Oxford Resources for IB

Biology – 2023 Edition

Answers

Topic B1 – Molecules

Page 184 Data-based questions: Health consequences of the consumption of fructose

1. sucrose is a disaccharide; fructose is a monosaccharide;
2. body fat accumulation increased over time for all four groups;

   fructose caused the (significantly) greatest accumulation of fat and water the least;

   sucrose and artificial sweetener/diet soft drink had the same increase;

   sucrose, artificial sweetener and water did not start accumulating fat until after 20 days while fructose increased from the beginning;

   glucose-fed group has no/little increase in triglycerides while fructose-fed group has a (large) increase;

   glucose-fed group has smaller variability than the fructose-fed group;

   more triglycerides in fructose-fed group than glucose-fed group (from week 2 to week 10);
3. glucose has a much greater range of uptake / vice versa;

   but a (much) lower mean / uptake / vice versa;

   there is no overlap (so there is clear evidence);
4. fructose

Page 198 Data-based questions: Essential amino acids

1. **a.** essential amino acids must be obtained from the diet;

   they cannot be synthesized by the body ***OR*** they cannot be synthesized from other amino acids;

   b. contains all the essential amino acids;

   human milk has higher levels of 5 (out of 9) essential amino acids than cow milk ***OR*** human milk has the same or more of essential amino acids except histidine and lysine compared to cow milk;

   human milk is the same or higher in all essential amino acids except histidine compared with hen egg ***OR*** human milk has higher levels of 4 (out of 9) essential amino acids compared with hen egg;

   human milk contains less histidine than both hen egg AND cow milk;

   c. tyrosine can only be synthesized when phenylalanine is in the diet;

   d. PAH enzyme not functional / mutation leading to non-functional PAH;

Page 205 Data-based questions: Haemoglobin subunits during development

1. epsilon-globin and zeta-globin;

2. gamma is expressed in the first 10 weeks while beta is not;

while gamma declines, beta increases;

gamma is not expressed at 6 months while beta is significant fraction of haemoglobin at 6 months;

both are expressed in approximately equal amounts at 24 days;

3. at 10 weeks, haemoglobin is composed of equal amounts of alpha and gamma globin;

At 6 months, haemoglobin is primarily composed of alpha globin and beta globin with smaller amounts of delta globin;

4. maternal blood;

5. foetal blood and maternal blood differ in affinity for oxygen;

(difference in haemoglobin structure gives) foetal blood greater affinity so oxygen moves from mother to fetus;

change (with development) necessary so fetus can prepare for independent gas exchange/transition from placental to pulmonary gas exchange;

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1. a. triglycerides are composed of three fatty acids and glycerol;

fatty acids are amphipathic whereas triglycerides are not;

triglycerides have a higher molecular weight;

b. all have a higher concentration of triglyceride at Site 1 than at Site 2;

HT (and WS) highest at both sites/at Site 1;

MW lowest at Site 1 and AR lowest at Site 2; [2 max]

Do not allow answers quoting only numerical statements.

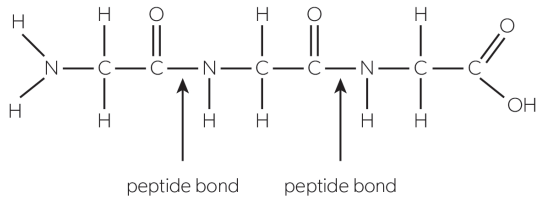
c. triglyceride higher at Site 1 because more fat deposition / HT eats more;

butyrate higher at Site 2 because more fat/triglyceride utilized / HT eats more;

d. (data supports hypothesis) because triglyceride levels higher at Site 1;

butyrate levels higher at Site 2; [2 max]

2.



3. Na^+/K^+ pump involved in the exchange of ions necessary for nerve signal conduction;

haemoglobin for oxygen transport in blood;

myosin for muscle contraction

4. cellulose is a polysaccharide;

composed of subunits/linear chains of glucose;

linked by β-1,4-glycosidic bonds;

held together by hydrogen bonds;

5. both are amphipathic;

both are unsaturated / both involve dehydrogenation;

a *trans* bond creates a straight chain whereas a *cis* chain is bent;

6. **a.** the sequence of amino acid determines the primary structure;

b. secondary structure consists of regions stabilized by hydrogen bonds;

local structure rather than overall 3-dimensional structure;

between the amino hydrogen and carboxyl oxygen atoms within the polypeptide;

most common forms are α-helix and β-pleated sheet;

c. five groups;

d. conserved sequences suggest common ancestry;

it could indicate convergent evolution because LCC have an adaptive advantage and could have evolved multiple times;

this is less likely the more times convergent evolution would have to occur;

e. (1 + 5 + 4 + 17) = 27

f. $\frac{304}{460} \times 100 = 66(.1)\%$

g. plant kingdom shares 52 (LCC protein) groups with animal kingdom but only nine groups with prokaryote kingdom;

plant kingdom shares 47 groups with animal kingdom that are not found in prokaryote kingdom but only four groups with prokaryotes that are not found in animals;

insufficient data for prokaryotes to be more closely related;

Topic B2 – Cells

Page 214 Data-based questions: Membrane permeability

1. **a.** both positive among tails and negative among heads;

MMB4 more positive among tails and more negative among heads;

b. both negative among tails and decreasingly negative among heads;

progesterone more negative among tails and less negative among heads;

2. **a.** progesterone;

b. MMB4;

3. more hydrophilic;

MMB4 has two, 3-PAM has one and the others have none;

4. impermeable: MMB4/2-PAM;

low: theophylline;

medium: diazepam; high: promazine;

5. high permeability;

Page 215 Data-based questions: Diffusion of oxygen in the cornea

1. 1 mm = 1000 µm; 400 µm × 1 mm / 1000 µm = 0.4 mm;

2. **a.** decreasing with distance;

sharply at first but then decreasing more gradually;

b. used by cornea cells for aerobic respiration;

diffusion from the air is slow;

no blood supply to bring oxygen;

no cells / no respiration in aqueous humour / oxygen supplied by blood capillaries in iris;

3. **a.** higher than the inner cornea; lower than the inner cornea;

b. concentration is lower in the cornea;

there would not be (net) diffusion from the aqueous humor;

4. levels quickly fall off over a distance of 100 µm;

making it an ineffective mechanism of transport over larger distances;

5. **a.** increase in the distance O_2 has to move / decreasing concentration at the inner cornea;

b. increase moisture / increase O_2 permeability of the lens;

6. an indication of the variability of the data;

provides an indication of the reliability of the data;

Page 218 Data-based questions: Phosphate absorption in barley roots

1. reduction in oxygen concentration below 21% reduces phosphate absorption;
from 21% to 2.1%, the reduction is very small/not significant;
large/significant reductions below 0.9% / from 0.9% to 0.1%;

2. phosphate absorbed by active transport;
ATP required for active transport;
ATP produced by aerobic respiration in roots;
aerobic respiration requires oxygen;

3. phosphate absorbed mainly by active transport;
when DNP blocks production of ATP by aerobic respiration, phosphate absorption drops to a low level;

4. still some phosphate absorption when DNP has blocked ATP production by aerobic respiration;
some ATP might be produced by anaerobic respiration;
active transport probably not the only method of phosphate absorption;
aerobic respiration fully blocked at 6 mmol dm^{-3} DNP, as phosphate absorption does not drop any lower above this concentration;

Page 221 Data-based questions: Frost hardiness and double bonds in chickpeas

1. **a.** negative correlation/LT_{50} rises as double bond index falls;

b. unsaturated fats have a lower melting point;
unsaturated fats remain liquid to a lower temperature; membrane leakage if membrane lipids change from liquid to solid;

2. reduces LT_{50};
increases double bond index;

3. causes the double bond index to rise;
increases the proportion of unsaturated lipids;

4. cold acclimatization more effective;
LT_{50} reduced from above −11 °C to below −12 °C/no overlap;
effect of ABA treatment not as marked/less clear-cut;

Page 233 Data-based questions: Structure and function in mitochondria

1. C

2. C

3. circular in section so could be spherical;
but could be other shapes which are circular in one or more planes of section;

4. those in Figure 8d produced most;
greatest area of cristae;
where oxidative phosphorylation/chemiosmosis/ATP synthesis happens;

5. **a.** cell wall/plasma membrane

   b. rough endoplasmic reticulum

Page 243 Data-based questions: Adaptations of the Western spadefoot toad

1. **At low water levels:**

   toads can mate earlier as conditions are dry;

   toads can move to larger ponds;

   tadpole / organism cannot survive in absence of water;

   At high water levels:

   larger toads more resistant to predation;

   larger toads more attractive to mates;

2. concentrations of thyroxine and corticosterone higher in low water group / vice versa;

   greater difference in thyroxine concentration / less difference in corticosterone concentration between the two groups;

   in both groups thyroxine concentrations are higher than corticosterone concentrations;

3. differentiation requires differences in gene expression;

   thyroxine and corticosterone likely affect gene expression;

   turning on the genes for differentiation into adult body form;

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1. **a.** 98 130 μm^2

   b. (1780 ÷ 98 130) × 100% = 1.81% total area;

   c. outer membrane is smooth/not folded;
   inner membrane is infolded;
   to form cristae;

d. high amounts of rER;

high amounts of mitochondria;

both the above suggest high amounts of protein synthesis (explaining rER);

which is catabolic and therefore requires energy (explaining mitochondria);

2. a. i. active transport;

ii. facilitated diffusion;

iii. osmosis;

b. because chloride ions are not present;

due to mutated chloride channels;

water does not leave cells;

due to osmosis;

the mucus is thus dehydrated;

and doesn't flow and isn't easily moved by cilia lining the respiratory tract;

3. a. as the diameter of the molecule increases, the rate of diffusion decreases;

exponential decline in rate with increase in diameter;

b. i. simple diffusion: 10–15 mmol cm^{-3} cells hr^{-1};

ii. facilitated diffusion: 360 mmol cm^{-3} cells hr^{-1};

Topic B3 – Organisms

Page 257 Data-based questions: Concentration gradients

1. inhaled air mixes with air in alveolus which has a lower oxygen concentration / is stale air;

some oxygen has diffused into capillaries that surround the alveoli due to low partial pressure of oxygen in those capillaries;

2. a. $\left|\frac{105-40}{40}\right| \times 100\%$;

the partial pressure of oxygen is 163% higher in the alveolus;

b. diffusion;

c. i. $\left|\frac{3-27}{3}\right| \times 100\%$;

800% increase in CO_2 concentration between inhaled and exhaled air;

ii. CO_2 produced by cell respiration;

CO_2 enters blood as it flows through tissues of the body;

CO_2 has diffused out of the blood into the alveolus raising the CO_2 concentration in the alveolus;

d. nitrogen concentration in blood is already as high as in the atmosphere;

nitrogen not used by tissues of the body;

no concentration difference between blood and air in alveolus;

as many carbon dioxide molecules move from blood to air as from air to blood / no net movement;

Page 259 Data-based questions: COPD and gas exchange

1. a. typical results: healthy lung 8–16 times; lung with emphysema 4–8 times;

b. COPD reduces the area of gas exchange surfaces decreases; by about half;

the volume of the alveoli increases;

decreasing surface area-to-volume ratio;

decreasing total gas exchange per unit time;

2. total gas exchange per unit time decreases;

lower levels of oxygen in blood;

lower availability of ATP for energy requiring activities;

3. greater resistance to blood flow in the lungs because of decreased numbers of capillaries;

leads to an increase in blood pressure;

Page 263 Data-based questions: Sun and shade leaves

1. Plan diagrams should show tissue areas and not individual cells and the size of each area should be proportional to its actual size. All tissues should be clearly labelled. Upper and lower epidermis, palisade and spongy mesophyll and xylem and phloem should be labelled. The circle of cells around the veins is the bundle sheath. A sharp pencil should be used for drawing or an appropriate software package. Labelling lines should be ruled but not margins of tissues because they are not exactly straight.

2. lower leaf is thicker overall;

lower leaf has thicker waxy cuticle on the upper surface;

lower leaf has more layers of cells in the palisade mesophyll;

upper leaf has thicker spongy mesophyll;

3. a. lower leaf was in the sun;

b. more photons of light received by the sun leaf;

light penetrates further in the leaf;

hotter so water loss/transpiration more problematic;

Page 277 Data-based questions: Hypertension

1. 25/10000;

2. as both increase, death rates increase;

increases in systolic blood pressure have a larger effect;

3. 160 – 70 = 90 mm Hg;

4. difference appears to be important only at very high systolic rates;

Page 289 Data-based questions: Heart action and blood pressures

1. blood is pumped from atria to ventricles 0 seconds to 0.1 seconds (NB the slight rise in atrial pressure at 0.15 seconds is probably due to the AV valve bulging back into the atria as ventricular systole starts);
2. ventricles start to contract at 0.10 seconds;
3. AV valve closes at 0.1 seconds (atrial pressure falls below ventricular pressure);
4. SL valve opens at 0.15 seconds (ventricular pressure rises above arterial pressure);
5. SL valve closes at 0.4 seconds (ventricular pressure falls below arterial pressure);
6. blood is pumped from the ventricle to the artery from 0.15 to 0.4 seconds;
7. **a.** blood in the ventricle is at a maximum at 0.1 seconds (just before the SL valve opens);

   b. blood in the ventricle is at a minimum at 0.4 seconds (at the end of ventricular systole);

Page 290 Data-based questions: Modelling root pressure

1. −250 in soil;

   −650 in xylem sap;
2. from soil to root cells;

   from root cells to xylem sap;

   from higher to lower water potential;
3. active transport, because the ions are moving against the concentration gradient;
4. soil is at atmospheric pressure;
5. lower pressure in xylem because the sap can flow upwards;

   higher pressure inside cells because plasma membrane is pushed against the cell wall;

Page 296 Data-based questions: transverse sections of striated muscle

1. a longitudinal section is one that is cut along the long axis of a structure;
   a cross section would be one that is perpendicular to the long axis;
2. the light band, as it contains only actin;
3. the first and second have the same pattern of large dots;

   the first and the third have the same pattern of small dots;

   the first is heterogeneous while the second and the third are homogenous;

   the first is a combination of the second and the third;
4. the first diagram shows the region of the sarcomere where actin and myosin are both found (the dark band);

   the second diagram shows myosin only (central part of the dark band – sometimes called the H zone);

   the last diagram shows actin only (light band);

Page 304 Data-based questions: Relationship between movement and food sources

1. a. 1450 m

b. 980 m

2. shark 2 turns / changes direction more often than shark 1 / vice versa

3. shark 1 swims in water where the zooplankton levels are low;

shark 2 swims in water where the zooplankton levels are higher;

shark 2 turns more often because it is feeding in plankton / food rich water / shows highest degree of turns where zooplankton levels are highest;

shark 1 turns less often because it is still searching for food / there is not much to eat;

4. water temperature; other sharks / competitors; mates; water currents; pollution; any other possible reasons;

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1. a. spring, green light

b. in green light, birds migrate North in spring but South in autumn;

in red light, birds orientate (North) West in both autumn and spring;

c. in red light, birds do not migrate in the normal pattern/direction;

red light disorientates the birds/interferes with the functioning of magnetoreceptors;

red light has (almost) the same effect as total darkness / birds do not see in red light;

d. during the daytime;

direction of migration is not normal/wrong orientation in darkness;

e. no effect;

may become (even) more random;

2. a. muscle contractions cause the pressure inside the thorax to drop below atmospheric pressure;

air is drawn into the lungs until the lung pressure rises to atmospheric pressure (inspiration);

muscle contractions cause the pressure inside the thorax to rise, forcing air out of the lungs (expiration);

b. ventilation involves the movement of air in and out of the lungs;

respiration involves exchange of gases in the alveoli and in cells;

c. during inspiration, the external intercostal muscles contract and the internal intercostal muscles relax;

during expiration, the external intercostal muscles relax and the internal intercostal muscles contract;

d. spirometer

e. 2.65 litres × 70 breaths = 186 litres

f. both increase with treadmill speed;

ventilation rate increases exponentially with treadmill speed;

tidal volume increases but then levels off;

3. a. $\frac{100}{1.85^2} = 29.2 \text{ kg m}^{-2}$

b. Q5 in adolescence has the highest risk of CHD;

Q4 in adolescence has the second highest risk of CHD;

Q5 in adulthood raises risk but not as much;

there is no data for the fifth quartile BMI in adulthood;

4. a. i. airways become blocked, so ventilation stops; oxygen concentration of alveoli falls so saturation drops;

ii. reduced oxygen saturation wakes the sleeper; airways reopened by moving the soft palate;

iii. 55 cycles in one hour; 65 seconds per cycle;

b. 65%;

5 hours 40 minutes;

c. normal sleep initially;

then apnoea for rest of night apart from two periods of normal sleep;

5. a. Antagonistic muscles are a pair of muscles that work together, such that when one contracts the other relaxes. This could be illustrated with the external and internal intercostal muscles in the ribcage.

b. 26 flaps;

c. vigorous contractions during take-off and landing, less vigorous contractions during fast flight;

decreasingly vigorous contractions during take-off and fast flight / increasingly during landing;

fewer contractions per unit time in (later stages of) fast flight than other phases;

most vigorous contractions during landing;

d. TB is used (mainly) for landing;

e. the upstroke of the wing;

f. similar frequency to the SB muscles / same number of contractions;

the peaks of activity would be out of phase / alternate with those of the SB and TB;

g. ATP binds to the myosin head and breaks the cross-bridge between the myosin and actin filaments;

ATP is hydrolysed into ADP + P, changing the angle of the myosin head. Myosin head forms new cross-bridge with actin further from the centre of the sarcomere;

ADP + P is released, and myosin head returns to its original position, pushing the actin filament (power-stroke);

Collective power-strokes cause contraction of the muscle;

Topic B4 – Ecosystems

Page 314 Data-based questions: Intertidal zonation

1. use a transect down the beach;

line/belt laid out using measuring tapes;

abundance of each species assessed at each interval along the transect;

2. *Sargassum muticum* is abundant across a large shore distance;

3. $\frac{5000\text{ mm}}{3\text{ mm}} \approx 1667\times$;

1667 × 54 mm = 90000 mm = 90 m

4. **a.** *Enteromorpha sp.*

b. *Fucus serratus*

c. *Arenicola marina*;

5. cannot tolerate desiccation;

cannot tolerate high salt found in evaporating tidal pools;

adapted to a particular type of wave action;

upper tidal species are better adapted to variable conditions that persist in the upper tidal pools;

6. *Sargassum muticum* and *Anemonia viridis*;

7. Quantitative measurement of abundance rather than qualitative estimation;

Page 315 Data-based questions: Data-logging pH in an aquarium

1. sharp rises and falls are due to artificial light being switched on and off by a timer;

fluctuations when artificial light is on are due to variation in natural light/cloudy or sunny conditions;

2. six days;

3. **a.** pH rises in the light; becomes more alkaline/basic;

b. absorption of carbon dioxide (which is acidic) from the water;

by photosynthesis;

4. **a.** pH falls in darkness (mostly)/becomes more acidic;

b. more cell respiration than photosynthesis;

carbon dioxide released into the water;

Page 325 Data-based questions: Mixotrophy in golden algae

1. Both grow most rapidly with both light and prey;

   2951 grows with light only but 1393 does not;

   2951 grows with prey only but 1393 does not;

2. obligate mixotroph;

   because it grows when given both light and prey;

   but does not grow when either light or prey are not supplied;

3. can obtain carbon compounds/energy/nutrition by photosynthesis;

   can obtain carbon compounds/energy/nutrition by feeding on bacteria/Vibrio;

   grows fastest with mixotrophic nutrition;

Page 327 Data-based questions: Fishing down marine food webs

1. check its stomach contents; determine trophic level of organisms within the stomach;
2. **a.** both have been declining over the study period; rate of decline is faster in fresh water populations;

   rate of decline is more constant in marine/accelerating in freshwater;

   b. freshwater fisheries are more established/have been overfished for longer, freshwater populations smaller/more susceptible to disruption;
3. increasing age means increasing size; increasing size means broader range of prey including larger fish/higher trophic level fish;
4. age correlated with trophic level; lowering of trophic level means lowering of mean age;
5. greater biomass of lower trophic level means higher sustainable yield which allows higher trophic levels to recover;

Page 334 Data-based questions: Competitive exclusion in cat-tails

1. both grow best at 50 cm;

   T. latifolia grows more between −20 cm and 50 cm;

   both grow at a low rate at −20 cm;

   only *T. angustifolia* grows at 80 cm and above;

2. no growth at depths of 20 cm or less with competition;

   maximum growth at 50 cm without competition and 80 cm with competition;

3. *T. latifolia* and *T. angustifolia* have overlapping fundamental niches;

   but *T. angustifolia* can grow in deeper water than *T. latifolia;*

   realized niche of *T. angustifolia* is narrower than its fundamental niche because it is excluded from shallower water;

   realized niche of *T. latifolia* is similar to its fundamental niche but maximum growth is at 20 cm rather than 50 cm

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1. a. 87 °C (units required)(accept answers in the range of 86 °C to 88 °C);

b. as pH increases, optimum growth temperature increases / directly proportional / positive correlation;

c. Archaea survive at a greater range of pH than the bacteria;

Archaea can survive at higher temperatures than the bacteria;

Archaea can survive at lower values of pH than the bacteria;

overlap in (optimum)temperature (for the two groups) between pH 5 and 7;

d. there is some overlap between the values;

(overlap) occurs at approximate pH 5–7 / temperature about 75 °C to 88 °C;

classification based on the features / DNA / metabolism not considered by the data;

e. anaerobic environments / appropriate example.

2. a. i. slope and (occlusal) relief decrease with wear / teeth become flatter

ii. teeth of early Hominids have a greater slope / (occlusal) relief (at all stages) than *A. afarensis*;

wear has greater effect on slope in *A. afarensis* than in early Hominids;

wear has less effect on (occlusal) relief in both;

the (occlusal) relief of Hominids progressively decreases whereas it remains relatively stable for *A. afarensis*;

b. early Hominids ate more elastic foods such as meat;

early *A. afarensis* ate more hard, brittle foods;

the diets were similar at wear stage 3;

c. tools found with early Hominid fossils;

bones of prey found with early Hominid fossils;

plant remains (e.g., pollen, seeds) found in the immediate area;