson Element

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Learner Activity

Task 1

Cut these cards out and place into the correct columns in the table below to show if they are part of anaerobic respiration, aerobic respiration or both.

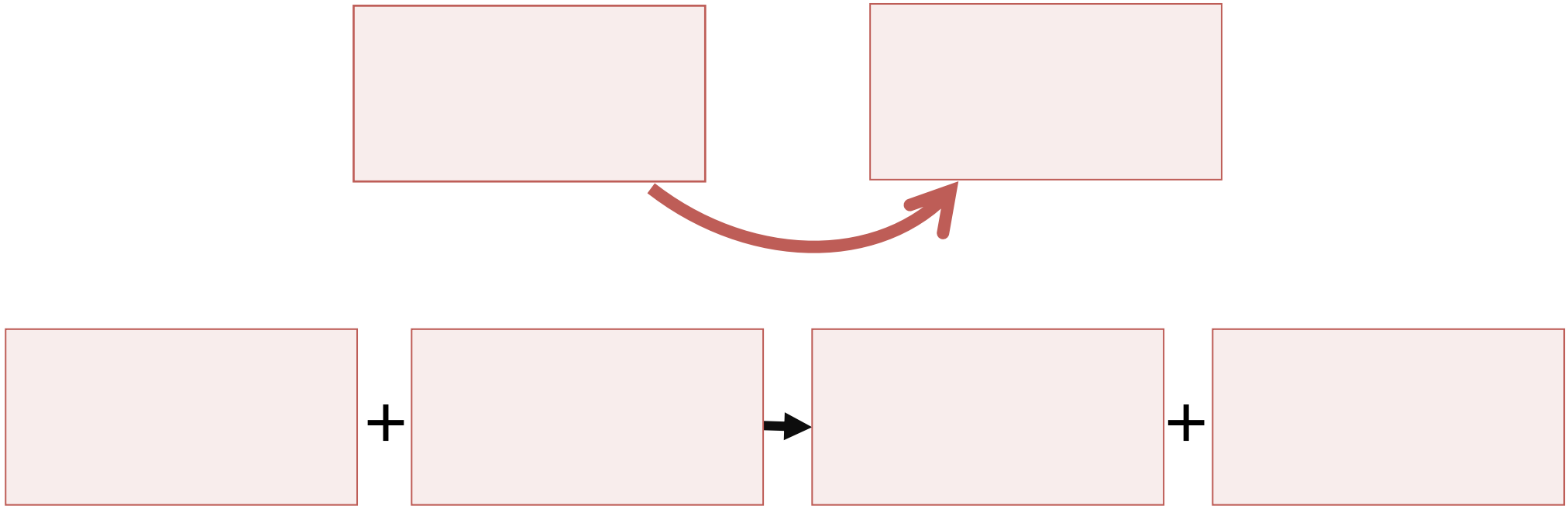
Glucose	Water	Fermentation
ATP	O_2	CO_2
ADP and P	Lactate	H_2O
$C_6H_{12}O_6$	Exothermic	Ethanol

Anaerobic Respiration	Both	Aerobic Respiration

Task 2a

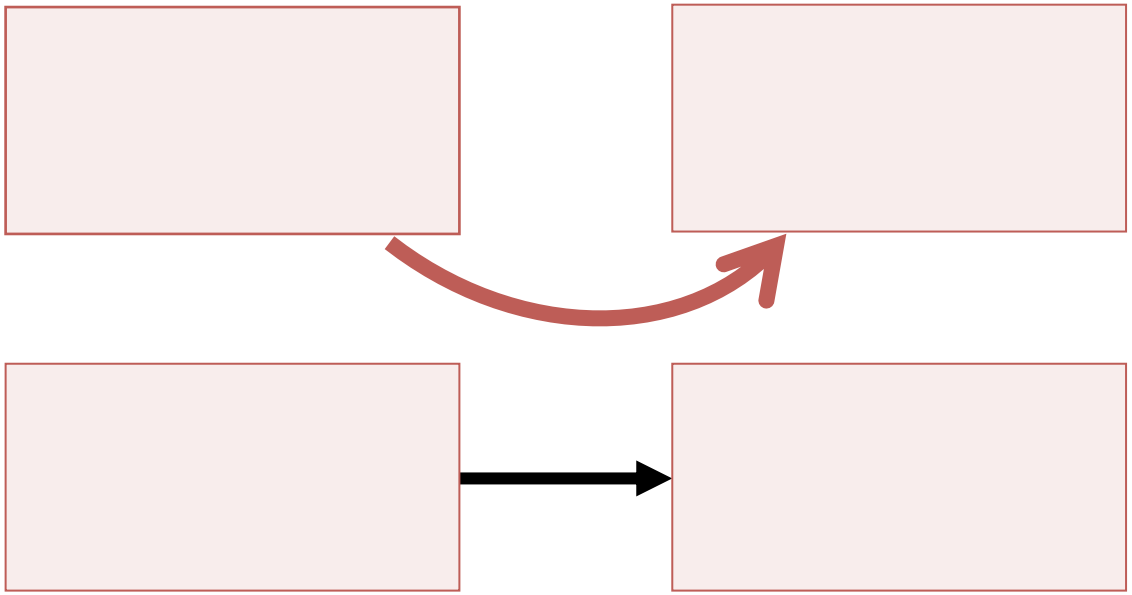
Use your cards from Task 1 to complete the following equations. How would you balance this equation?

Aerobic Respiration



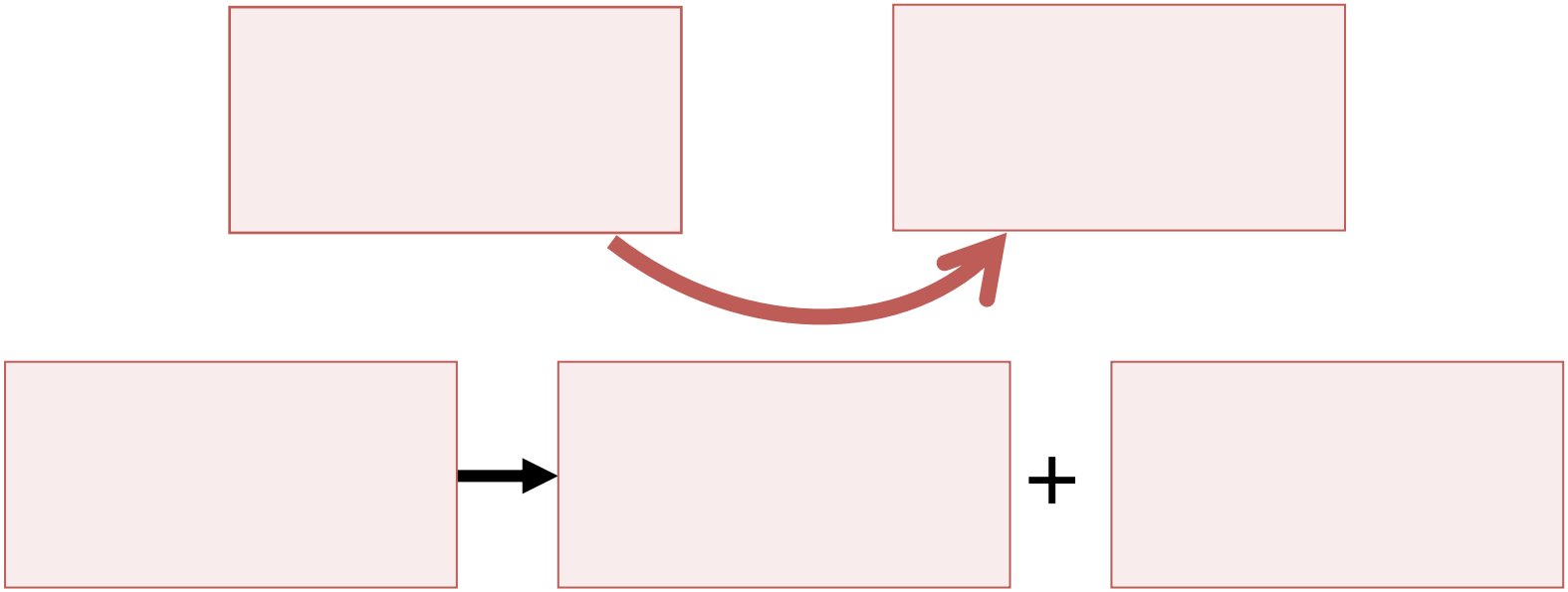
Task 2b

Anaerobic Respiration in animals



Task 2c

Anaerobic Respiration in micro-organisms



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2.
3.

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2.
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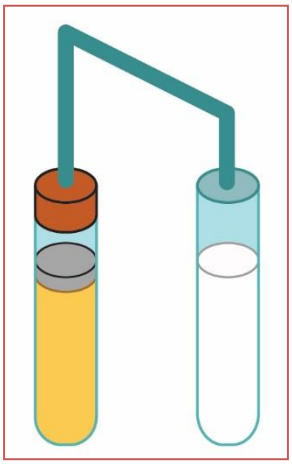

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   2)

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