A-Level Workbook

Edexcel Biology A

The Big Sleep

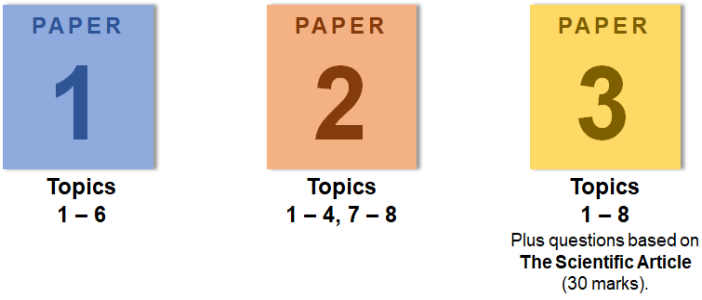
Pre-Release Article 2025

Preparation Booklet

Exam Breakdown

There are three Biology papers to complete in this course. Each paper will assess you for **two hours** and is worth **100 marks**. Each paper will make up **33%** of your final A-Level qualification. The image below shows the topics you will be assessed for each paper. The **statistical tests** will appear all three papers.

Our exam board so ***Pearson Edexcel Biology A (Salters-Nuffield)***, also called ***SNAB***.



The final **30 marks** are questions based on the **pre-released scientific article**.

This booklet contains many potential questions for this article. Familiarise yourself with these questions and topics as similar questions may be asked in your exam.

Edexcel Command Words

In your exams you will be asked to answer questions with a range of different command words. Each question will start with a command word which gives you an idea of what level of detail you need to go into in order to achieve marks.

Command Word	Definitions
Add / Label	Show information or name something on a graph, diagram or table.
Give / State / Name	Recall one or more pieces of information.
State what is meant by	Write down what the term in the question means.
Draw	Produce a diagram with or without a ruler. Simple line diagrams for scientific equipment and circuit symbols for a circuit diagram.
Write	When the questions ask for an equation e.g. a balanced symbol equation.
Plot	Produce a graph by marking points accurately on a grid from data that is provided and then drawing a line of best fit through these points. A suitable scale and appropriately labelled axes must be included if these are not provided in the question.
Sketch	Produce a drawing without a ruler e.g. sketch a rough graph with axes and a line.
Complete	Add values to a table or diagram.
Estimate	Find a rough number or amount from the information given in the question.
Identify	Choose key details from information given in the question.
Calculate	Work out your answer using the numbers in the question. Include units in your answer.
Show that	Prove the statement in the question is right.
Determine	Use information in the question and give a numerical answer or show how the answer can be reached quantitatively.
Deduce	Come to a decision based on information in the question.
Give a reason	Say why something happens; only write the number of reasons the question asks for.
Describe	Give an account of something, or link facts, information, events or processes in a logical order.
Explain	Say how or why something happens; 'because' will be an important part of your answer.
State and explain	Make a point and link ideas to justify that point.
Comment on	Look at data or information and decide what it shows.
Compare and contrast	Give similarities and differences between several things, not just one.
Predict	Say what you think will happen based on what you know.
Discuss	Pick out the situation or argument in the question, explore all aspects of it, investigate it and come to a conclusion.
Justify	Give evidence to support an answer.
Assess	Read the information in the question carefully and pick out the most important parts to help you answer the question or come to a conclusion.
Evaluate	Look at the information in the question and bring it together to make a decision and come to a conclusion with evidence from the question.
Devise	Plan a method or experiment using your knowledge.
Suggest	Always used with another command word, e.g. Suggest an explanation. Suggest tells you that you need to apply your knowledge to a new situation, and in this case to give a possible explanation.

Article Summary

Article Overview

Hibernation is not just sleep – it is a special state called '**torpor**' where animals **significantly reduce** their **metabolism**, **body temperature** and **energy use** during harsh environmental **conditions** (e.g. extreme colds and food scarcity).

The scientific article explores the following themes:

- Identifying **genes** and **nervous pathways** involved in hibernation.
- How hibernation **differs** between mammal such as ground squirrels and black bears.
- The idea **human ancestors** hibernated.
- The idea that **modern humans** and other **non-hibernating** mammals still possess genes involved in hibernation.
- Understanding hibernation could be used to develop **medicines** to treat **Alzheimer's disease**, **cardiovascular disease**, **aging** and potentially inducing **low-energy states** for long-distance **space travel**.

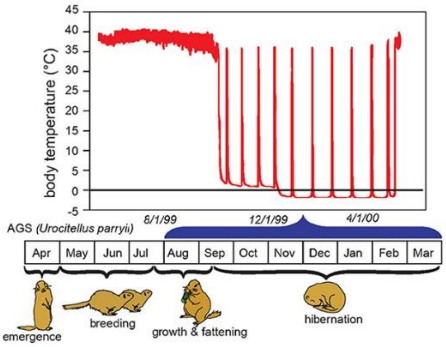
Video: *How Does Hibernation Work? (04:48)*
Channel: *TED-Ed*
URL: *https://www.youtube.com/watch?v=xptpXSTtgSY*
Description: A good introductory video, summarising the major themes of the article.

*During hibernation, **small mammals**, like ground squirrels can **significantly reduce** their body temperature almost to the level of the surrounding air.*

***Larger animals**, such as black bears only reduce their temperature **slightly** but still **conserve energy** during winter.*

*During hibernation, arctic ground squirrels go through **multiple cycles** of **torpor** (reduced metabolism) and **arousal** (regular metabolism) every few days.*

*Metabolism is the sum of **all chemical reactions** (and **energy usage**) which occur in an organism, this includes cell division, respiration and thermoregulation.*



***Stasis chambers** from the movie **Alien (1986)**.*
*These chambers are designed to induce a **low-energy state** for long-distance **space travel**.*

*A potential future benefit of researching the mechanisms which control **hibernation**.*

Paragraph Breakdown

The following table **summarises each paragraph** from the article and the **topics** it relates to.

Para.	Description	Link to SNAB
1	Ancient human ancestors might have had the ability to hibernate as an adaptation to harsh conditions such as low temperatures and food shortages.	Natural selection, adaptations, thermoregulation.
2	Hibernation not only conserves energy but also protects against various stresses (e.g. cold and famine) and may even reduce risks for diseases such as Alzheimer's* and CVD. **Alzheimer's disease causes death in neurones located in the brain, which results in memory loss. A common symptom is the build-up of misfolded proteins (called amyloid plaques) which surround the damaged neurones.*	Cardiovascular diseases, brain imaging.
3	Evidence indicates that the common ancestor for all mammals was a hibernator, even those that don't usually hibernate, retain parts of the 'genetic hardware' involved entering a low-energy state.	Genetics, DNA profiling, molecular phylogeny.
4 5	Researchers are exploring whether it's possible to trigger these dormant (inactive) genetic pathways in humans to harness the benefits of hibernation. Although hibernation and sleep both involve the brain, they are completely different – hibernation is defined by a reduction in metabolism, called torpor, not just changes in brain activity.	Metabolism, thermoregulation, classification, respiration, enzyme activity, Q_{10}.
6 7 8	During torpor animals lower their body temperature and metabolic rate; these changes can vary widely – from signification reductions in metabolism and body temperature in small mammals (e.g. ground squirrels) to more moderate reductions in large mammals (e.g. bears).	Animal models, SA:V, adaptations, enzyme activity.
9	Mimicking a hibernation state (synthetic torpor) in humans could help counteract the negative effects of long-duration space travel, such as muscle and bone loss.	Muscle structure and muscle contraction.
10 11 12	Research is focused on understanding the cellular and molecular changes during hibernation, including the identification of key genes involved in the process. Scientists have collected tissue samples from hibernators to monitor changes in gene products during torpor and rewarming. By comparing the genomes and transcriptomes* of hibernating and non-hibernating species, researchers can pinpoint genes and molecules that help protect against metabolic stresses. **The transcriptome is the sum total of all RNA molecules expressed by the genome (this includes mRNA and non-coding RNA such as tRNA).*	Tissue banks, gene expression, protein synthesis, DNA profiling, genetic modification, comparative genomics, post-transcriptional modification.

13	Some hibernators, like the thirteen-lined ground squirrel, use processes such as urea recycling and brain protection to maintain health during hibernation.	Cardiovascular diseases, homeostasis, energy budgets, obesity indicators.
14 (BOX)	The ultimate aim is to develop drugs that can mimic the benefits of hibernation, offering new ways to treat diseases and manage stress on the body. This includes its potential use in space travel, to induce low-energy states and preserve bone and muscle structure	Drug development, muscle structure, enzyme activity, Q_{10}.
15	Adenosine, an inhibitory neurotransmitter involved in sleep, is also involved in lowering body temperature and reducing metabolism during hibernation.	Synaptic transmission, action potentials.
16 17	Experiments in rats show that increasing the concentration of adenosine can lower body temperature without triggering the negative effects typically associated with hypothermia. Research also suggests that activating adenosine pathways might induce a hibernation-like state in animals that normally do not hibernate, such as humans.	Thermoregulation, designing an investigation, handling data, animal models.
18	The raphe pallidus, a region of the brain located in the brainstem, plays a role in managing body temperature and autonomic responses, acting as a control centre for hibernation-related changes.	Brain structure and function.
19	Hibernators show slower aging during torpor, hinting that reduced metabolism may contribute to increased lifespan.	Metabolism, rate of reaction, gene expression.
20 21	Future research might enable the creation of drugs that induce hibernation-like states through targeted changes in neural activity or by mimicking environmental triggers. The article concludes with a message of cautious optimism – while much is still unknown, advances in technology and research are gradually unlocking the secrets of hibernation.	Drug development, nervous responses, epigenetics.

Potential Questions

Paragraph 1

Q1. State the type of adaptation that hibernation is an example of. **(1)**

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Q2. Describe how mammals evolved the ability to hibernate. **(4)**

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Q3. Describe mechanisms which control the core temperature of mammals during 'cold snaps'. **(4)**

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Paragraph 2

Alzheimer's disease is a neurodegenerative disease.
Figure 1 shows an fMRI scan of a patient's brain.

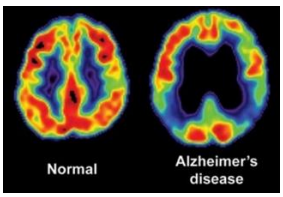

Figure 1

Q4. Suggest how fMRI is able to show areas in the brain which are active. **(2)**

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Q5. Explain why fMRI scans were used instead of CT. **(2)**

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Q6. Memory loss is a symptom of Alzheimer's disease.
Using figure 1, explain how memory loss occurs in Alzheimer's patients. **(3)**

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Q7. A symptom of Alzheimer's disease are amyloid plaques which form around neurones.
Amyloid plaques are caused by a buildup of misfolded proteins.
Explain why these proteins are misfolded. **(4)**

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Q8. Acetylcholine is a neurotransmitter involved in memory and learning.
Current treatments for Alzheimer's disease include the use of acetylcholinesterase inhibitors.
Explain how this treatment can improve memory. **(4)**

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Q9. Describe how atherosclerosis can lead to a heart attack. **(4)**

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Paragraphs 3 - 6

Q10. 'Evidence suggests that many non-hibernating mammals retain an ability to enter reduced-energy states' and 'It is possible we all have it in our genetic hardware'.
Explain how scientists may have identified these genes involved in entering 'reduced-energy states' in humans. **(5)**

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Q11. Hibernation is 'marked by a reduction in body temperature and metabolism'.
Devise a procedure to investigate the effects of temperature on metabolism. **(5)**

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Q12. State what is meant by the temperature coefficient (Q_{10}). **(1)**

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Q13. An experiment was carried out to determine the effect of temperature on the activity of catalase in yeast cells. The results are shown in figure 2.

Temperature / °C	Mean volume of oxygen / mm^3
20	80
30	240
40	540
50	320
60	120

Figure 2

Determine the temperature coefficient (Q_{10}) for this reaction between 20 °C and 30 °C. **(1)**

Q_{10} = ...

Q14. Explain the effects of a temperature increase from 20 °C to 30 °C on the initial rate of activity of catalase. **(3)**

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Q15. Explain what happens to the Q_{10} value between 40 °C and 50 °C. **(2)**

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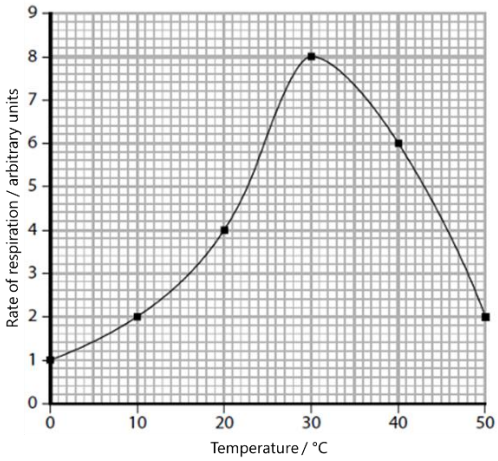
Q16. The graph shows the effect of temperature on the rate of respiration.



Calculate the Q_{10} for respiration between 20 °C and 30 °C. **(1)**

Q_{10} = ...

Paragraphs 7 - 9

Q17. Give two ethical issues relating to the use of small mammals, like the thirteen-lined ground squirrel in experiments involving physiology. **(4)**

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Q18. "It's not feasible to think that humans could get down to the levels of small hibernators"
Deduce why it is not feasible to humans to lower the core temperatures to that of small hibernators. **(3)**

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Q19. The alveoli of thirteen-striped ground squirrels can be modelled using spheres.

Alveolus diameter / µm	Volume / µm^3	Surface area / µm^2	Surface area to volume ratio
37	26 522		

Determine the surface area to volume ratio of an alveolus, using the formula, surface area = $4\pi r^2$
Give your answer to two significant figures. **(3)**

Answer = ...

Paragraphs 10 - 11
Q20. Explain how tissue banks are able to preserve tissue samples for decades. **(2)**

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Q21. Describe how genes can 'throw the switches controlling hibernation'. **(4)**

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Q22. Describe how genes of mice could be 'modified to mimic the beneficial properties hibernation bestows.' **(4)**

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Q23. Bacterial cells can also be modified to produce proteins involved in hibernation.
Describe the functions of the enzymes used to genetically modify bacteria. **(4)**

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Q24. State one concern for genetically modifying mice to display hibernation. **(1)**

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Q25. Research suggests that hundreds to thousands of genes are differentially expressed during hibernation.
State the term used to describe this trait. **(1)**

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Q26. Describe how comparative genomics could be used to identify important genes related to hibernation. **(2)**

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Paragraph 12 – 14

Q27. Describe how 'genes make proteins'. **(5)**

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Q28. The transcription is the sum total of all the mRNA molecules expressed from the genes of in an organism. Explain how a single mRNA molecule can code for multiple protein. **(4)**

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Q29. Deduce how epigenetic changes can change the proteins produced by genes. **(3)**

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Q30. Discuss the benefits of the human genome project in medicine. **(3)**

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Q31. State two concerns related to sequencing a person's genome. **(2)**

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Q32. Scientists wish to 'eventually use these findings to design therapeutic drugs'.
Explain the purpose of each phase of this protocol for developing these therapeutic drugs. **(4)**

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Q33. Describe the function of placebos and double-blind trails in drug development. **(4)**

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Q34. Explain how a lack of insulin sensitivity results in huge weight gain. **(3)**

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Q35. 'Bears and squirrels can preserve bone structure while in torpor.'
Describe how stem cells could be used to preserve bone structure. **(4)**

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Q36. 'Muscles will waste away [after] being bombarded with cosmic rays.'
Deduce the effects of radiation on muscle contraction. **(4)**

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Paragraph 15 - 18
Q37. Adenosine is an inhibitory neurotransmitter involved in sleep.
Explain how adenosine causes sleep. **(4)**

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Q38. 'Uptake of adenosine in the rats' brains lowered their core body temperature.
Devise a method to produce valid results for this statement. **(5)**

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Q39. State what is meant by hypothermia. **(1)**

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Q40. Explain how shivering could reduce the symptoms of hypothermia. **(2)**

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Q41. Explain how respiration can result in an increase in body temperature. **(3)**

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Q42. Explain how the structure of the mitochondria allows it to carry out its function. **(4)**

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Q43. Describe the function of raphe pallidus. **(1)**

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Paragraphs 19 - 21

Q44. 'Decades of research on caloric restriction and fasting have revealed a strong link between metabolism and lifespan.'

Design a study to investigate the effects of caloric restrictions and fasting on the lifespan of rats. **(5)**

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Q45. Devise a null hypothesis for this experiment. **(2)**

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Q46. The median life expectancy of rats with different caloric intakes was investigated.

The results of the investigation are shown below.

Rat	Caloric intake (kcal/wk)	Rank for caloric intake	Median life expectancy (months)	Rank for median life expectancy	Difference in rank (d)	Difference in rank squared (d^2)
A	40	1	42	6		
B	50	2	40	5		
C	60	3	38	3.5		
D	70	4	38	3.5		
E	80	5	32	2		
F	90	6	28	1		

Complete the table and calculate the Spearman's rank correlation coefficient (r_s), using the equation below. **(3)**

$$r_s = 1 - \frac{6\Sigma d^2}{n(n^2-1)}$$

Answer = ...

Q47. The table shows critical values for r_s.

	Probability		
df	**0.10**	**0.05**	**0.01**
4	0.935	0.900	1.000
5	0.829	0.886	1.000
6	0.714	0.786	0.929
7	0.643	0.738	0.833

Deduce a conclusion for data shown in the previous question. **(3)**

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Q48. Explain how the lack of certain nutrients can cause metabolic pathways to suppress cell growth. **(3)**

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