M14/4/BIOLO/SP3/ENG/TZ1/XX/M

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BIOLOGY

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Option A — Human nutrition and health

1. (a) highest 34, lowest 17; ***[1]***

(b) BMI above 30 is obese;
more obesity/more values above 30 in 2003 than 1993;
maximum value of 40/higher maximum in 2003 compared to 34 in 1993;
greater range (of BMI values) / values above 30 in 2003;
mode/peak/most common BMI value has increased from 21 in 1993 to 22 in 2003;
mean BMI higher in 2003; ***[3 max]***

(c) change in eating habits/diet/junk food has led to more obesity;
reduced levels of physical activity may lead to more obesity;
population/migration/demographic changes (over 10 years);
more underweight individuals because of eating disorders/anorexia;
similar pattern in both sets of data so possibly no major changes in diet/lifestyle;
larger sample size in 2003 may account for greater range of BMI Values; ***[3 max]***

2. (a) minerals are elements in ionic form/are ions/are inorganic while vitamins are organic compounds ***[1]***
Do not accept vitamins are made in the body, minerals are not.

(b) fish / named fish / fish oil;
liver;
eggs/egg yolk;
dairy foods or example;
foods/cereals with added vitamin D; ***[2 max]***
Do not accept action of sunlight.

(c) should take enough to meet individual's needs/RDA;
need sufficient to prevent scurvy/promote tissue regeneration;
higher intake (than minimum) may give protection against infections/boost immune system / *OWTTE*;
excess vitamin C is excreted in the urine/cannot be stored;
danger of rebound malnutrition / normal intake may not suffice after a period of excessive intake; ***[3 max]***

3. (a) fibre cannot be digested;
supports peristalsis in the intestine / adds bulk/prevents constipation;
may reduce the risk of intestinal disorders/cancer;
reduces blood cholesterol;
bulk in stomach may help to prevent obesity (by the feeling of fullness);
slows sugar absorption/helps prevent diabetes; ***[2 max]***

(b) food miles measure how far food has travelled from production to consumption;
local food may cause less air pollution/greenhouse gas emissions/traffic congestion;
supports local producers;
encourages a more diverse local food economy;
local food is fresher/tastier/more vitamins;
transport of food allows increased choice/supports economies in developing countries;
eating local seasonal food has a lower environmental impact; ***[3 max]***

Option B — Physiology of exercise

4. (a) *men:* 60–69 (years)
women: 50–59 (years) ***[1]***
Both needed for ***[1]****.*

(b) more women than men have (at least some) muscle mass loss in all age categories / fewer women have normal muscle mass in all age categories;
onset of severe muscle mass loss earlier in men (18–29) than in women (30–39) / women lose muscle mass at an earlier age than men;
muscle mass loss continues to increase with age in women but plateaus in men;
muscle mass loss increases with age in both men and women; ***[2 max]***

(c) less exercise / injury / illness (preventing exercise);
less protein in the diet / poverty / dementia (resulting in poor diet choices);
normal result of aging / less regeneration;
reduced hormone output; ***[2 max]***

(d) (exercise will) help to build up muscles/improve stamina;
intense exercise will help to build up fast muscles/improve strength;
level of exercise adjusted to suit age group;
improve balance / avoid injuries due to falls; ***[2 max]***

5. (a) volume of air taken in or out with each inhalation/exhalation / *OWTTE* ***[1]***

(b) more (cell) respiration / ATP production causes a greater demand for O_2/production of CO_2;
increased tidal volume allows for increased supply of O_2/removal of CO_2;
increase concentration gradients in lungs; ***[2 max]***

(c) blood flow to the brain is unchanged during exercise;
blood flow to the heart muscle/skeletal muscles/skin is greater during exercise;
blood flow to the kidneys/stomach/intestines/other abdominal organs is reduced during exercise; ***[2 max]***

6. (a) (intense) exercise leads to anaerobic respiration/production of lactate;
lactate turned into pyruvate (in the liver);
pyruvate broken down/respired aerobically/requires additional oxygen;
increased ventilation continues after exercise has stopped;
replenish stored ATP / CP;
reoxygenate myoglobin; ***[3 max]***

(b) (i) the physical condition of the body (that allows) for a particular exercise/activity ***[1]***

(ii) exercising at speed indicates effective anaerobic respiration;
involves fast muscle activity;
indicates fitness for (short bursts of) intense exercise / sprinting;
not adequate (as a way of measuring fitness) for activities that require stamina / aerobic exercise / exercise involving slow muscle activity; ***[2 max]***

Option C — Cells and energy

7. (a) clay-bound enzyme with copper chloride ***[1]***
*Both needed for **[1]**.*

(b) both reduce enzyme activity;
copper chloride causes a greater decrease;
accept a numerical comparison of the reduction in activity; ***[2 max]***

(c) reduces the activity of/inhibits both free and bound enzymes;
reduces the activity of/inhibits free enzyme more than the control;
greatest inhibition/reduction in activity of the clay-bound enzymes;
correct numerical comparison; ***[2 max]***
Answers must be comparisons not just quoted numbers.

(d) copper binds to the enzyme away from the active site;
this changes the shape of the active site;
prevents substrate binding; ***[2 max]***

8. (a) (i) X ***[1]***

(ii) Z ***[1]***

(iii) W ***[1]***

(b) C2 compound/acetyl (Co A) reacts with a C4 compound/oxaloacetate;
C6 compound/citrate formed;
two carbons are removed (in steps) / carbon dioxide/CO_2 is formed;
C4 compound / oxaloacetate is regenerated;
ATP is formed;
reduced NAD/NADH/FADH is formed; ***[3 max]***
Accept suitably annotated diagram.

9. (a) hydrogen ions released by photolysis of water (by photosystem II);
proton pumps use energy to move hydrogen ions to the thylakoid interior;
against concentration gradient;
small volume / narrow space inside thylakoid allows concentration to build up; ***[2 max]***

(b) concentration of H^+ ions / protons inside the thylakoid creates a (electrochemical) gradient;
the H^+ ions diffuse through the thylakoid membrane (into the stroma);
via ATP synthase;
process is called chemiosmosis;
ATP is formed from ADP and Pi; ***[3 max]***

Option D — Evolution

10. (a) *length range:* accept answers in the range 270 to 350 (mm)
age range: accept answers in the range 3.3 to 2.4 (millions of years) ***[1]***
Both needed for ***[1]***.

(b) the ranges overlap/are similar;
H. erectus has the shortest value / *H. neanderthalensis* has the longest value;
femur length of *H. erectus* changes over time, whereas *H. neanderthalensis* does not; ***[2 max]***

(c) overall trend of increasing femur length implies evolutionary advantage;
example given from the data;
species with shorter femurs died out;
may allow for more energy-efficient/faster movement/upright posture/gait;
taller to see predators;
overlap in ranges (for more recent specimens) suggests no strong selective advantage;
evidence not strong since few specimens exist; ***[2 max]***

(d) few older specimens / gaps in the fossil record;
fossil specimens may not be identified correctly;
age of specimens may not be accurate;
fossils may be incomplete / femur lengths of incomplete fossils are estimates; ***[2 max]***

11. (a) internal chemical environment different from the surroundings ***[1]***

(b) some prokaryotes carried out photosynthesis;
oxygen is a waste product of photosynthesis; ***[1 max]***

(c) endosymbiotic theory;
endocytosis / engulfing of free-living organisms to form mitochondria/chloroplasts;
mitochondria/chloroplasts have (circular) DNA and (70S) ribosomes;
mitochondria/chloroplasts have similar size to prokaryotes;
double membrane suggests engulfing by endocytosis;
mitochondria/chloroplasts are capable of replicating independently;
it is a theory that cannot be repeated/ falsified; ***[3 max]***

12. (a) (i) the time taken for radioactivity (of a radioisotope) to fall to half of its original level/for half of the atoms of the isotope to decay ***[1]***

(ii) ^{40}K decays into ^{40}Ar;
ratio/proportion of ^{40}K to ^{40}Ar indicates the age of the rock/fossil
half-life of ^{40}K is 1250 million years / 1.25 billion years;
^{40}K can (only) be used to date very old samples / over 100 000 years; ***[2 max]***
Do not accept if reference to age is less than 100 000 years.

(b) members of a species can (freely interbreed and) produce fertile offspring;
species may be identified according to appearance / morphological features;
some members of a species vary morphologically/are polymorphic;
some morphologically similar organisms produce sterile offspring (so are not part of the same species);
multiple/a combination of features/genetic/DNA may be used (to define a species);
some species reproduce asexually;
sometimes a species can only be identified by the genes / DNA; ***[3 max]***

Option E — Neurobiology and behaviour

13. (a) before antler casting/January, February, March groups are 100 % male;
after antler casting percentage of males decreases;
reaches lowest value after velvet shedding/in September, October;
(from October to December) percentage of males increases to 100 %; ***[2 max]***

(b) antler casting begins in March / begins at the same time each year;
antler casting ends earlier/occurs in a shorter time period in 1981 than in other years;
velvet shedding happens in July / at the same time each year;
velvet shedding lasts for (almost) the same length of time each year; ***[2 max]***
*For **[2]** both antler casting and velvet shedding must be mentioned.*

(c) (percentage of males falls as) females join social groups for breeding;
group may be dominated by a single male who drives off other males;
after antler casting, males are more vulnerable to predators;
after breeding, females leave the groups (so percentage of males increases);
males form new social groups where dominance hierarchy is established; ***[2 max]***

(d) increasing day length/temperature may stimulate antler casting;
change in diet;
cues from the behavior of other animals;
may involve hormones released in response to external stimulus; ***[1 max]***
Do not accept changes in the weather or global warming.

14. (a) sound waves/vibrations in air cause ear drum/tympanic membrane to vibrate;
vibrations <u>amplified</u> by middle ear bones/ossicles/malleus, incus, stapes;
causes oval window/fluid in cochlea to vibrate;
stimulates mechanoreceptors/hair cells;
auditory nerve passes nerve impulse to brain; ***[3 max]***

(b)

Rods	Cones
function well in dim light / more sensitive to low light	function well in bright light;
absorb all wavelengths of visible light / not responsible for colour vision	sensitive to red, green or blue wavelengths / responsible for colour vision;
poor visual acuity / impulses from several rods pass to a single neuron in the optic nerve	good visual acuity / impulses from a single cone pass to a single neuron in the optic nerve;

[2 max]

Do not accept "rods detect black and white images".

15. (a) alcohol / benzodiazepines / tetrahydrocannabinol (THC) / marijuana / other valid example ***[1]***
Do not accept brand names.

(b) psychoactive drugs may increase/decrease post synaptic transmission;
can affect mood/behaviour;
increase / decrease the release of neurotransmitters;
delay the breakdown of neurotransmitters;
interfere with storage/re-uptake;
mimic the action of neurotransmitters / block receptors;
reduce the effect of excitatory neurotransmitters / increase the effect/release of inhibitory neurotransmitters; ***[3 max]***

(c) some individuals are genetically predisposed (whilst others are not);
some individuals are affected by peer pressure / cultural traditions;
some individuals suffer (named) social problems / trauma;
the pleasurable effects of dopamine may lead to addiction; ***[2 max]***

Option F — Microbes and biotechnology

16. (a) bacteria killed at low pH/below 4.4–4.7;
growth inhibited at higher pH/between 4.4 and 6.5;
bacteria grow at higher pH/above 6.3–6.5; ***[2 max]***

(b) growth decreases as nisin concentration increases;
even at high nisin concentrations some bacteria survive;
bacteria are killed at all pH values with high nisin;
growth only occurs at very low NaCl concentrations;
growth only occurs at lower NaCl or higher pH;
numerical response in place of the above; ***[3 max]***

(c) pH 6.5–6.8 or 8.5 (*the question does not state which concentrations of NaCl*) ***[1]***

(d) less salt is used;
food can be preserved at higher pH;
prevents disease/food poisoning caused by (pathogenic) bacteria; ***[1 max]***

17. (a) may have naked or enveloped capsid;
shape of the capsid/virus can vary;
DNA or RNA (but not both);
DNA/RNA may be single stranded or double stranded; ***[2 max]***

(b) (i) gene therapy / description of the process ***[1]***

(ii) SCID/other valid example ***[1]***

(c) reverse transcriptase (enzyme);
obtained from retroviruses (such as HIV);
used to make DNA/cDNA from (mature) mRNA;
without introns;
double strand completed by DNA polymerase;
double stranded DNA spliced into host DNA; ***[3 max]***

18. (a) (i) arrow from atmospheric nitrogen to ammonia marked X ***[1]***

(ii) *Nitrosomonas* ***[1]***

(b) raw sewage contains pathogens/toxins which enter the water;
(organic content/live microorganisms) cause eutrophication;
(eutrophication) causes algal blooms;
deoxygenation/high BOD;
causes death of aquatic organisms; ***[2 max]***

Option G — Ecology and conservation

19. (a) 2006 ***[1]***

(b) increases steadily from 1998 to 2002 and plateaus between 2002 and 2006;
overall increasing trend / lowest percentage in 1998 and highest in 2006; ***[1 max]***

(c) fledging success is always greater than breeding success;
show opposite trends before 2002 (*accept a description)*;
follow (closely) similar trends after 2002; (*accept a description)*;
maximum difference (in percentage) in 1998;
difference remains smallest between 2002 and 2006; ***[2 max]***

(d) many of the eggs laid do not hatch but those that do hatch fledge successfully ***[1]***

(e) eggs may have been laid late in the breeding season so warmer temperatures / shorter time for parental care (leading to low fledging success);
predation/disease of parents/chicks;
weather conditions at time of fledging may have been unusually harsh;
named resource / food may have been reduced; ***[2 max]***

20. (a) organisms are counted/estimated/identified;
along a line/string/set of markers;
abiotic factors can be measured;
results are used to correlate distribution with an abiotic variable; ***[2max]***

(b) measure the area where the population lives;
count individuals inside a quadrat;
use random sampling;
sample a representative area / place sufficient quadrats;
calculation: mean number per quadrat x total area / area of the quadrat; ***[2 max]***
Do not accept quadrant.

21. (a) (i) temperature;
water;
light;
soil pH;
salinity;
mineral nutrients;
presence of pollinators/dispersal vectors;
herbivores;
interspecific competition; ***[2 max]***

(ii) only one species can occupy a niche indefinitely;
more than one species results in competition for breeding sites/food/other named resource;
one species will disappear from the ecosystem/be excluded; ***[2 max]***

(b) lichens/mosses colonise the area;
lichens (release acids which) break up rocks;
decomposed plants/mosses/lichens contribute to soil development/increase organic matter;
minerals are extracted (by microorganisms) from underlying rocks and accumulate in soil;
root network and surface covering of plants help reduce erosion so soil can accumulate;
water retention increases; ***[3 max]***