(iv) More food is needed in order to grow

(3) Ectotherms – organisms that rely on external sources of heat to regulate their body temperature (tends to fluctuate with the external temperature)

(a) Once active – muscle contractions generate some heat from increased respiration

(b) Advantages

(i) Use less of their food in respiration

(ii) Need to find less food so may be able to survive for long periods of time without eating eg. snake can last several weeks between meals

(iii) Great proportion of the energy obtained from food can be used for growth

(c) Disadvantages

(i) Less active in cooler temperatures

(ii) Greater risk of predation – may need to warm up in the morning before can be active eg. often see lizards basking in the sun during the early morning and/or raises skin flaps

(iii) May not be capable of activity during the winter (not able to increase respiration rates to generate heat internally) – must have sufficient stores of energy to survive the winter without eating

(iv) Narrow geographical range – need a consistently warm climate

(4) Temperature regulation relies upon the exchange of heat with their environment – by negative feedback in endotherms…

(a) Rise in core temperature

(i) Thermoregulatory centre (thermoreceptors) in hypothalamus detects change

(ii) Hypothalamus sends signals to reverse the change

(iii) Nervous system and hormonal system carry signal to skin, liver and muscles

(iv) Decreased rate of metabolism eg. through less muscular contraction

(v) Less heat generated and more heat lost to the environment

(vi) Temperature falls

(b) Fall in core temperature

(i) Thermoregulatory centre (thermoreceptors) in hypothalamus detects change

(ii) Hypothalamus sends signals to reverse the change

(iii) Nervous system and hormonal system carry signal to skin, liver and muscles

(iv) Increased rate of metabolism eg. through extra muscular contraction

(v) More heat generated and less heat lost to the environment

(vi) Temperature rises

(c) Peripheral receptors in skin – monitor temperature in the extremities

(i) Provides an early warning that core body temperature may change – response can be faster to avoid too much variation in core body temperature

(ii) Information fed to thermoregulatory centre in the hypothalamus

(iii) Signal indicates external environment is very cold or very hot

(iv) Brain can initiate behavioural mechanisms to maintain temperature

(5) Physiological mechanisms to maintain body temperature (endotherms)

(a) Skin – largest organ in the body, controls the amount of heat lost or conserved

(n) Membrane potential difference rises to +40mV – neurone will transmit action potential because many voltage-gated sodium ion channels open

(o) Action potential reached is self-perpetuating – once it starts at one point in the neurone, it will continue along to the end of the neurone

(3) Repolarisation – return of the potential difference towards the resting potential

(a) Sodium voltage-gated channels close

(b) Potassium voltage-gated channels open

(c) Membrane is more permeable to potassium ions than sodium ions

(d) Potassium ions move out of axon

(e) Potential difference drops back down

(f) Repolarisation occurs – resting potential difference of -65mV returns

(4) Hyperpolarisation – inside of the cell becomes even more negative relative to the outside than usual

(a) Membrane is more permeable to potassium than sodium ions

(b) Potassium voltage-gated channels are slow to close which results in a huge loss of potassium ions out of the axon

(c) Potential difference drops further down, undershooting the resting potential

(5) Refractory period – period of time following an action potential

(a) During this time, it is impossible to stimulate the cell membrane to reach another action potential

(i) Determines maximum frequency of impulse transmission

(ii) Ensures impulses/action potentials are separated

(iii) Impulse can only travel in one direction along the axon

(b) Resting potential re-established by redistributing sodium and potassium ions

(i) Sodium/potassium ion pumps help to restore resting potential

(ii) Membrane is generally more permeable to potassium ions at resting potential

(iii) Sodium voltage-gated channels are closed

(iv) Potassium voltage-gated channels are opened

(v) Potential difference then returns to the resting potential

v) Describe and explain how an action potential is transmitted in a myelinated neurone, with reference to the roles of voltage-gated sodium ion and potassium ion channels

vi) Compare and contrast the structure and function of myelinated and non-myelinated neurons

(1) 2/3 of PNS neurones are non-myelinated – carry signals over shorter distances to coordinate body functions such as breathing and the action of the digestive system

(a) Several neurons loosely wrapped within one Schwann cell

(b) Action potential moves along the neurone in a wave rather than by jumping

(c) Where rapid response is not so important

(2) 1/3 of PNS neurones are myelinated – carry signals over long distances ie. from sensory receptors to the CNS and from the CNS to effectors

(a) Myelinated – insulated by an individual myelin sheath

(2) To supply more oxygen and glucose, the heart…
   (a) Increases the heart rate – increase the number of heart beats per minute
   (b) Increases the strength of its contractions
   (c) Increases the stroke volume – increase the volume of blood pumped per beat
(3) Control of heart rate
   (a) Myogenic heart muscle – responsible for and initiates its own contractions
   (b) SAN (sin-atrial node) – region of tissue in the right atrium wall that acts as the heart's own pacemaker
      (i) Generates an impulse
      (ii) Initiates an action potential which travels as a wave of excitation
      (iii) Wave of excitation travels over the atria walls, through the atrioventricular node (AVN) and down the Purkyne fibres to the ventricles
      (iv) Initiates the contraction of the chambers
      (v) Sets the hearts own natural rhythm – a set frequency under resting conditions
   (c) Nervous supply from the medulla oblongata
      (i) Medulla oblongata – found at the base of the brain in the brain stem which is the region of the brain that coordinates the unconscious functions of the body
      (ii) Cardiovascular centre – specific region of the medulla oblongata that receives sensory inputs about levels of physical activity, blood CO_2 concentration and blood pressure
      (iii) Nerves from the medulla oblongata connect to the SAN of the heart
      (iv) Does not initiate contractions but alters the frequency of excitation waves and therefore the frequency of contractions
      (v) Action potentials sent down the accelerator nerve to the heart to increase the heart rate
      (vi) Action potentials sent down the vagus nerve to the heart to decrease the heart rate
   (d) Heart muscle is responsive to the presence of adrenaline in the blood – produced in the adrenal cortex
(4) Factors which may affect heart rate
   (a) Stress, shock, anticipation or excitement
      (i) Adrenaline secreted as a response
      (ii) Body is prepared for activity – fight or flight
      (iii) Heart rate increases
   (b) More exercise
      (i) More CO_2 is produced
      (ii) Some CO_2 reacts with water in the blood plasma
      (iii) Decrease in blood pH
      (iv) Detected by chemoreceptors in the carotid arteries, the aorta and the brain
      (v) Chemoreceptors send impulses to the cardiovascular centre
      (vi) Heart rate increases
   (c) Movement of the limbs