**Topic 6 - data-based questions**

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1. blood is pumped from atria to ventricles 0 seconds to 0.1 seconds (N.B 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);

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1. a) increasing to peak in 1993; decreasing to 1996; increasing to a peak in 1998; declines to lowest level in 2002;

   b) pattern appears to be cyclical;

2. \( \frac{(5.2 - 16.0)}{16.0} \times 100\% = -67.5\% \);

3. lowest levels of resistance occurred after programme implementation; therefore same success; peak in 1998 suggests programme not fully effective;

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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) \( \frac{105 - 40}{40} \times 100\% = 163\% \); the partial pressure of oxygen is 163% higher in the alveolus;

   b) diffusion;

   c) (i) \( \frac{3 - 27}{3} \times 100\% = 800\% \); 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;

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1. a) *typical results*: healthy lung 8 times; lung with emphysema 4 times; units are number of gas exchange surfaces per 60 mm of micrograph; (if the magnification of the micrograph is known, the units could be converted to per micrometre of lung);

   b) as a result to emphysema, the mean number of gas exchange surfaces decreases; by about half; the volume of the alveolus increase; 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 increase in blood pressure;
WITHIN TOPIC QUESTIONS

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1. —72 mV;
2. —30 mV; because the membrane potential starts to rise very steeply on the trace when this potential is reached;
3. depolarisation takes approximately 2 ms according to the graph; repolarisation takes approximately 2 to 3 ms; depolarisation and repolarisation together take 4 to 5 ms;
4. more than 65 ms because the graphs shows that the resting potential has not been reached after than time; estimates between 80 and 500 ms are reasonable;
5. assuming a refractory period of 60 ms after the action potential during which impulses cannot be initiated, there could be one action potential per 80 ms; 1000 / 80 impulses per second = 12 action potentials per second;
6. pulse of current that was given to stimulate impulses has not yet finished and causes the membrane potential to rise briefly after the repolarisation;

Page 325–326
1. a) precursor to L-Dopa so increases dopamine production in existing neurons;
   b) prevents dopamine breakdown, prolonging dopamine effects;
   c) favours dopamine production pathway by blocking alternative pathway;
   d) an agonist either mimics or promotes the activity of a chemical such as dopamine;
   e) causes dopamine concentration to increase / remain high in the synapse;
2. a) stem cells cultured and develop into neurons; dopamine-secreting neurons / cells produced; transplanted into brain to replace dopamine-secreting neurons;
   b) insert functional copy of gene to replace mutant gene; insert into vector such as a virus; inject large numbers of transgenic viruses into patient;

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In person with diabetes:
   a) higher concentration of glucose at time zero;
   b) longer time to return to baseline (hasn’t occurred after 5 hours);
   c) much higher maximum glucose;
   d) delay in time before glucose begins to fall;

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1. a) the more menstrual cycles, the higher the bone mineral density; significant increase in bone density once the number of cycles surpasses 10; effect on bone density is not uniform across the bone;
   b) as few as 1–3 has clear effect on entire bone but 4–10 has a different effect depending on the part of the bone; neck of femur has lower density when number is between 4–10; trochanter has higher density when number is between 11–13; lowest density reached in neck/highest density reached in trochanter; both show the relationship that the more menstrual cycles, the higher the bone mineral density;
2. a) may have better diets; may have more moderate running regimes;
   b) lower bone density might be caused by caused by insufficient nutrient intake; lower bone density might be caused by low estrogen levels; older runners might be over-represented in this category; high energy consumption might forestall bone maintenance;
3. a) preserving resources for demanding exercise regime; reduced estrogen impacts uterine and ovarian hormone cycles;
   b) reduced appetite/exercise regime is part of weight loss strategy.
Topic 6 - end of topic questions

1. a) success rate increases as age of mother increases; success rate much lower above age 39; success rates slightly lower below 30 than 30–34;
   b) success rates increase as more embryos are transferred; but rate with two/three is not double/triple rate with one; rate with three embryos only slightly greater than rate with two;
   c) restricting the number of embryos transferred reduces chance of multiple birth; multiple births increase the health risks for mother/child; restricting number of embryos to two would prevent (almost all) triplets; older mothers at less risk of multiple births so more embryos could be transferred;

2. a) glucose is stored in liver as glycogen when blood sugar is high; when blood sugar is low, glucose is released from liver stores; daily fluctuations in glycogen levels is linked to daily fluctuations in blood glucose; caused by eating; and activity;
   b) homeostasis is maintenance of variables at or near a set point; blood sugar regulated by the hormones insulin and glucagons; these hormones whether glucose is stored as glycogen; or released from glycogen stores; considerable daily variation is glycogen stores enables blood sugar homeostasis;

3. 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;

4 and 5

a) (i) the magnitude of the depolarization is lower; and it takes longer to reach;
   (ii) the action potential has a longer duration; highest value takes longer to reach; re-polarization takes longer;

b) with reduced extra-cellular Na⁺ the magnitude of depolarization will be lower, as the concentration difference is lower and the electrochemical gradient is lower;

c) membrane potential does not rise as far during depolarisation / does not rise above 0 mV; fewer potassium channels open; potassium ions diffuse out of axon at slower rate;

d) the magnitude of the action potential is lower in the mutants; the rate of depolarization is approximately equal; the rate of re-polarization is much longer in the mutant; as a result the duration of the action potential is longer in the mutant; final resting potential is the same in both;

e) K⁺ channels faulty / don’t all open / don’t open for as long so slower diffusion of K⁺ ions explaining the slower repolarisation; K⁺ channels might open early preventing maximum depolarisation.