Option A — Human nutrition and health

1. (a) highest 34, lowest 17;  
   (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;  
       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;  
   (c) min 12, max 17;  
       mean BMI higher in 2003;  
       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;  

2. (a) minerals are elements in ionic form/are ions/are inorganic while vitamins are organic compounds  
       Do not accept vitamins are made in the body, minerals are not.  
       fish / named fish / fish oil;  
       liver;  
       eggs/egg yolk;  
       dairy foods or example;  
       foods/cereals with added vitamin D;  
       Do not accept action of sunlight.  
       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. (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)  
    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; \([2\text{ max}]\)  

(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; \([2\text{ max}]\)  

(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; \([2\text{ max}]\)  

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; \([2\text{ max}]\)  

(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; \([2\text{ max}]\)
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
    *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;
        *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/CO₂ 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)
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

(ii) \(^{40}\text{K}\) decays into \(^{40}\text{Ar}\);
    ratio/proportion of \(^{40}\text{K}\) to \(^{40}\text{Ar}\) indicates the age of the rock/fossil
    half-life of \(^{40}\text{K}\) is 1250 million years / 1.25 billion years;
    \(^{40}\text{K}\) can (only) be used to date very old samples / over 100 000 years;
    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;
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; For [2] both antler casting and velvet shedding must be mentioned. [2 max]

(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; Do not accept changes in the weather or global warming. [1 max]

14. (a) sound waves/vibrations in air cause ear drum/tympanic membrane to vibrate; vibrations amplified 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)

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

Do not accept “rods detect black and white images”.
15. (a) alcohol / benzodiazepines / tetrahydrocannabinol (THC) / marijuana / other valid example
   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;

   (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;
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  

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

(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;  

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

(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;  

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;  

(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;  
Do not accept quadrant.
21. (a) (i) temperature; 
water; 
light; 
soil pH; 
salinity; 
mineral nutrients; 
presence of pollinators/dispersal vectors; 
herbivores; 
interspecific competition; 

(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; 

(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; 

[2 max] 

[2 max] 

[3 max]