BIOLOGY UNIT 5 SUMMARY QUESTIONS

1. **For each of the following, name the type of response described and the survival value of the response;**
2. **Some species and bacteria move away from the waste products that they produce**

Negative chemotaxis – wastes are often removed from an organism because they are harmful. Moving away prevents the waste harming the organism and so increases chance of survival

1. **The sperm cells of a moss plant are attracted towards a chemical produced by the female reproductive organ of another moss plant**

Positive chemotaxis – increases the chances of sperm cells fertilising the egg cells of other mosses and so helps to produce more moss plants/future generations. Cross-fertilisation increases genetic variability, making species better able to adapt to future environmental changes.

1. **The young stems of seedlings grow away from gravity**

Negative geotropism – takes the seedlings above the ground and into the light, where they can photosynthesise. More photosynthesis means more carbohydrate and so a better chance of survival

1. **What is the function of the autonomic nervous system**

It controls the involuntary activities of internal muscles and glands

1. **Distinguish between the functions of the sympathetic and parasympathetic nervous systems**

SYMPATHETIC – stimulates effectors and so speeds up an activity. Prepares for stressful situations such as the fight or flight response

PARASYMPATHETIC – inhibits effectors and slows down an activity. Controls activities under resting conditions, conserving energy and replenishing the body’s reserves

1. **Suppose the parasympathetic nerve connections from the medulla oblongata to the SAN were cut. Suggest what might happen if a person’s blood pressure increases above normal**

Blood pressure remains high because the parasympathetic nervous system is unable to transmit nerve impulses to the SA node, which decreases heart rate and so lowered blood pressure

1. **The nerve connecting the carotid artery to the medulla oblongata of a person is cut. This person then undertakes some strenuous exercise. Suggest what might happen to the person’s;**
2. **Heart rate –** remains as it was before taking exercise – after exercise, blood pressure increases and carbon dioxide concentration of blood rises (causing blood Ph to be lowered). The changes are detected by pressure and chemical receptors in the wall of carotid arteries. As the nerve from here to the medulla oblongata is cut, no nerve impulse can be sent to the centres that control heart rate.
3. **Blood carbon dioxide concentration –** blood carbon dioxide concentration increases as a result of increased respiration during exercise.
4. **What is a stretch-mediated sodium channel**

A special type of sodium channel that changes it permeability to sodium when it changes shape/is stretched

1. **Describe the sequence of events by which pressure of a Pacinian corpuscle results in the creation of a generator potential**

Pressure on Pacinian corpuscle = corpuscle changes shape = stretches membrane of neurone = wides stretch-mediated sodium ion channels = allows sodium ions into neurone = changes potential of membrane/depolarises = produces a generator potential

1. **Explain why brightly coloured objects often appear grey in dim light**

Only rod cells are stimulated by low-intensity (dim) light. Rod cells cannot distinguish between different wavelengths/colours of light, therefore the object is perceived only in a mixture of black and white i.e. grey

1. **At night, it is often easier to see a star in the sky by looking slightly to the side of it rather than directly at it. why**

Light reaching earth from a star is of low light intensity. Looking directly at a star, light is focused on to the fovea, where there are only cone cells. Cone cells respond only to high light intensity so they are not stimulated by the low light intensity from the star and cannot be seen. Looking to one side of the star means that light from the star is focused towards the outer regions of the retina, where there are mostly rod cells. These are stimulated by low light intensity and therefore the star is seen.

1. **State three ways in which a response to a hormone differs from a response to a nerve impulse**

Hormone response is slow, widespread and long-lasting

Nervous response is rapid, localised and short-lived

1. **Name two chemical mediators and state the effects they each have on blood vessels**

Histamine and prostaglandins – both cause dilation of small arteries and arterioles and increase permeability of capillaries

1. **Suggest two advantages to a plant of having roots that respond to gravity by growing in the direction of its pull**

Response ensures that roots grow downwards into the soil, this anchoring the plant firmly and bringing them closer to water which is needed for photosynthesis

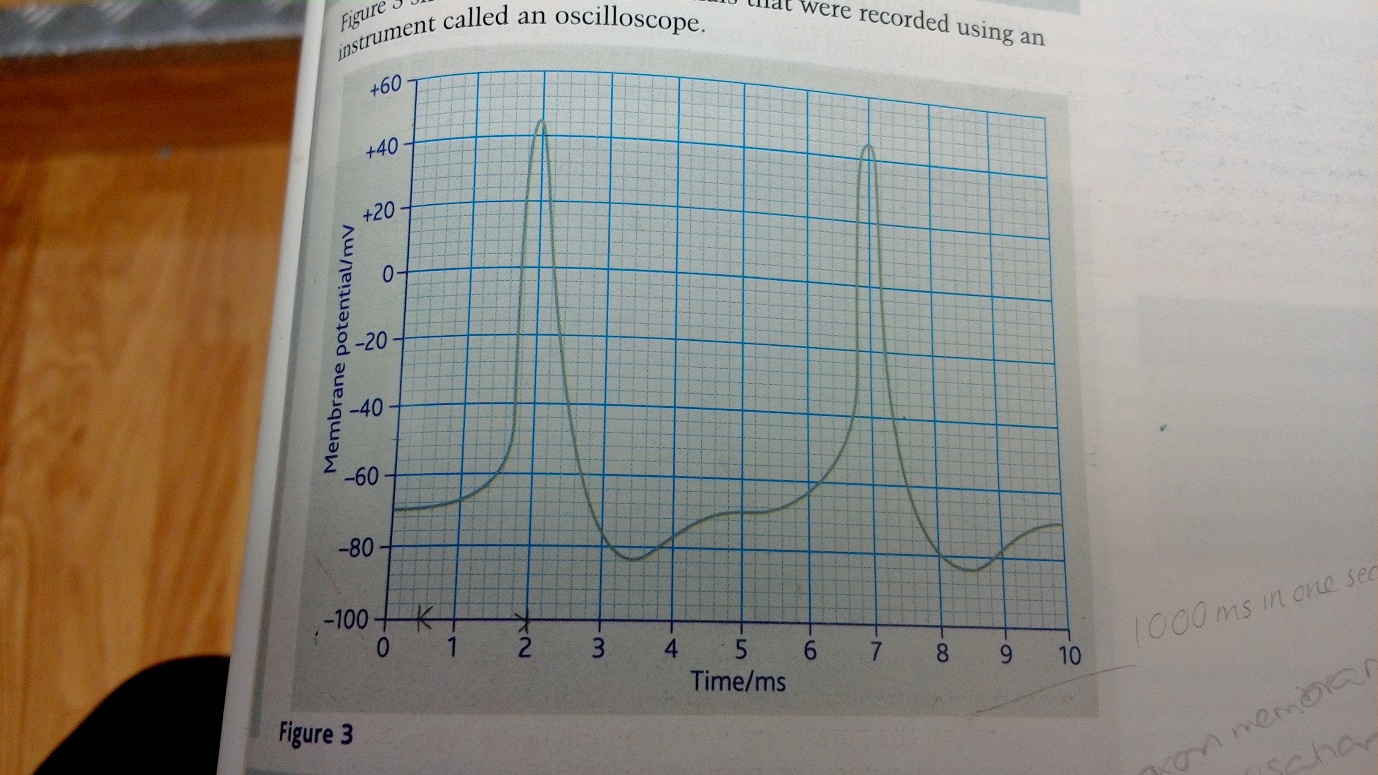
1. **State two differences between animal hormones and plant growth factors.**

Animal hormones are made in particular organs and affect other organs some distance away

Plant growth factors are made by cells located throughout the plant and have localised effects

1. **Describe how the movement of ions establishes the resting potential in an axon**

Active transport of sodium ions out of the axon by sodium-potassium pumps is faster than active transport of potassium ions into the axon. Potassium ions diffuse out of the axon but few, if any, sodium ions diffuse into the axon because sodium ‘gates’ are closed. Overall, there are more positive ions outside than inside and therefore the outside is positive relative to the inside.

1. ** (a) between 0.5 and 2.0 ms there is a considerable change in membrane potential. Explain how this change is brought about**

At resting potential (0.5ms) there is a positive charge on the outside of the membrane and a negative charge inside, due to the high concentration of sodium ions outside the membrane. The energy of the stimulus causes the sodium voltage-gated channels in the axon membrane to open and therefore sodium ions diffuse in through the channels, along their electrochemical gradient. Being positively charged, they begin a reversal in the potential difference across the membrane. As sodium ions enter, so more sodium ion channels open, causing an even greater influx of sodium ions and an even greater reversal of potential difference: from -70 mv to +40 mv at 2.0 ms

**(b) how many action potentials will occur in 1 second if the frequency shown on the graph is maintained for this period?**

Two action potentials take place in 2 ms

Each action potential takes 10 ÷ 2 = 5 ms (action potentials are 5 ms apart)

There are 1000ms in 1 second

Therefore there are 1000 ÷ 5 = 200 action potentials in 1 second

1. **In a myelinated axon, sodium and potassium ions can only be exchanged at certain points along it.**
2. **What is the name given to these points**

Node of ranvier

1. **Explain why ions can only be exchanged at these points**

Because the remainder of the axon is covered by a myelin sheath that prevents ions being exchanged/prevents a potential difference being set up

1. **What effect does this have on the way an action potential is conducted along the axon**

It moves along in a series of jumps from one not of ranvier to the next

1. **What name is given to this type of conduction**

Salutatory conduction

1. **How does it affect the speed with which the action potential is transmitted compared to an unmyelinated axon**

It is faster

1. **What happens to the size of an action potential as it moves along an axon?**

It remains the same/does not change

1. **Explain how the refractory period ensures that nerve impulses are kept separate from one another**

During the refractory period the sodium voltage-gated channels are closed so no sodium ions can move inwards and no action potential is possible. This means there must be an interval between one impulse and the next

1. **What is the all-or-nothing principle**

There is a particular level of stimulus that triggers an action potential. At any level above this threshold, a stimulus will trigger an action potential that is the same regardless of the size of the stimulus, below this threshold no action potential is triggered

1. **The table shows the speeds at which different axons conduct action potentials**

|  |  |  |  |
| --- | --- | --- | --- |
| **axon** | **myelin** | **Axon diameter/m** | **Transmission speed/m s-1** |
| **Human motor axon to leg muscle** | **Yes** | **20** | **120** |
| **Human sensory axon from skin pressure receptor** | **Yes** | **10** | **50** |
| **Squid giant axon** | **No** | **500** | **25** |
| **Human motor axon to internal organ** | **no** | **1** | **2** |

1. **Using data from the table, describe the effect of axon diameter on the speed of conductance of an action potential**

The greater the diameter of the axon the faster the speed of the conductance. Comparing data for the two myelinated axons shows that the 20m diameter axon conducts at 120 m s-1 while the 10 m diameter axon conducts at 120 m s -1. Likewise, the data for the two unmyelinated axons shows that the 500 m diameter axon conducts at 25 m s-1 while the 1 m diameter axon conducts at 2 m s-1

1. **The data shows that a myelinated axon conducts an action potential faster than an unmyelinated axon. Explain why**

In myelinated axons, the myelin acts as an electrical insulator. Action potentials can only form where there is no myelin (at nodes of ranvier), the action potential therefore jumps from node to node (salutatory conduction) which makes its conductance faster

1. **What is the name of the cells whose membranes make up the myelin sheath around some types of axon**

Schwann cells

1. **State which has the greater effect on the speed of conductance of an action potential; the presence of myelin or the diameter of the axon. Use the table to explain your answer**

The presence of myelin has the greater effect because a myelinated human sensory axon conducts an action potential at twice the speed of the squid giant axon, despite being only 1/50th of its diameter

1. **The squid is an ectothermic animal. This means that its body temperature fluctuated with the temperature of the water in which it lives. Suggest how this might affect the speed at which action potentials are conducted along a squid axon**

Temperature affects the speed of conductance of action potentials. The higher the temperature, the faster the conductance. The conductance of action potentials in the squid will therefore change as the environmental temperature changes. It will react more slowly at lower temperatures.

1. **How is a presynaptic neurone adapted for the manufacture of neurotransmitter**

It possesses many mitochondria and large amounts of endoplasmic reticulum

1. **How is the postsynaptic neurone adapted to receive the neurotransmitter**

It has receptor molecules on its membrane

1. **Describe the basic events in the transmission of a nerve impulse form one neurone to another**

Neurotransmitter is released from vesicles in the presynaptic neurone into the synaptic cleft when an action potential reaches the synaptic knob. The neurotransmitter diffuses across the synapse to receptor molecules on the postsynaptic neurone to which it binds, thereby setting up a new action potential

1. **If a neurone is stimulated in the middle of an axon, an action potential will pass both ways along it to the synapses at each end of the neurone. However, the action potential will only pass across the synapse at one end. Why**

Only one end can produce a neurotransmitter and so this end alone can create a new action potential in the neurone on the opposite side of the synapse. At the other end there is no neurotransmitter that can be released to pass across the synapse and so no new action potential can be set up.

1. **When walking along a street we barely notice the background noise of traffic. However, we often respond to louder traffic noises, such as the sound of a horn**
2. **From your knowledge of summation, explain this difference**

The relatively quiet background of traffic produces a low-level frequency of action potentials in the sensory neurones from the ear. The amount of neurotransmitter released into the synapse is insufficient to exceed the threshold in the postsynaptic neurone and to trigger an action potential and so the noise is ‘filtered out’ or ignored. Louder noises create a higher frequency and the amount of neurotransmitter released is sufficient to trigger an action potential so there is a response. This is an example of temporal summation

1. **Suggest an advantage in responding to high-level stimuli but not to low-level stimuli**

Reacting to low-level stimuli that present little danger can overload the central nervous system and so organisms may fail to respond to more important stimuli. High-level stimuli need a response because they are more likely to represent danger.

1. **Explain why hyperpolarisation reduces the likely hood of a new action potential being created**

As the inside of the membrane is more negative than at resting potential, more sodium ions must enter in order to reach the potential difference of an action potential i.e. it is more difficult for depolarisation to occur. Stimulation is less likely to reach the threshold level needed for a new action potential.

1. **For each of the following, state the name of the substance described;**
2. **They diffuse into the postsynaptic neurone where they generate an action potential**

Sodium ions

1. **A neurotransmitter found in a cholinergic synapse**

acetylcholine

1. **It is released by mitochondria to enable the neurotransmitter to be re-formed**

ATP

1. **Their influx into the presynaptic neurone causes synaptic vesicles to release their neurotransmitter**

Calcium ions

1. **Why is it necessary for acetylcholine to be hydrolysed by acetylcholinesterase**

To recycle the choline and ethanoic acid; to prevent acetylcholine from continuously generating a new action potential in the post synaptic neurone

1. **Drugs such as morphine and codeine bind to the specific receptors used by endorphins. Suggest the likely effect of drugs like morphine and codeine on the body**

They will reduce pain

1. **Explain how the effect you suggest might be brought about**

They act like endorphins by binding to the receptors and therefore preventing action potentials bring created in the neurones of the pain pathways

1. **Prozac affects serotonin within the synaptic clefts. Serotonin is a neurotransmitter involved in the regulation of emotional states. Suggest a way that the drug Prozac might affect serotonin within synaptic clefts**

Prozac might prevent the elimination of serotonin from the synaptic cleft

1. **Explain how the effect you suggest makes Prozac an effective antidepressant.**

By increasing the concentration of serotonin in the synaptic cleft, its activity is increased, reducing depression which is caused by reduced serotonin activity

1. **Valium enhances the binding of GABA to its receptors. GABA is a neurotransmitter that inhibits the formation of action potentials when it binds to postsynaptic neurones. Suggest the likely effect of Valium on the nerve pathways that cause muscle contraction**

It will reduce muscle contractions by causing muscle to relax

1. **Explain the reasoning for your answer**

Valium increases the inhibitory effects of GABA so therefore there are fewer action potentials on the nerve pathways that cause muscles to contract

1. **Epilepsy can be the result of an increase in the activity of neurones in the brain due to insufficient GABA. An enzyme breaks down GABA on the postsynaptic membrane. A drug called Vigabatrin has molecular structure similar to GABA and is used to treat epilepsy. Suggest a way in which Vigabatrin might be effective in treating epilepsy.**

The molecular structure of Vigabatrin is similar to GABA so it may be a competitive inhibitor for the active site of the enzyme that breaks down GABA. As less GABA is broken down by the enzyme, more of it is available to inhibit neurone activity. Or Vigabatrin might bind to GABA receptors on the neurone membrane and mimic its action, thereby inhibiting neuronal activity.

1. **Suggest a reason why there are numerous mitochondria in the sarcoplasm**

Muscles require much energy for contraction. most of this energy is released during the krebs cycle and electron transport chain in respiration, both of these take place in the mitochondria

1. **If we cut across a myofibril at certain points, we see only think myosin filaments. Cut at a different point we see only thin actin filaments. At yet other points we see both types of filament. Why**

The actin and myosin filaments lie side by side in a myofibril and overlap at the edges where they meet. Where they overlap, both filaments can be seen. Where they do not overlap, we see one or other filament only

1. **How do slow-twitch fibres differ from fast-twitch fibres in the way they function**

Slow-twitch fibres contract more slowly and provide less powerful contractions over a longer period. Fast-twitch fibres contract more rapidly and produce powerful contractions but only for a short duration

1. **Describe how each type of fibre is adapted to its function**

Slow -twitch fibres have myoglobin to store oxygen, much glycogen to provide a source of metabolic energy, a rich supply of blood vessels to deliver glucose and oxygen and numerous mitochondria to produce ATP

Fast-twitch fibres have thicker and more numerous myosin filaments, a high concentration of enzymes involved in anaerobic respiration and a store of phosphocreatine to rapidly generate ATP from ADP in anaerobic conditions

1. **How is the shape of the myosin molecule adapted to its role in muscle contraction**

Myosin is made of two proteins. The fibrous protein is long and thin in shape, which enables it to combine with others to form a long thick filament along which the actin filament can move. The globular protein forms two bulbous structures at the end of a filament. This shape allows it to exactly fit recesses in the actin molecule, to which it can become attached. Its shape also means it can be moved at an angle. This allows it to change its angle when attached to actin and so move it along, causing the muscle to contract.

1. **Trained sprinter have high levels of phosphocreatine in the muscles. what is the advantage of this**

Phosphocreatine stores the phosphate that is used to generate ATP from ADP in anaerobic conditions. A sprinter’s muscles often work so strenuously that the oxygen supply cannot meet the demand. The supply of ATP from mitochondria during aerobic respiration therefore ceases. Sprinters with the most phosphocreatine have an advantage because ATP can be supplied to their muscles for longer, and so they perform better

1. **During the contraction of a muscle sarcomere, a single actin filament moves 0.8** **m. If the hydrolysis of a single ATP molecule provides enough energy to move an actin filament 40nm, how many ATP molecules are needed to move the actin filament 0.8** **m?**

A single ATP molecule is enough to move an actin filament a distance of 40 nm

1. **Dead cells can no longer produce ATP. Soon after death, muscle contract, making the body still – rigor mortis. From your knowledge of muscle contraction, explain why rigor mortis occurs after death**

One role of ATP in muscle contraction is to attach to the myosin heads, thereby causing them to detach from the actin filament and making the muscle relax. As no ATP is produced after death, there is none to attach to the myosin, which therefore remains attached to actin, leaving the muscle in a contracted state

1. **What is homeostasis**

The maintenance of a constant internal environment in organisms

1. **Explain why maintaining a constant temperature is important in mammals**

Maintaining a constant temperature is important because enzymes function within a narrow range of temperatures. Fluctuations from the optimum temperature mean enzymes function less efficiently. If the variation is extreme, the enzyme may be denatured and cease to function all together

1. **Explain why maintaining a constant blood glucose concentration is important in mammal**

It is important in ensuring a constant water potential. Changes to the water potential of blood and tissue fluids may cause cells to shrink and expand (even to bursting point), due to water leaving or entering by osmosis. In both instances the cells cannot operate normally. A constant blood glucose concentration also ensures a reliable source of glucose for respiration by cells.

1. **State the three ways by which heat loss to, and gained from, the environment**

Conduction, convection, radiation

1. **Name four structures in the skin that are involved with thermoregulation in mammal**

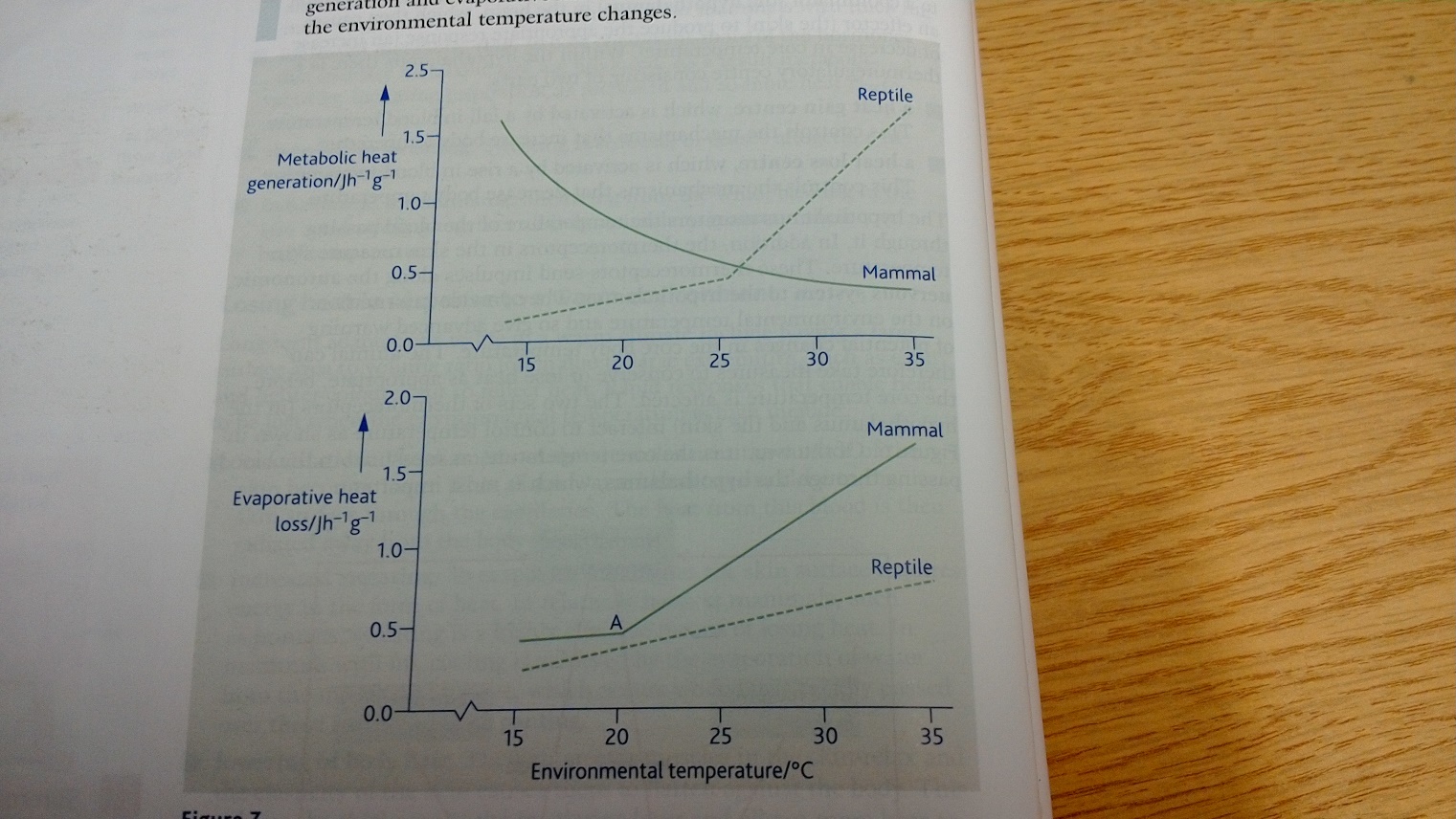
Sweat glands, hair erector muscle, fat tissue, arterioles (shunt vessels)

1. **Explain why a large, compact mammal will probably require less food per gram of body mass to maintain its body temperature in a cold climate than a small, less compact mammal**

Food is a source of heat produced by its metabolism in the body. A large, compact mammal will have a smaller surface area to volume ratio than a smaller, less compact one. Because heat is lost from the ‘surface’ and produced in the ‘volume’, the larger mammal will both produce more heat and lose less heat per gram of body mass compared to the smaller mammal. It will therefore need less food in order to maintain its body temperature.

1. **Explain why the skin of humans often appears paler on a cold day than on a hot day. What is the significance of this difference**

On a cold day, the arterioles in the skin are made smaller in diameter (vasoconstriction) to help conserve heat, thus reducing the flow of blood to the body surface. This lack of surface blood makes the skin appear pale. On a hot day, vasodilation occurs and so more blood flows near the body surface and the skin appears redder. Vasoconstriction conserves body heat while vasodilation increases heat loss – they are therefore mechanisms of thermoregulation

1. **The graphs below compare the rates of metabolic heat generation and evaporative heat loss in a mammal and a reptile as the environmental temperature changes:**
2. **Give a reason why the values for heat generation and heat loss are measured per gram of body mass**

It allows accurate comparisons to be made even though the animals have different body masses. An increase in body size or body mass means there is increased heat generation

1. **Describe the relationship between metabolic heat generation and evaporative heat loss in a reptile**

Both increase proportionally up to 25C. above 25C, heat generation increases more rapidly (gradient of line increases), whereas evaporative heat loss increases at the same rate (gradient of line remains the same)

1. **How does this relationship differ in a mammal**

in a mammal, the relationship is the inverse/opposite i.e. as evaporative heat loss increases, heat generation decreases

1. **Reptiles frequently seek shade when the environmental temperature rises above 25C. use the graphs to explain this type of behaviour**

Above 25C, the metabolic heat generation in reptiles becomes much more rapid. They therefore generate heat faster than they can lose it. as a result, their body temperature increases and enzymes may be denatured, leading to death. As reptiles have no physiological means of cooling, they must seek shade to reduce their body temperature

1. **Suggest a reason for the change in the evaporative heat loss in the mammal at point A**

Sweating or panting increases

1. **State one difference between the causes of type I and type II diabetes**

Type I is caused by an inability to produce insulin. Type II is caused by receptors on body cells losing their responsiveness to insulin

1. **State one difference between the main ways of controlling type I and type II diabetes**

Type 1 is controlled by the injection of insulin. Type II is controlled by regulating the intake of carbohydrate in the diet and matching this to the amount of exercise taken

1. **Suggest an explanation for why tiredness is a symptom of diabetes**

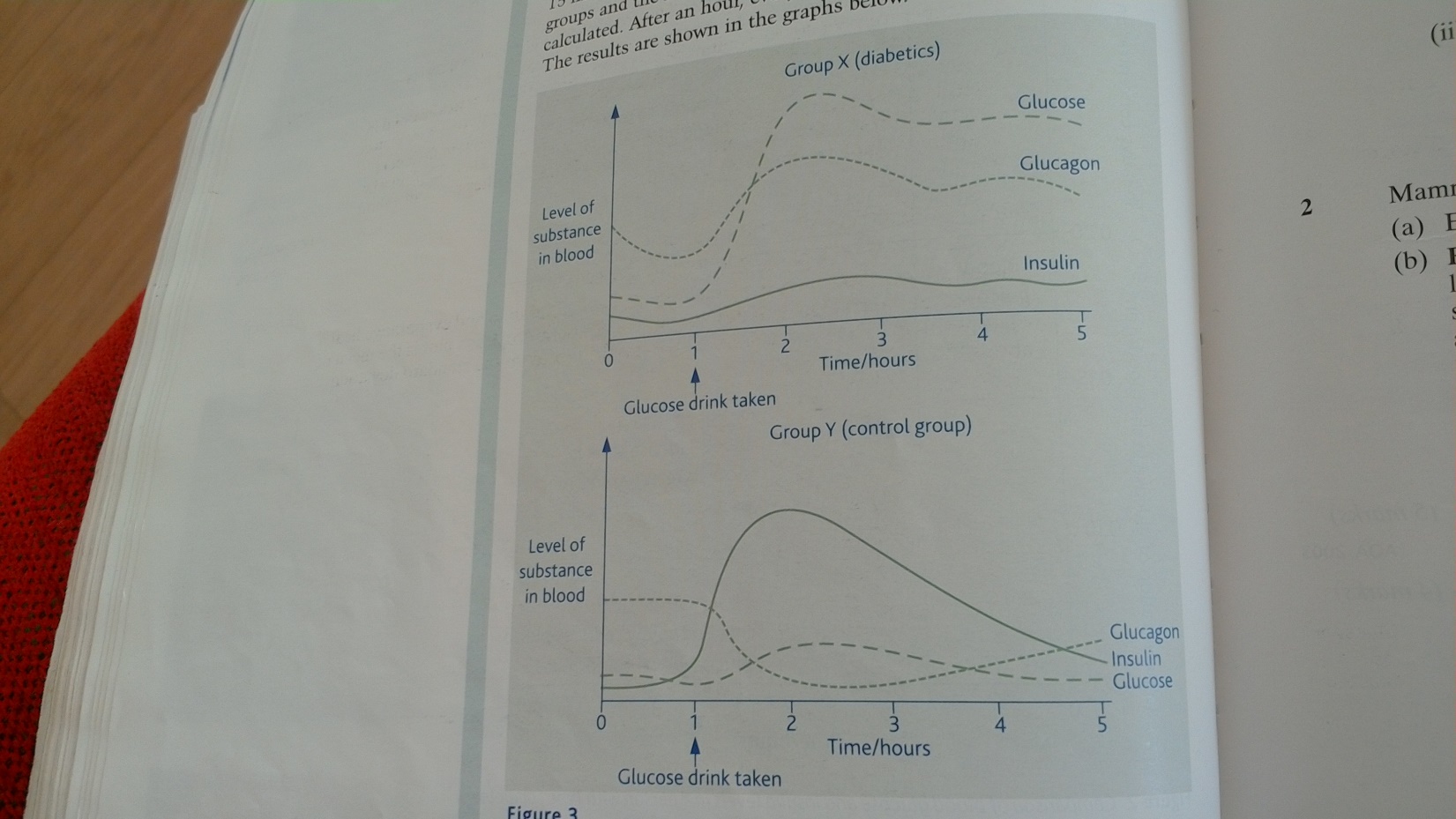
Diabetes is a condition in which insulin is not produced by the pancreas. This leads to fluctuations in the blood glucose level. If the level is below normal, there may be insufficient glucose for the release of energy by cells during respiration. Muscle and brain cells in particular may therefore be less active, leading to tiredness

1. **What lifestyle advances might you give someone in order to help them avoid developing type II diabetes**

Match your carbohydrate intake to the amount of exercise you take. Avoid becoming overweight by not consuming excessive quantities of carbohydrate and by taking regular excercise

1. **Name a hormone other than insulin and glucagon that is involved in regulating blood glucose**

adrenaline

1. **An experiment was carried out. Group X had type I diabetes while group Y did not. Every 15 minutes blood samples were taken from all members of both groups and the mean levels of insulin, glucagon and glucose were calculated. After an hour, every person was given a glucose drink**
2. **state two differences between groups X and Y in the way insulin secretion responds to the drinking of glucose**

the rise in insulin level is both greater and more rapid in group Y rather than X

1. **Suggest a reason why the glucose level falls in both groups during the first hour**

Glucose is removed from blood by cells using it during respiration

1. **using the information from the graphs, explain the changes in the blood glucose level in group Y after drinking glucose**

glucose level rises at first because the glucose that is drunk is absorbed into the blood (glucose line rises). This rise in glucose causes insulin to be secreted from Beta cells in the pancreas (insulin line rises steeply). Insulin causes increased uptake of glucose into liver and muscle cells, activates enzymes that convert glucose into glycogen and fat, and increases cellular respiration. The effect of all these actions is to reduce glucose levels (glucose line falls from 2.5 onwards). As the glucose level rises after 1 hour, so the glucagon level falls. The reduction in glucagon level decreases glucose production from other sources (glycogen, amino acids and glycerol) and so also helps to reduce blood glucose levels. As the blood glucose level falls (after 2.5 hours) so that glucagon level increases to help maintain the blood glucose at its normal level.

1. **Explain the difference in blood glucose level of group X compared to group Y**

Group X has diabetes and therefore the glucose intake does not stimulate insulin production (insulin level on graph is low). The glucose level in the blood therefore continues to rise (glucose level rises steeply) as there is no insulin to reduce its level. Blood glucose level remains high, falling only slightly as it is respired by cells

1. **Suggest what might happen to the blood glucose level of group X if they have no food over the next 24 hours**

As it is respired by cells, the glucose level will decrease steadily until it falls below the normal level

1. **Distinguish between positive and negative feedback**

Positive feedback occurs when the feedback causes the corrective measures to be turned on. In doing so, it causes the system to deviate even more from the original normal level

Negative feedback occurs when the feedback causes the corrective measures to be turned off. In doing so, it returns the system to its original normal level

1. **Why is negative feedback important in maintaining a system at a set point**

If the information is not fed back once an effector has corrected any deviation and returned the system to the set point, the receptor will continue to stimulate the effector and an over-correction will lead to a deviation in the opposite direction from the original one

1. **What is the advantage of having separate negative feedback mechanisms to control deviations away from normal**

It gives a greater degree of homeostatic control

1. **Describe the change in water potential that occurs in the blood as a result of sweating**

As sweating involves a loss of water from the blood, its water potential will decrease

1. **In each of the following cases, name the structure that produces the hormone:**
2. **LH –** pituitary gland
3. **Progesterone –** corpus luteum in the ovary
4. **Oestrogen –** follicle in the ovary
5. **Describe an example of control by negative feedback in the oestrous cycle**

More oestrogen = more inhibition of FSH production = less FSH = less stimulation of oestrogen production = less oestrogen

Or

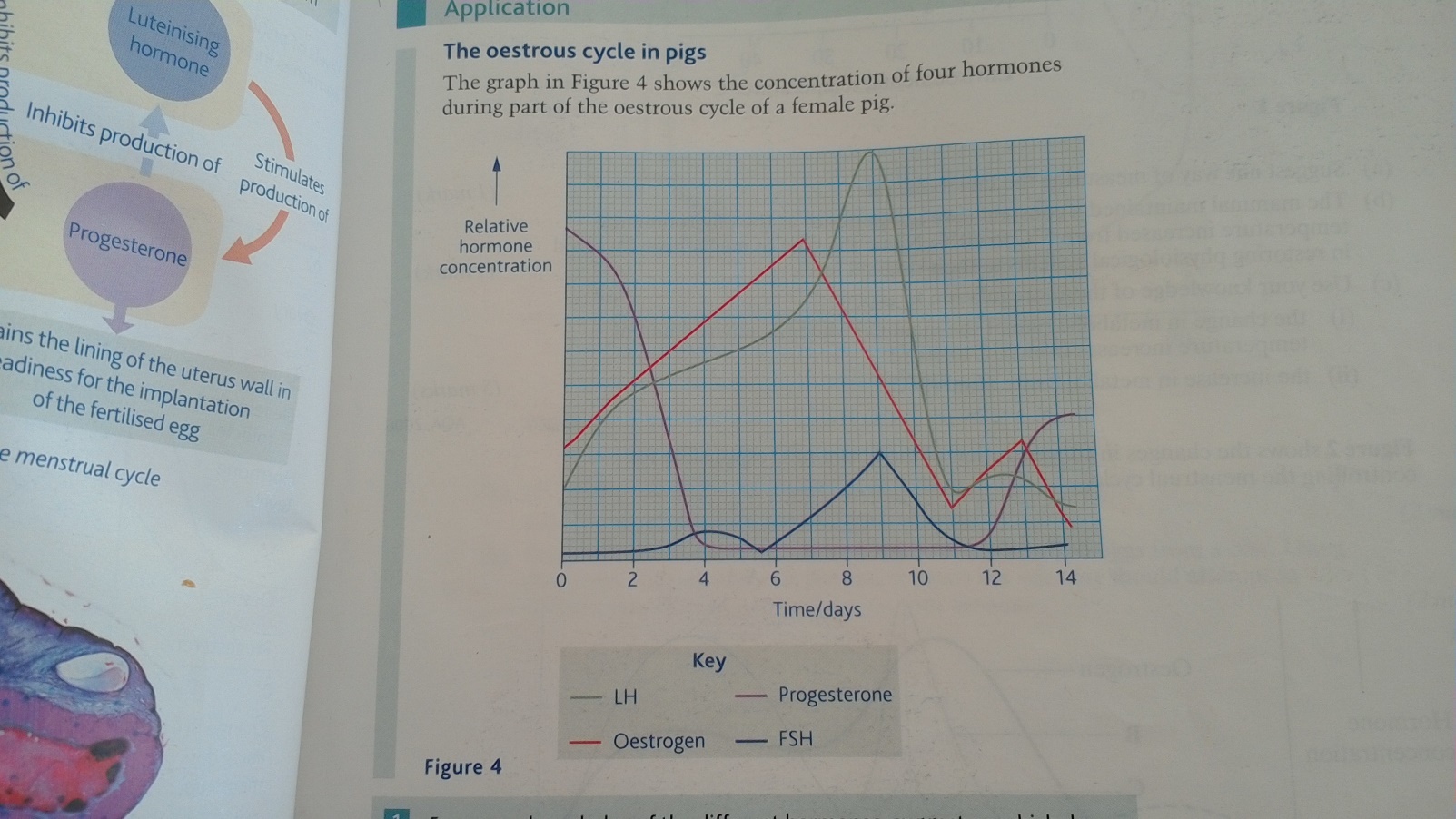
More progesterone = more inhibition of LH production = less LH = less stimulation of progesterone production = less progesterone

1. **When a female human reaches the menopause, she has very few follicles left in her ovaries. Suggest a reason why levels of FSH in the blood rise in women reaching the menopause**

Oestrogen is produced in developing follicles. Menopausal women have few follicles left so produce less oestrogen. Oestrogen inhibits the production of FSH so the reduction in oestrogen level means that there is less inhibition of FSH therefore more FSH is produced and FSH levels rise

1. **Some female farm animals were given progesterone in their diet. When the progesterone was withdrawn from the diet, they all ovulated a few days later. Why**

High progesterone levels inhibit the production of FSH and LH. When progesterone is withdrawn from the diet, its level falls and so the production of FSH and LH resumes. FSH causes follicles to develop in the ovary and LH causes eggs to be released (ovulation)

1. **Below shows the concentration of 4 hormones during part of the oestrous cycle of a pig**
2. **Suggest on which day ovulation is most likely to occur**

9 as ovulation is caused by a high concentration of LH

1. **Explain the effects of oestrogen on the production of FSH from day 0 to 12**

Days 0 – 5. Oestrogen levels are rising but relatively low, inhibiting the production of FSH (negative feedback) and so FSH levels are low

Days 5 – 6. Oestrogen levels rise to a critical point, stimulating the production of FSH (positive feedback) and so FSH levels rise

Days 9 – 12. Oestrogen levels fall below the same critical level, inhibiting FSH production again (negative feedback) and so FSH levels also fall

1. **Explain why pigs injected with progesterone may not ovulate**

Progesterone inhibits the production of FSH and FSH causes follicles in the ovary to develop and mature. If FSH levels are low, follicles will not develop and so no mature eggs will be available for release

1. **Explain why the genetic code is described as:**
2. **Universal –** because it is the same in all organisms
3. **Degenerate –** because most amino acids have more than one codon
4. **Non-overlapping –** because each base in the sequence is read only once
5. **State three ways in which the molecular structure of RNA differs from DNA**

RNA is smaller than DNA. RNA is usually a single strand and DNA a double helix. The sugar in RNA is ribose while in DNA it is deoxyribose. In RNA the base uracil replaces the base thymine in DNA

1. **Distinguish between a codon and an anticodon**

A codon is the triplet of bases on messenger RNA that codes for an amino acid

An anticodon is the triplet of bases on a transfer RNA molecule that is complementary to the codon

1. **Describe the role of RNA polymerase in transcription**

The enzyme RNA polymerase moves along the template DNA strand, causing the bases on this strand to join with the individual complementary nucleotides from the pool that is present in the nucleus. The RNA polymerase adds the nucleotides one at a time, to build a strand to pre-mRNA until it reaches a particular sequence of bases on the DNA that it recognises as a stop codon

1. **Which other enzyme is involved in transcription and what is its role**

DNA helicase – this acts on a specific region of the DNA molecule to break the hydrogen bonds between the bases, causing the two strands to separate and expose the nucleotide bases in that region

1. **Why is splicing of pre-mRNA necessary**

Because pre-mRNA has nucleotide sequences derived from introns of DNA. These introns are non-functional and, if left on the mRNA, would lead to the production of non-functional polypeptides or no polypeptides at all. Splicing removes these non-functional introns from pre-mRNA

1. **A sequence of bases along the template strand of DNA is ATGGAAGTCCAG**
2. **What is the sequence of bases on a pre-messenger RNA molecule that has been transcribed from this part of the DNA molecule**

UACGUUCAGGUC

1. **How many amino acids does the sequence code for**

4 (One is coded for by 3 bases so 12 bases code for 4 amino acids)

1. **A gene is made up of 756 base pairs. The mRNA that is transcribed from this gene is only 524 nucleotides long. Why is there a difference**

Some of the base pairs in the genes are introns (non-functional DNA). These introns are spliced from pre-mRNA so the resulting mRNA has fewer nucleotides

1. **Name the cell organelle involved in transcription**

ribosome

1. **A codon found on a section of mRNA has the sequence of bases AUC. List the sequence of bases found on;**
2. **The tRNA anticodon that attaches to this codon**

UAG on tRNA

1. **The template strand of DNA that formed the mRNA codon**

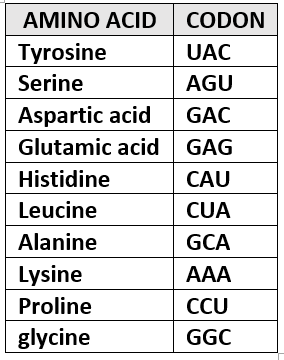
TAG on DNA

1. **Describe the role of tRNA in the process of translation**

A tRNA molecule attaches an amino acid at one end and has a sequence of three bases, called an anticodon, at the other end. The tRNA molecule is transferred to a ribosome on an mRNA molecule. The anticodon on tRNA pairs with the complementary codon on mRNA. Further tRNA molecules, with amino acids attached, line up along the mRNA in the sequence determined by the mRNA bases. The amino acids are joined by peptide bonds. Therefore the tRNA helps to ensure the correct sequence of amino acids in the polypeptide

1. **A strand of mRNA has 64 codons but the protein produced from it has only 63 amino acids. Suggest a reason for this difference**

One of the codons is a stop codon that indicated the end of polypeptide synthesis. Stop codons do not code for any amino acid so there is one less amino acid than there are codons

1. **The table lists a number of amino acids and their corresponding codons on mRNA. The strand of DNA against which mRNA is transcribed is called the template strand**
2. **Using the table state;**
3. **The tRNA anticodon for histidine -** GUA
4. **The triplet on the DNA template strand that codes for serine -** TCA
5. **Name the amino acid coded for by the tRNA anticodon GAU**

leucine

1. **The sequence of bases on a template strand of DNA is CTCCGTGGAATGCGT. List the sequence of amino acids that would appear in a polypeptide coded for by this DNA**

Glutamic acid – alanine – proline – tyrosine – alanine

1. **The sequence of amino aids in a section of polypeptide is histidine, proline, aspartic acid and leucine, list the sequence of bases on the template strand that codes for this polypeptide section**

GTAGGACTGGAT

1. **In an experiment, the radioactive amino acid phenylalanine and four mixtures, differing only in their mRNA, were set up as follows:**

* **mRNA made up of a chain of nucleotides only containing adenine = poly A**
* **mRNA made up of a chain of nucleotides only containing uracil = poly U**
* **mRNA made up of a chain of nucleotides only containing cytosine = poly C**
* **no mRNA was present**

**the results were:**

|  |  |
| --- | --- |
| **TYPE OF SYNTHETIC mRNA** | **RADIOACTIVITY / COUNTS MIN-1** |
| **Poly A** | **50** |
| **Poly U** | **39800** |
| **Poly C** | **38** |
| **none** | **44** |

1. **state one codon for the amino acid phenylalanine that is suggested by the results of this experiment. Explain your answer**

The codon UUU – because the very radioactive polypeptide (39800 counts min) was only produced from the mixture containing poly U. this polypeptide must be made up of phenylalanine because this is the only radioactive amino acid present. As the synthetic mRNA contains only the bases sequence UUUUUUU, etc., one codon for phenylalanine must be UUU

1. **why was a mixture without any synthetic RNA used**

as a control experiment to show that the radioactivity was due to the labelled phenylalanine rather than some other factor such as background radiation

1. **the following is a sequence of 12 nucleotides within a much longer mRNA molecule: AUGCAUGUUACU. Following a gene mutation the same 12 nucleotide portion of the mRNA molecule is AUGCUGUUACUG. What type of gene mutation has occurred?**

A deletion because the fifth nucleotide has been lost. The sequence prior to and after this is the same.

1. **Explain why a deletion gene mutation is more likely to result in a change to an organism than a substitution gene mutation**

In a deletion, all codons after the deletion are affected (frame shift). Therefore most amino acids coded for by these codons will be different and the polypeptide will be significantly affected. In a substitution, only a single codon, and therefore a single amino acid, will be affected. The effect on the polypeptide is likely to be less severe.

1. **Explain why a mutation that is transcribed on to mRNA may not result in any change to the polypeptide that it codes for**

The mutation may result from the substitution of one base in the mRNA with another. Although the codon affected will be different, as the genetic code is degenerate, the changed codon may still code for the same amino acid. The polypeptide will be unchanged and there will be no effect.

1. **Errors in transcription occur about 100,000 times more often than errors in DNA replication. Explain why errors in DNA replication can be far more damaging than errors in transcription**

There errors may be inherited and may therefore have a permanent affect on the whole organism. Errors in transcription usually only affect specific cells, are temporary and are not inherited. They therefore are less damaging

1. **Which two types of gene control cell division in normal cells. What is the role of each**

Proto-oncogenes, which stimulate cell division and tumour suppressor genes which inhibit cell division

1. **Certain chemicals can remove groups from nucleotide bases. Nitrous acids can remove an -NH2 group from cytosine in DNA, changing it into uracil**

**Suggest what might be the result of this change on the codons on a mRNA molecule that is transcribed from a section of DNA with the triplets GCA CTC ATC**

The codons in mRNA will be CAU AAA UAA.

1. **Some radiation can alter DNA so DNA polymerase can no longer act on them. State one genetic effect of DNA polymerase being unable to act on DNA**

The replication of DNA required DNA polymerase and so the process cannot continue

1. **What are totipotent cells**

Cells with the ability to develop into any other cell of the organism

1. **How does the distribution of totipotent cells in animals differ from that of plants**

In animals, only a few cells are totipotent. In humans these are known as stem cells and are found in the embryos, the inner lining of the intestine, skin and bone marrow. In plants, many of the cells throughout the plant are totipotent.

1. **All cells possess the same genes and yet a skin cell can produce the protein keratin but not the protein myosin, while a muscle cell can produce myosin but not keratin. Why**

In skin cells, the gene that codes for keratin is expressed but not the gene for myosin. The genetic code for keratin is translated into the protein keratin which the cell therefore produced, but the genetic code for myosin is not translated. In muscle cells, the gene for myosin is expressed but not the gene for keratin. In the same way the genetic code for myosin rather than keratin is translated and so only myosin is produced

1. **Name the process by which the totipotent cells of the plant tissue culture change is appearance and develop into shoot or root cells**

differentiation

1. **Write reasons for and against the continued use of embryos for stem cell research**

FOR 🡪 huge potential to cure many diseases. Wrong to allow suffering when it can be relieved. Embryos are created for other purposes such as IVF so why not stem cells. Embryos of less than 14 days are not recognisably human and so do not command the same respect as adults or foetuses. There is no risk of research escalating or including foetuses because current legislation prevents this. Adult stem cells are not as suitable as embryonic stem cells and it may be many years before they are, in the meantime many people suffer unnecessarily.

AGAINST 🡪 it is wrong to use humans, including potential humans, as a means to an end. Embryos are human, they have human genes, and deserve the same respect and treatment as adult humans. It is the ‘slippery slope’ to the use of older embryos and foetuses for research. It could lead to research and development of human cloning and, although banned in the UK, the information gained could be used elsewhere. It undermines respect for life. Adult stem cells are an available alternative and energies should be directed towards developing these.

1. **What is the role of a transcriptional factor**

To stimulate transcription of a gene

1. **Describe how oestrogen stimulated the expression of a gene**

Oestrogen diffuses through the phospholipid portion of the cell-surface membrane into the cytoplasm of a cell, where it combines with a site on a receptor portion of the transcriptional factor. Oestrogen changes shape of the receptor molecule, releasing an inhibitor molecule from the DNA binding site on the transcription factor. The transcriptional factor now enters the nucleus through a nuclear pore and combines with DNA, stimulating transcription of the gene that makes up that portion of DNA i.e. it stimulated gene expression

1. **One of the two strands of siRNA combines with an enzyme and guides it to an mRNA molecule which it then cuts. Explain why the mRNA is unlikely to be cut if the other siRNA strand combines with the enzyme**

The other strand would have complementary bases (i.e. GCUA instead of CGAU). It is unlikely that these opposite base parings would complement a sequence on the mRNA. The siRNA, with enzyme attached, would therefore not bind to the mRNA and so would be unaffected

1. **Explain why a doctor may enquire about a patients family medical history before deciding on using x-ray analysis for a condition other than cancer**

A person with a family history of cancer may already have one mutated allele for the inactivation of the tumour suppressor gene. As x-rays increase mutation rates they might advance the likelihood of cancer in these patients. Patients with no family history of cancer are less at risk because they are less likely to have an inherited mutant allele.

1. **Suggest a reason why a single mutant allele of a proto-oncogene can cause cancer, but it requires two mutant alleles of the tumour suppressor gene to do so**

The proto-oncogene mutant allele might be dominant whereas the tumour suppressor mutant allele might be recessive. If so, it requires just one dominant proto-oncogene allele to cause cancer whereas it will take two recessive tumour suppressor alleles to cause cancer

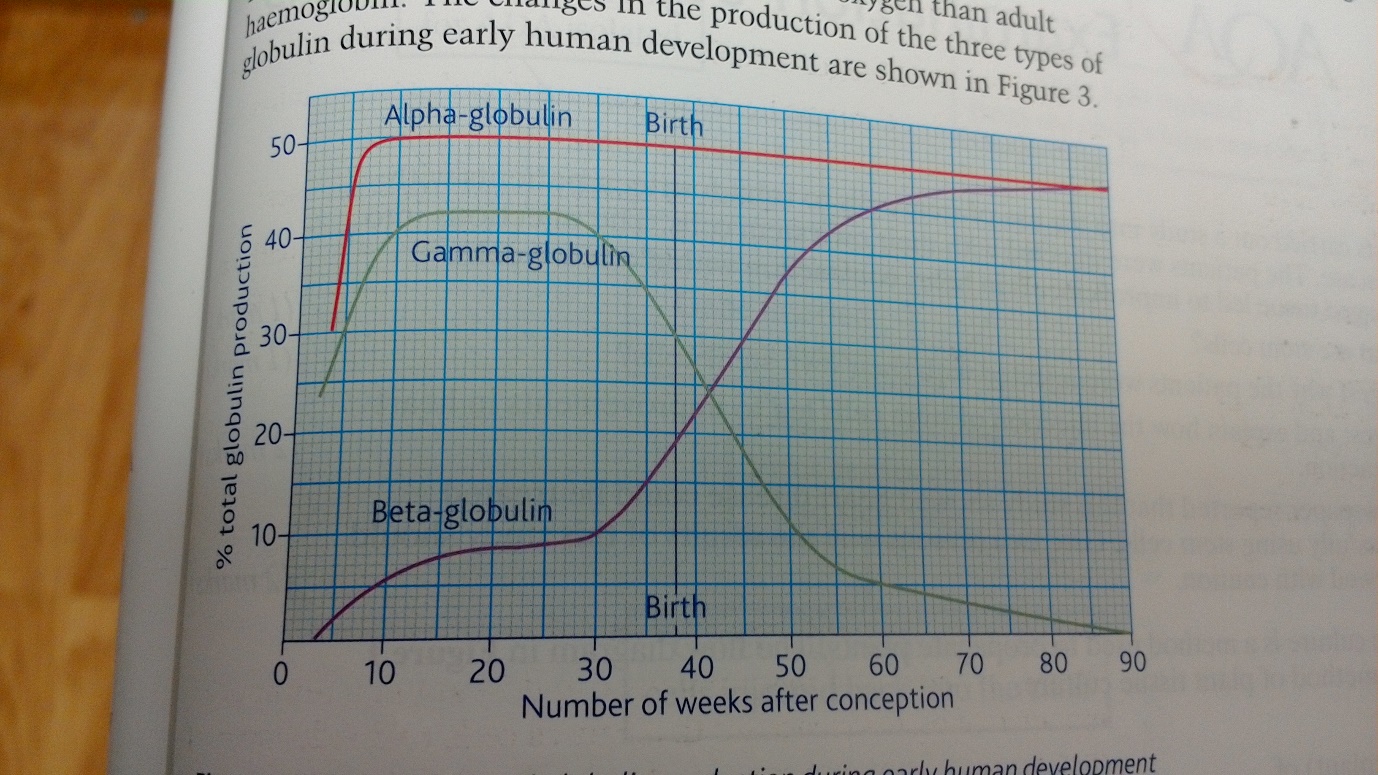
1. **One experimental treatment for cancer involves introducing tumour suppressor genes into rapidly dividing cells in order to arrest tumour growth. Explain how this treatment might work**

Tumour suppressor genes inhibit cell division. Mutated forms of these genes are inactive and so cell division increases and a tumour forms. The introduction of normal tumour suppressor genes means that the inhibition of cell division will be resumed and the tumour growth will stop

1. **Another experimental treatment is the development of an antibiotic drug that will destroy certain protein receptors on membranes of cancer cells. Explain how this treatment might be effective**

Oncogenes cause cancer by permanently activating protein receptors on cells so they stimulate cell division. By destroying these receptors on cancer cells, division will be halted and tumour growth will be stopped

1. **In adult human haemoglobins, two of the poly peptide chains are alpha-globulin and two are beta-globulin. In a human foetus, however, much of the beta-globulin is replaced with a third type; gamma-globulin. Foetal haemoglobin has a greater affinity for oxygen than adults. The changes in the production of the three types of globulin during early human development are shown:**

**humans have genes that code for the production of all three types of globulin. The production of the different haemoglobin depends upon which gene is expressed. The expression of these genes changes at different times during development**

1. **Suggest an advantage of foetal haemoglobin having a greater affinity for oxygen than adult haemoglobin.**

It allows the foetus to load its haemoglobin with oxygen from the mothers haemoglobin where the two blood supplies come close to each other at the placenta

1. **At birth, what percentage of the total globulin production is of each globulin type**

Alpha = 50% beta = 20% gamma = 30%

1. **Describe the changes in gene expression that occur at 25 weeks**

The gene for gamma-globulin is expressed less while the gene for beta-globulin is expressed more

1. **Outline two possible explanations for the change in the expression of the gene for gamma-globulin after 25 weeks**

Expression of the gene for gamma-globulin is progressively reduced as a result of either preventing transcription, and hence preventing the production of mRNA or by the breakdown of mRNA before its genetic code can be translated

1. **Sickle cell disease is the result of a mutant form of haemoglobin. In Saudia Arabia and India, some individuals have high levels of foetal haemoglobin in their blood, even as adults. Where these individuals have sickle cell disease, their symptoms are much reduced. Suggest how controlling the expression of the genes for globulin might provide a therapy for sickle cell disease**

A possible therapy would be to express the gene for gamma-globulin and prevent the expression of the gene for beta-globulin. This would result in haemoglobin being of the foetal rather than the adult type

1. **What is the role of a vector during in vivo cloning**

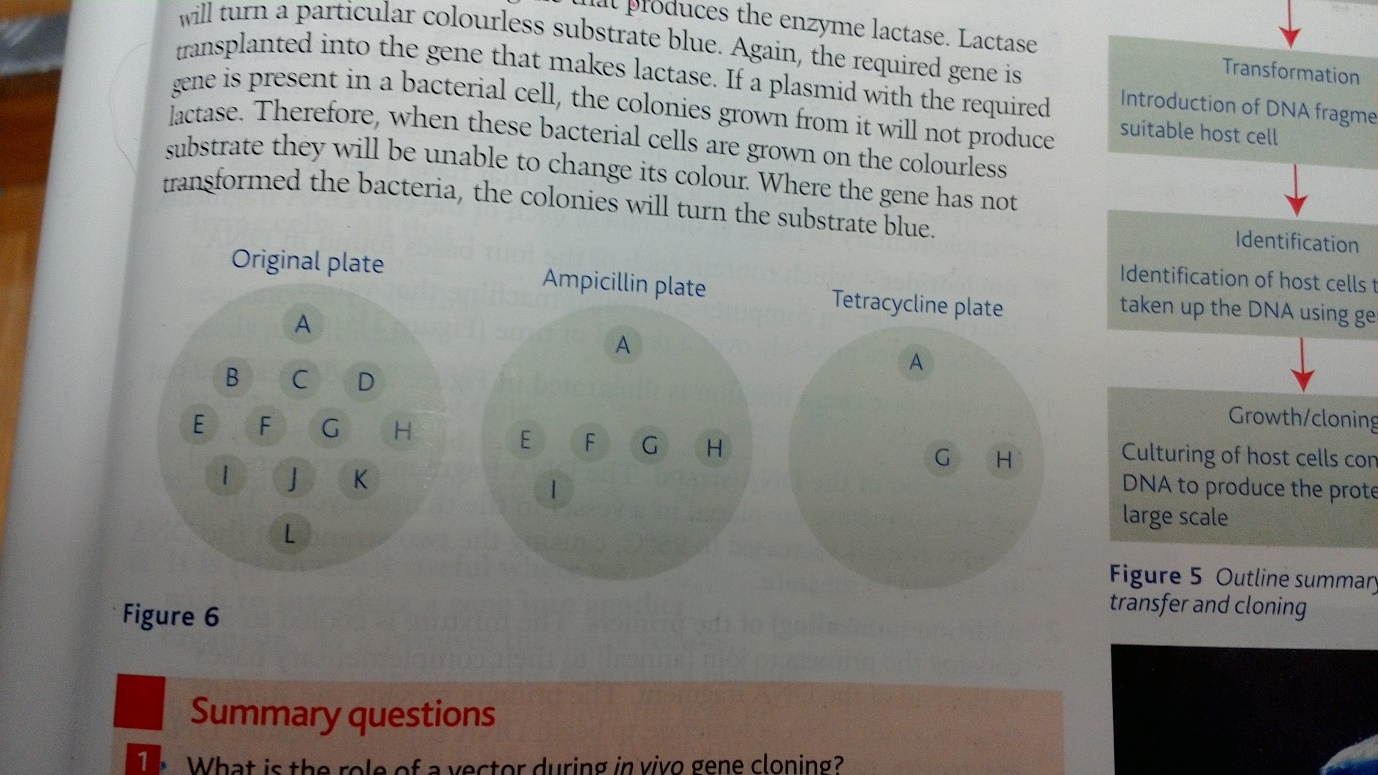
to transfer genes from one organism into another

1. **Why are gene markers necessary during in vivo cloning**

To show which cells (bacteria) have taken up the plasmid with the gene

1. **Give one advantage of using fluorescent gene markers rather than antibiotic markers.**

Results can be obtained more easily and more quickly because, with anti-biotic resistant markers, the bacterial cells with the required gene are killed, so replica plating is necessary to obtain the cells with the gene. With fluorescent gene markers, the bacterial cells are not killed and so there is no need to carry out replica plating

1. **the diagram shows the results of an experiment using anti-biotic resistance gene markers to find which bacterial cells have taken up a gene X. the circles within each plate represent a colony of growing bacteria**

**Which colonies on the original plate:**

1. **did not take up any plasmids with gene X**

B, C, D, J, K and L because those that did not take up the plasmid will not have taken up the gene for ampicillin resistance and so will be the ones that are killed on the ampicillin plate i.e. the colonies that have disappeared.

1. **Contained plasmids possessing gene X**

E, F and I because those with the plasmid containing gene X will have lost the gene for tetracycline resistance and therefore the colonies will have been killed on the tetracycline plate i.e. the colonies will have disappeared

1. **In the polymerase chain reaction, what are primers**

Short pieces of DNA that have a set of bases complementary to those at the end of the DNA fragment to be copied

1. **What is the role of these primers**

Primers attach to the end of a DNA strand that is to be copied and provide the starting sequences for DNA polymerase to begin cloning DNA. DNA polymerase can only attach nucleotides to the end of an existing chain. They also prevent the two separate strands from re-joining

1. **Why are two different primers required**

Because the sequences at the opposite ends of the two strands of DNA are different

1. **When DNA strands are separated in the PCR, what type of bond is broken**

Hydrogen bonds

1. **It is important in the PCR that the fragments of DNA used are not contaminated with any other biological material. Why**

Biological contaminants may contain DNA and this DNA would also be copied

1. **State one advantage to humans of genetically modified tomatoes**

The tomatoes do not soften when they ripen and so they can be harvested, transported and stored more easily and without damage and yet the flavour is unimpaired

1. **Suggest one benefit and one possible disadvantage of using genetically modified herbicide-resistant crop plants together with the relevant herbicide.**

ADVANTAGE – the crop yield is greater and so food prices are not as high. This is because the herbicide kills only the weeds that are competing for light, water and minerals

DISADVANTAGE – the herbicide (or its breakdown products) might accumulate further up the food chain and might be toxic to other organisms. The herbicide resistant gene might pass to other plants which will then be unaffected by the herbicide, rendering it useless

1. **Why is insulin produced by recombinant DNA technology better than insulin extracted from animals**

Insulin produced by recombinant DNA technology is identical to human insulin and so has no side-effects. It does not induce an immune response. There is no need to slaughter animals to obtain it. there is less risk of transferring infections or disease because there is no donor animal.

1. **Explain how two parents, neither of whom suffers from cystic fibrosis, might have a child with the disease**

If both parents are heterozygous for the CFTR gene, then each would carry one dominant and one recessive allele for the condition. They would not suffer from CF as they have the dominant allele. If an offspring inherits one recessive allele from each parent, they could suffer from CF

1. **Why does somatic-cell gene therapy fail to provide a permanent cure for cystic fibrosis**

Somatic cell gene therapy targets just the affected tissues, e.g. lung tissue, and the additional gene is not present in sperm or eggs and is therefore not passes on to future generations. As the cells of the lung tissues are continuously dying and being replaced, the treatment needs to be repeated periodically – as often as every few days

1. **In which two ways can a normal CFTR gene be delivered to the lungs of a patient with cystic fibrosis**

Using a harmless virus (an adenovirus) as a vector 🡪 wrapping the gene in lipid molecules to enable it to pass through the cell-surface membrane of lung epithelial cells. The gene preparation is sprayed into the nostrils and drawn into the lungs during breathing

1. **Why does the secondary immune response prevent a particular difficulty for patients undergoing gene therapy**

Because somatic-cell gene therapy requires regular repeat treatments, the secondary response means that the immune system is enhanced on the second and subsequent occasions

1. **Explain why the fact that somatic-cell therapy is short lived, can induce an immune response and uses viral vectors to deliver the gene does not necessarily present a problem for germ-line gene therapy**

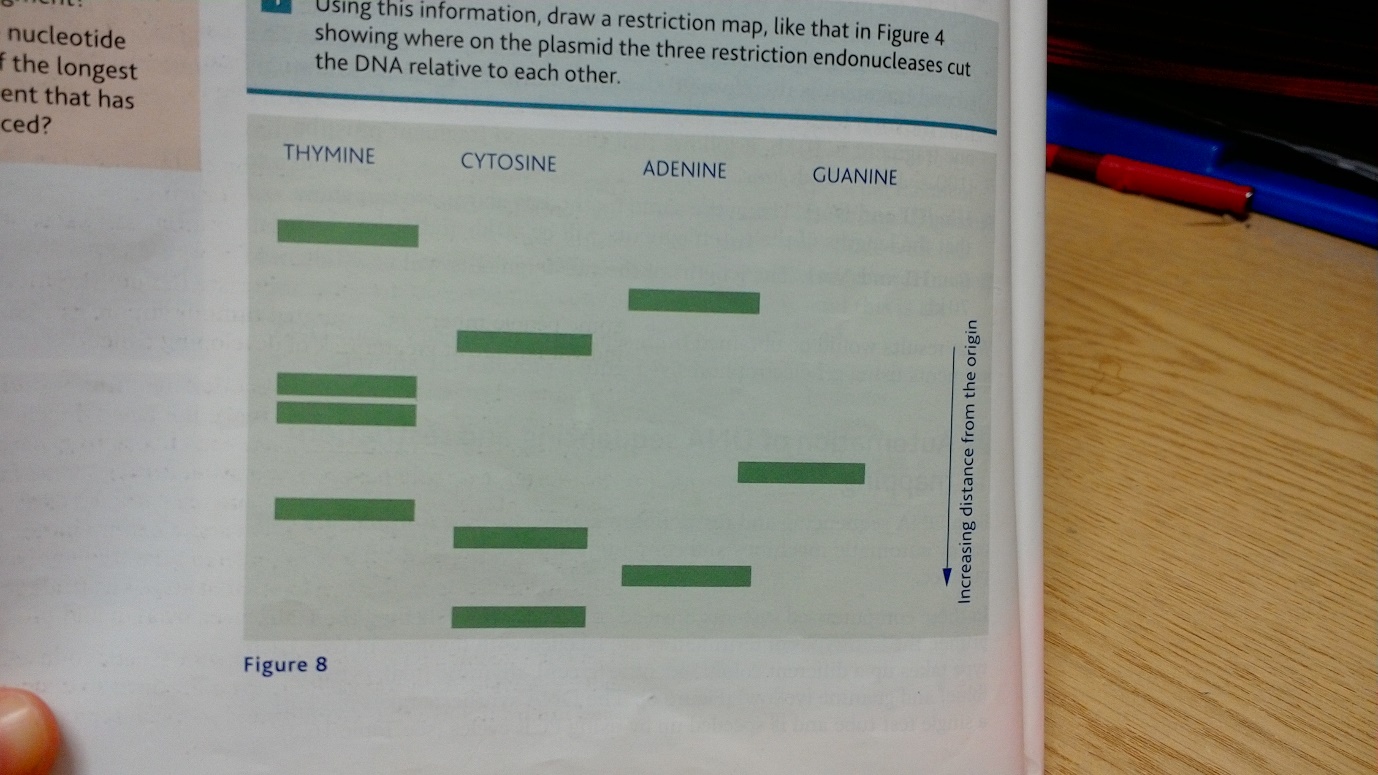
Germ-line therapy means that all body cells have the additional gene permanently. Therefore the effect lasts for an individual’s lifetime and no repeat treatments are required, there is no immune response and no need for a means of delivery

1. **What is a DNA probe**

A short, single-stranded section of DNA that has some label attached that makes it easily identifiable

1. **State two roles of a primer used in the sanger method of sequencing DNA**

It starts the process of DNA synthesis by making the DNA double stranded (DNA polymerase only works on double strands). It carries the radioactive label for later identification of the DNA fragment produced

1. **Look at the diagram below. It shows the results of the sanger method of sequencing a fragment of DNA**
2. **How many adenine bases were present in the fragment of DNA**

two

1. **Which nucleotide starts the shortest fragment**

Cytosine

1. **What is the nucleotide sequence of the longest DNA fragment that has been produced**

CACTGTTCAT