A-Level Workbook
Edexcel Biology A

The Big Sleep
Pre-Release Article 2025
Mark Scheme

Paragraph 1

1	Physiological
2	Mutation leads to some mammals {hibernating / slow metabolic rate}. {Food scarcity / cold temperatures / winter} acts as a selection pressure. (Mammals with mutation) are more likely to survive and reproduce. Advantageous alleles passed on to offspring. Frequency of advantageous allele increases over time.
3	Thermoreceptors detect a decrease in temperature. Impulses sent to thermoregulatory centre in hypothalamus. Vasoconstriction (of arterioles) reduce blood flow to surface of skin. Reduces heat loss (by radiation). {Adrenalin / thyroxine} increase metabolism to generate heat. Erector pili muscles contract for insulation. Shivering increase rate respiration to generate more heat.

Paragraph 2

4	Active areas {use more oxygen / increased supply of oxygenated blood}. fMRI signals {reflected / not absorbed} by oxygenated blood.
5	fMRI has a better resolution. fMRI shows brain activity in real time. No use of X-rays. fMRI signals {are safer / less risk of mutation}.
6	Cerebral cortex involved in memory. {No activity / damaged neurones} in cerebral cortex. Fewer impulses reach the cerebral cortex.
7	Change in the base sequence of **DNA**. Causes a change to the {triplet code / codons) in mRNA. Therefore, there will be a change in the {amino acid sequence / primary structure}. Changing {bonds / named bonds} in the tertiary structure of proteins. Resulting a different 3D shape.
8	Drugs prevent the breakdown of acetylcholine in the synapse (by acetylcholinesterase). Acetylcholine levels remain high in the synapse. Binds to receptors on post-synaptic membrane. {Increases permeability / opens} Na^{2+} channels in the postsynaptic membrane. Initiating {depolarisation / action potential} in postsynaptic neurone.
9	High blood pressure damages endothelium of an artery. {Cholesterol builds-up / atheroma forms}. Narrows the lumen of the artery. Reduce blood flow to the heart resulting in cell death.

Paragraphs 3 - 6

10	Collect DNA samples of genes involved in reduce energy states in humans AND hibernating mammals. Amplify DNA using PCR. Cut DNA using restriction enzymes. Separate fragments using electrophoresis / description of electrophoresis. Similarities in {size / position} of bands suggest the genes are very similar. OR Isolate {proteins / enzymes} involved in reduced energy states in humans. Sequence the {amino acids in protein / bases in gene}. Compare with {proteins / genes} of hibernating mammals. Determine number of {differences / similarities} in the sequence. More similarities suggest these genes went through very little mutation through {phylogenetic tree / evolution}.
11	Description of how two suitable temperatures will be controlled (e.g. two water baths with 10 °C difference). Provide excess hydrogen peroxide. Control concentration of catalase. Measures the volume of oxygen produced at stated time intervals (e.g. every 10 seconds for the first minute). Calculate initial rate / draw tangent to calculate initial rate. Description of how Q_{10} can be determined / $Q_{10} = \dfrac{\text{initial rate at higher temperature}}{\text{initial rate at lower temperature}}$
12	Ratio of rate of an enzyme reaction taking place at temperatures differing by 10 °C. ALLOW equation: $Q_{10} = \dfrac{\text{initial rate at higher temperature}}{\text{initial rate at lower temperature}}$
13	$240 \div 80 = 3$
14	(Between 20 °C and 30 °C) there is more kinetic energy available. Therefore, more frequent collisions (between enzyme and substrate). More enzyme-substrate complexes form. ($Q_{10} = 3$, which indicates) the activity triples with the 10 °C temperature rise.
15	Q_{10} value is 0.593. Because enzymes have denatured. Few enzyme-substrate complexes formed / substrates no longer binds to active sites.
16	$8 \div 4 = 2$

Paragraphs 7 - 9

17	Argument in favour Utilitarianism – overall benefits if the experiment is greater than any harm done. Animals used a treated as well as possible / animals used are regulated. Argument against All animals have rights / animals experience pain. Results may not be applicable to humans. Animals are unable to consent.
18	Humans have a smaller surface area to volume ratio.

	Therefore, lose heat from skin surface at a slower rate.
19	Radius = 18.5 μm Surface area = 4 300 (ALLOW 4 300.84) SA:V = 4 300 ÷ 26 522 = **0.16 : 1**

Paragraphs 10 – 11

20	Samples are kept at low temperatures. Reduces enzyme activity / less kinetic energy between enzyme and substrates. This reduces the rate of {metabolism / aging / decomposition}.
21	Trigged by {chemical signals / epigenetic changes}. Genes involved with hibernation are {activated/ switched on/ expressed}. Transcription factors bind to promotor regions of genes. Only active genes {are transcribed / produce mRNA). mRNA is {translated / used} to produce {proteins / enzymes} involved in hibernation.
22	Isolate gene involved in hibernation (from a hibernating mammal). Inject into the nucleus of a {zygote / fertilised egg cell}. Implant the egg into the uterus of an adult mouse. Genetically modified mice will produce proteins involved in hibernation.
23	Restriction enzyme used to {cut plasmid/ isolate gene}. Forms complementary sticky ends. Ligase enzymes used to join gene to plasmid. Forms phosphodiester bonds. Recombinant {DNA/ plasmid} produced.
24	Transmission of genetic material into wild populations. Ethics related to modifying animals for human benefit. Genes may have unforeseen consequence on the health of the animal.
25	Polygenic (trait / characteristic).
26	Sequencing {genome / genes / DNA} with hibernators and non-hibernators. Identify {difference in sequence / mutations} (between hibernators and non-hibernators).

Paragraphs 12 – 14

27	{Gene / DNA sequence} is transcribed. Complementary base pairing between RNA nucleotides and DNA (producing mRNA). mRNA attaches to ribosomes. Pairing between mRNA codons and tRNA anticodons. tRNA provides specific amino acids. Condensation reaction form {peptide bonds / polypeptide}.
28	mRNA splicing / post-transcriptional modification. Different exons removed / exons joined in different sequences. Producing different mRNA (from the same gene). Translation gives different {amino acid sequences/ polypeptides / proteins}.
29	Histone modification/ acetylation of histones / DNA methylation.

	{Activates / deactivates} genes. Only activated genes are transcribed and translated to produce proteins.
30	Identify {genes / proteins} involved in disease. Develop new drugs to target identified proteins. Personalised medicines.
31	Description of a two-tier health service. Description of discrimination (e.g. from insurance companies). Psychological harm (if drug is not responsive to a person's genetics). Personalised treatments may be expensive (for rare conditions or genetics).
32	(Phase 1) – finding a safe dosage. (Phase 2) – to test for side effects on healthy volunteers. (Phase 3) – to test for {effectiveness / side effects} on a larger group of {patients / volunteer with conditions}. (Phase 3) – double blind trails to compare with {placebo / pre-existing drug}.
33	Placebo: Provides a control group for comparison. Ensuring drug is causing effect / improvements not due to psychological effect. Double blind trail: Neither doctors nor patients know who has been given the drug. Removes bias from trail.
34	(Lack of insulin sensitivity) prevents glucose being stored as glycogen (in liver and muscle cells). Glucose converted in to {fat/ lipids/ triglycerides}. Excess glucose stored in fat reserves around the abdomen.
35	By differentiation. Stimulus (e.g. chemical signal). Causes some genes to be {active / switched on / expressed}. Only active genes {are transcribed / produce mRNA}. mRNA translated to produce proteins. Idea that protein {modifies / determines} cell structure.
36	Radiation damages {DNA / mRNA} involved in production of muscle fibres. Decrease in protein synthesis. Decrease in the production of actin and myosin. Less actin-myosin cross bridges formed. Less muscle contraction can occur.

Paragraphs 15 - 18

37	Released from vesicle in the postsynaptic {membrane / knob}. Diffuses across the synaptic cleft. Binds to receptors in the hippocampus. Causes Na^{2+} channels to close / prevents Na^{2+} influx in the hippocampus. Depolarisation less likely to occur in hippocampus.
38	Give five different concentrations of adenosine to rats. A controlled biotic factor (e.g. species / age of rats). A controlled abiotic factor (e.g. temperature of environment). Record the difference in temperature in set amount of time (e.g. 10 minutes).

	A control group (e.g. rats not given adenosine). Repeat test for each concentration to calculate a mean. Use Spearman's rank to identify significant correlation between adenosine concentration and temperature change.
39	(A condition in which) core body temperature drops below 35 °C.
40	Increased rate of respiration. Causing skeletal muscles to contract and relax rapidly. Release heat into the body.
41	ATP is produced in {respiration / glycolysis / Kreb's cycle / oxidative phosphorylation}. (ATP) contains phosphate bonds. Which are hydrolysed. Energy released rapidly used as heat.
42	Inner membrane contains electron transport chain which pumps {protons / H^+} into the intermembrane space. Inner membrane contains ATP synthase involved in ATP production. Cristea increases surface area for increased oxidative phosphorylation. Matrix contains enzymes involved in respiration.
43	Controls automatic bodily processes.

Paragraphs 19 – 21

44	Have five groups of rats with different {caloric restrictions / fasting periods}. A controlled biotic factor (e.g. species / age of rats). A controlled abiotic factor (e.g. temperature of environment). Record the life span of rats. A control group (e.g. rats without restrictions). Repeat experiment to calculate a mean. Use Spearman's rank to identify significant correlation between fasting and lifespan.
45	There is no (significant) difference between life span and {caloric restrictions / fasting} in mice.

| 46 | Correct values for d and d^2 calculated (ignore minus symbol, no marks awarded for this point).

 $6\Sigma d^2 = 6 \times 68.5 = $ **411**
 Divided by $n(n^2 - 1) = 6(36 - 1) = $ **210**
 $r_s = 1 - \frac{411}{210} = $ **-0.96**, ALLOW **-0.957** |

Rat	Difference in rank (d)	Difference in rank squared (d^2)
A	-5	25
B	-3	9
C	-0.5	0.25
D	0.5	0.25
E	3	9
F	5	25

47	Degrees of freedom = n = 6 (no marks awarded for this point). R_s value is (±0.96) is greater than the critical value.* At the {0.05 / 5%} probability level / critical value is 0.786. There is **significant negative correlation** between caloric intake and median life expectancy in rats. *Negative values can be converted into positive values in order to compare with a critical value. This one works for two-tailed statistical tests.*

48	Trigged by epigenetic changes.
	Description of DNA methylation / histone modification / acetylation.
	Genes involved with suppression of {growth / mitosis} are {activated/ switched on/ expressed}.