

PiXL Independence:

Biology – Student Booklet

KS5

Photosynthesis and respiration

Contents:

- I. Level 1- Multiple Choice Quiz – 20 credits
- II. Level 2 - 5 questions, 5 sentences, 5 words – 10 credits each
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PiXL Independence – Level 1

Multiple Choice Questions

A-level Biology – Photosynthesis and respiration

INSTRUCTIONS

Score: /20

- Read the question carefully.
- Circle the correct letter.
- Answer all questions

Part 1 – Photosynthesis

1. What is the specific location of the light dependent reaction that takes place during photosynthesis
 - a. Chloroplast
 - b. Thylakoid membranes
 - c. Stroma
 - d. Lumen of the grana

2. What is the function of the antennae complex
 - a. To act as a “sunscreen” to protect the chlorophyll from excess sunlight
 - b. To transfer H⁺ ions from the Stroma to the lumen of the grana
 - c. To receive light energy from Chlorophyll a
 - d. To absorb light energy and transfer it to the reaction centre

3. Photosynthetic pigments can be identified by their R_f values in thin layer chromatography. On a student’s chromatogram, the following data was gathered. The solvent travelled 52mm.

Pigment	Distance travelled (mm)
Carotenoid	12
Chlorophyll B	25
Chlorophyll A	32
Pheophytin	41

- What is the correctly calculated R_f value of the Pheophytin?
- a. 0.21
 - b. 1.27
 - c. 0.79
 - d. 0.37
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4. What are the products of the light dependent reaction?
 - a. Glucose
 - b. TP & GP
 - c. Reduced NADP and ATP
 - d. Amino acids, lipids & Glucose

5. Which enzyme catalyses the joining of CO₂ and a 5 carbon product to make an unstable 6 carbon product?
- ATP synthase
 - Rubisco
 - NADP Reductase
 - NADP
6. What is photorespiration?
- The production of organic molecules using light energy
 - The release of energy from organic molecules
 - The oxygenation of RUBP to produce CO₂ but no energy
 - The process of respiration in plants to allow functions such as the opening of the stomata to take place
7. Which is the correct sequence of events during the Calvin cycle?
- RuBP → GP → TP → RuBP
 - RuBP → TP → GP → RuBP
 - RuBP → GP → TP → ATP
 - RuBP → GP → TP → Glucose
8. A student carried out a traditional experiment investigating the rate of photosynthesis. She used pond weed submerged in a 1% sodium hydrogen carbonate solution and illuminated it with an incandescent light bulb. She then moved the bulb further away from the plant and measured the volume of gas given off per minute. Which factor has she not controlled effectively?
- Light
 - CO₂
 - Temperature
 - Size of bubbles
9. In the same experiment in question 9, the student obtained the following results

Distance of light source/ cm	Volume of oxygen/ cm ³
10	5
20	1.25
30	0.56
40	0.31

- Which mathematical rule describes the results?
- The inverse square law
 - An exponential decrease
 - Indirectly proportional relationship
 - Directly proportional relationship
10. Which piece of equipment would be most useful in experiments in measuring the rate of photosynthesis of aquatic plants?
- Chlorophyll fluorimeter
 - Colorimeter
 - Oxygen meter
 - pH meter

Part 2 – Respiration

1. What is the specific location of the electron transport chain?
 - a. Mitochondria
 - b. Matrix
 - c. Inner membrane space
 - d. Inner membrane
2. Which is the correct order of biochemical reactions that take place during aerobic respiration?
 - a. Glycolysis → Link reaction → Krebs cycle → Oxidative phosphorylation
 - b. Glycolysis → Lactate fermentation → Oxidative phosphorylation
 - c. Glycolysis → Oxidative phosphorylation
 - d. Glycolysis → Lactate fermentation
3. Which is the correct number of each of NAD, FAD and ATP made during the Krebs cycle per molecule of glucose?

a.	NAD	6	FAD	1	ATP	2
b.	NAD	3	FAD	1	ATP	1
c.	NAD	3	FAD	2	ATP	2
d.	NAD	6	FAD	2	ATP	2
4. Which of these is a correct reason for not achieving the theoretical yield of 38 ATP?
 - a. Some ATP is used to shuttle NAD into the mitochondria
 - b. Some H⁺ ions are able to pass through the membrane without passing through ATP synthase
 - c. Transport of ADP and phosphate into the mitochondria
 - d. All of the above
5. Which of the following shows the correct sequence for the events during glycolysis?
 - a. Glucose → ATP + NADH → Hexose biphosphate → Pyruvate
 - b. Glucose → Hexose biphosphate → Pyruvate
 - c. Glucose → Hexose biphosphate → Triose phosphate → Pyruvate
 - d. Glucose → Triose phosphate → Hexose biphosphate → Pyruvate
6. Which molecule is responsible for shuttling hydrogen ions from the matrix to the electron transport chain?
 - a. ATP
 - b. NAD
 - c. Acetyl co-enzyme A
 - d. ATP synthase
7. Which term would be most appropriate to describe the ability of yeast to respire in different conditions?
 - a. Facultative anaerobe
 - b. Obligate anaerobe
 - c. Obligate aerobe
 - d. All of the above

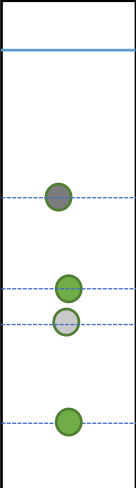
8. Respiratory quotients can give an indication of the type of substrate being respired. What would the RQ value be in the following reaction: $C_{16}H_{32}O_2 + 23 O_2 \rightarrow 16 CO_2 + 16 H_2O$?
- 0.667
 - 1.438
 - 0.696
 - 0.719
9. The rate of respiration can be measured using a respirometer. Oxygen is consumed and carbon dioxide is captured using a chemical which leads to a fall in the volume of the air in the chamber. This causes movement of a liquid through a capillary tube, the rate of which can be measured. What is the name of the chemical that captures the carbon dioxide?
- DC PIP
 - Methyl Blue
 - Sodium citrate
 - Potassium hydroxide
10. Which of the following provides evidence that chemio-osmosis is the mechanism that leads to production of ATP in respiration?
- There is a lower pH in the intermembrane space than the matrix
 - There is a potential difference across the cell membrane
 - Removal of the stalked particles leads to a cessation in ATP synthesis
 - B & C
 - A, B and C.

PiXL Independence – Level 2
5 questions, 5 sentences, 5 words
A Level Biology – Photosynthesis and respiration

INSTRUCTIONS

- For each statement, use either the suggested website or your own text book to write a 5-point summary. In examinations, answers frequently require more than 1 key word for the mark, so aim to include a few key words.
- It is important to stick to 5 sentences. It is the process of selecting the most relevant information and summarizing it, that will help you remember it.
- Write concisely and do not elaborate unnecessarily, it is harder to remember and revise facts from a big long paragraph.
- Finally, identify 5 key words that you may have difficulty remembering and include a brief definition. You might like to include a clip art style picture to help you remember it.

Example:

QUESTION:	Describe how to separate photosynthetic pigments.			
Sources:	SAPS – Thin layer chromatography – https://www.saps.org.uk/secondary/teaching-resources/1347-a-level-set-practicals-tlc Download the student notes on the right hand side of the page. There is also a useful video on this page on thin layer chromatography.			
	<ol style="list-style-type: none"> 1. Mark a pencil line 1cm from the bottom on a TLC / Thin layer chromatography plate. 2. Grind up a plant sample with a propanone, in a mortar and pestle. Add several drops of the extract to the pencil line. 3. Place your TLC plate into a small vial. Add some running solvent to the vial, ensure the solvent is below your pencil line. Leave until the solvent is nearly at the top. 4. Remove your TLC plate, IMMEDIATELY mark with a pencil the position of each dot and the solvent line. 5. Calculate the Rf value by : distance moved by component/ distance moved by solvent. Rf values can be used to identify the pigment as the relative positions are always the same for the SAME solvent and same stationary phase. 			
Stationary phase The material on the TLC plate	Rf Values Relative distance moved by pigments	Solvent front The position of the solvent as it moves up the TLC plate	TLC – Thin layer chromatography A method to separate pigments, much like year 8 chromatography	Running solvent – the organic solvent used to separate the pigments

QUESTION 1:

Explain how a plant is able to generate ATP and reduced NADP.

Sources:

Website: <https://www.khanacademy.org/science/biology/photosynthesis-in-plants/the-light-dependent-reactions-of-photosynthesis/a/light-dependent-reactions>
Interactive : **Mcgraw Hill Photosynthesis** – [Photosynthesis Light reaction, Calvin cycle, Electron Transport 3D Animation - YouTubel](#)

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QUESTION 2:

Explain how a plant uses reduced NADP and ATP to produce glucose.

Sources:

Website: <https://www.khanacademy.org/science/biology/photosynthesis-in-plants/the-calvin-cycle-reactions/a/calvin-cycle>

Interactive : McGraw Hill Calvin cycle – [Photosynthesis Light reaction, Calvin cycle, Electron Transport 3D Animation - YouTube](#)

Note – the animation uses the phrase “3-phosphoglycerate,” you should use the term **GP**.

The animation also uses the phrase “Glyceraldehyde -3-phosphate,” you should use the term **TP**.

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QUESTION 3:

Explain how a mitochondrion uses pyruvate to produce reduced NAD and FAD.

Sources:

Website: <https://www.khanacademy.org/science/biology/cellular-respiration-and-fermentation/overview-of-cellular-respiration-steps/a/steps-of-cellular-respiration>

Interactive : McGraw Hill animation – Krebs cycle –

http://highered.mheducation.com/sites/0072507470/student_view0/chapter25/animation_how_the_krebs_cycle_works_quiz_1.html

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QUESTION 4:

Compare the anaerobic processes in yeast and humans.

Sources:

Website: Khan academy anaerobic respiration –

<https://www.khanacademy.org/science/biology/cellular-respiration-and-fermentation/variations-on-cellular-respiration/a/fermentation-and-anaerobic-respiration>

Interactive:

http://highered.mheducation.com/sites/0072507470/student_view0/chapter25/animation_how_glycolysis_works.html

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QUESTION 5:	Compare and contrast the mechanism of ATP generation in chloroplasts and mitochondria.
Sources:	Website: https://www.khanacademy.org/science/biology/cellular-respiration-and-fermentation/oxidative-phosphorylation/a/oxidative-phosphorylation-etc Interactive: Mcgraw Hill animation – Electron transport chain in respiration – http://highered.mheducation.com/sites/0072507470/student_view0/chapter25/animation_electron_transport_system_and_atp_synthesis_quiz_1.html

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PiXL Independence – Level 3

Science in the News

A Level Biology – Photosynthesis and respiration

Fake news

Sensationalised news stories have been around for some time, but with the mass growth of social media, the problem seems to have grown in recent years.

Therefore, the ability to identify real information, track it back to the source article and make your own judgement is a very important skill. This activity will help you develop that skill.

Can spinach turn you into Popeye?

News article – <https://www.theglobeandmail.com/life/health-and-fitness/popeye-was-right-spinach-can-make-you-stronger/article622134/>

NHS Choices – [Food for healthy bones - NHS \(www.nhs.uk\)](http://www.nhs.uk)

Full article – <https://www.sciencedirect.com/science/article/pii/S1550413111000052>

Task

You need to produce a 1 page essay on whether eating spinach can “make you big and strong like Popeye.” (Popeye is one of the top 50 fictional cartoon characters. When he ate spinach, he effectively did an incredible hulk transformation, albeit not turning green. I am fairly sure the whole point of the comic book and TV series, which was cancelled in 2004, was to get children to eat overcooked spinach!). There are plenty of episodes on You Tube if you feel it will help your learning! This article links to respiration through the effects on mitochondria.

Essay section	Activity
Introduction	Read the news article and write a summary paragraph on the health benefits of eating spinach. Explain how the researchers measured the impacts of the supplement. Write your initial thoughts on the reliability of this article, considering the language used and how clear it is what the test subjects were given in order to show an improvement in fitness.
Describe	Now read the short article. How do the conclusions from this paper differ from the newspaper article? Use the Search/Find function and look for the keyword spinach. Write what this tells you in terms of the way the article has been presented in the news. Look at the full paper, you do not need to read it all, but write a summary of the weaknesses in this study – tip – think about who was tested and how many of them were tested.
Explore	Finally, read the NHS Choices article and write a summary of the aspects you did not consider in judging the quality of this article. Remember this exercise is about demonstrating learning, not providing a perfect answer.
Conclude	Write a short reflection on your own learning. What aspects of the newspaper article did you look for and what aspects have you now learnt to look for?

PiXL Independence – Level 4

Scientific Posters

A Level Biology – Photosynthesis and respiration

Scientific Posters - Scientists communicate research findings in three main ways. Primarily, they write journal articles much like an experiment write up. These are very concise, appraise the current literature on the problem and present findings. Scientists then share findings at conferences through talks and scientific posters. During a science degree, you would practice all three of these skills.

Scientific posters are a fine balance between being graphically interesting and attracting attention and sharing just the right amount of text to convey a detailed scientific message. They are more detailed than a talk and less detailed than a paper.

Use this information to help structure your poster – <https://www.wikihow.com/Make-a-Scientific-Poster>

More detailed guidance is available at: <https://guides.nyu.edu/posters>

Creating your poster

It is easiest to create a poster in PowerPoint, however you need to add custom text boxes rather than using the standard templates.



Posters need to be eye catching, but readable from a distance. If you use PowerPoint, start with a 4:3 slide (for easier printing, it can then be printed on A3) and use a 14-16 pt font.

The first box could be larger to draw people in. You can use a background image, but pick a simple one that is of high quality. Select 'text box fill' and select 'change the transparency' to maintain the contrast and partially show the picture.

You can experiment with different layouts and you should include images. Avoid a chaotic layout, posters are read from top left column downwards.

Remember to include the authors and references.

Finally, look at the examples given on the University of Texas website which also offers an evaluation of each <https://ugs.utexas.edu/our/poster/samples>

Artificial Photosynthesis



Figure 1 Microscopic organism Euglenids *Phacus pleuronectes*

Background

Scientists proposed the idea of artificially recreating photosynthesis as early as 1912, however, more recent advances in technology and an increasing demand for alternative fuels have led to increased research. Artificial photosynthesis can refer to any technology which uses the sun's energy and captures it in the bonds of a molecule. Different products may be sought after, whether a fixed carbon product or hydrogen ions and oxygen.

Source article

Nature news : <http://www.nature.com/news/solar-energy-springtime-for-the-artificial-leaf-1.15341>

Use other sources as necessary.

Task

Produce a scientific poster on recent advances in artificial photosynthesis.

You should start with an outline of the key processes involved in photosynthesis. Target your poster at educated scientists of at least A-level standard, who may not have detailed knowledge of photosynthesis.

Recall	Give a summary of the processes of photosynthesis. Outline the need for artificial photosynthesis.
Describe	Write a summary of the article.
Compare	Find at least one other article that discusses an application of artificial photosynthesis. Compare the merits of each method used using information from the articles.
Evaluate	Evaluate the likelihood of artificial photosynthesis being a viable alternative to other fuels in the next 10 years.

PiXL Independence – Level 5
Video summaries
A-level Biology – Photosynthesis and respiration

Cornell Notes

At A level and University, you will make large amounts of notes, but those notes are only of use if you record them in a sensible way. One system for recording notes is known as the Cornell notes system. This method encourages you to select relevant information, rather than trying to write a transcript of everything said. More importantly, it forces you to spend a few minutes reviewing what you have written, which has been scientifically proven to aid learning and memory retention.

The ideal is to write everything on one page, but some students may prefer to type and others will to handwrite their notes. Whichever option you use, remember the aim is to summarise and condense the content with a focus on the objectives that you are trying to learn and understand.

There are three main sections to the Cornell notes

- 1 **Cue/ Objectives** – This can be done before or after the lecture. You may have been provided with the objectives or you may need to decide what they were or you may want to make the link to your learning if this is an additional task or lecture you are viewing, such as this video.
- 2 **Notes** – In this space you record concisely, simply the things you are LESS likely remember - **The NEW knowledge**.
- 3 **Summary** – The most important step that is carried out after the lecture or video. This helps to reinforce learning.

Background

The following short TED talks present two topics that link to your learning. The first is on human physiology and indirectly links to respiration. The second video discusses an application of science which leads to cheap renewable fuel production using photosynthesis.

Source article

Video 1 – Are athletes getting faster, better, stronger?

Ted Ed talks :

https://www.ted.com/talks/david_epstein_are_athletes_really_getting_faster_better_stronger

Video 2 – Energy from floating algae pods

Ted Ed talks:

https://www.ted.com/talks/jonathan_trent_energy_from_floating_algae_pods/up-next

Task:

You need to produce a set of Cornell notes for the video given above.
Use the following objective to guide your note taking, this links to your learning.

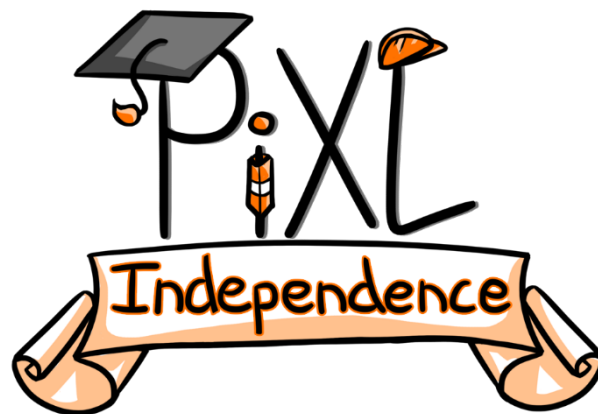
1. Discuss the reasons for the reduction in World record times in modern sport.
2. Discuss how energy can be produced using floating algae pods and evaluate the problems associated with this technology

Objectives What are the main learning outcomes that have been shared with you? This will help guide you to taking the RIGHT notes during the video.	Title
	Date
	Sketch down note and key words Do not write in full sentences whilst you listen, put quick sketches, single words, mind maps, short hand etc. To help train you for university, try not to pause the video because you could not pause a live lecture (However, a lecture may give more natural pauses for you to catch up).

Summary (after the video)
What are your main points of learning from this video.
This is your chance to make sense of your notes.
Make clear connections to the things you need to know

	Title Date
Objectives	
Summary	

	Title Date
Objectives	
Summary	



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