- Colour blindness and haemophilia are only formed on X chromosome so there's no subscript for Y chromosome
- X^b colour blindness, X^B no colour blindness
- X^h haemophilia, X^H no haemophilia
- All possible genotypes for colour blindness (could also be for haemophilia if H and h replace B and b
    - Not colour blind: $X^B X^B$
    - Colour blind: $X^b X^b$
    - Not colour blind: $X^B X^b$
    - Not colour blind: $X^B Y$
    - Colour blind: $X^b Y$

4.3.9- State that a human female can be homozygous or heterozygous with respect to sex-linked genes.

A human female can be homozygous or heterozygous with respect to sex-linked genes.

4.3.10- Explain that female carriers are heterozygous recessive alleles.

- Female carriers are heterozygous recessive alleles
- Only females can be heterozygous recessive because the alleles are only present on X chromosomes
- Therefore only females can be carriers
- Females have three possible genotypes and males only have two possible genotypes
- The single allele in males determines their phenotype

4.3.11- Predict the genotype and phenotype ratios of offspring of monohybrid crosses involving any of the above patterns of inheritance.

- You can use Punnett grids for normal, ABO blood groups and sex-linked traits
- Remember steps
    - Choose letters to represent dominant and recessive alleles
    - Determine the genotypes of the parents
    - Determine their gametes
    - Draw a Punnett grid to determine offspring
    - Interpret the grid for ratios

4.3.12- Deduce the genotypes and phenotypes of individuals in pedigree charts.

- Pedigree charts for dominant and recessive, and codominant alleles
    - Circle is female
    - Square is male
    - Filled in shape means they have the trait being studied
    - Horizontal line means they're the parents
    - Vertical line means they're the offspring

4.4- Genetic engineering and biotechnology

4.4.1- Outline the use of polymerase chain reaction (PCR) to copy and amplify minute quantities of DNA.

- the Polymerase Chain Reaction (PCR) is used to copy and amplify small amounts of DNA
- PCR copies all the nucleic acids in DNA and makes millions of copies
- used to get enough DNA to be able to analyse it
- thermocycler copies segments of DNA

4.4.2- State that, in gel electrophoresis, fragments of DNA move in an electric field and are separated according to their size.

In gel electrophoresis, fragments of DNA move in an electric field and are separated according to their size.

4.4.3- State that gel electrophoresis of DNA is used in DNA profiling.

Gel electrophoresis of DNA is used in DNA profiling.

4.4.4- Describe the application of DNA profiling to determine paternity and also forensic investigations.

proteins in labs	• proliferation of GM organisms could decrease biodiversity

4.4.11- Define *clone.*

- clone: a group of genetically identical organisms or a group of cells artificially derived from a single parent

4.4.12- Outline a technique for cloning using differentiated animal cells.

Cloning using a differentiated animal: Dolly the sheep

- original donor sheep was cloned by taking a somatic cell from the udder
- this cell was cultured and the nucleus was removed
- an unfertilized egg was collected from another sheep and its nucleus was also removed
- an electrical current was used to fuse the nucleus of the udder cell with the egg cell
- the embryo was placed in the womb of a surrogate mother sheep
- Dolly the sheep was born

4.4.13- Discuss the ethical issues of therapeutic cloning in humans.

- in nature, embryos are created only for reproduction and so many people believe that using them for experiments is unnatural and wrong
- however, embryonic stem cells can lead to some major breakthroughs
    - growing skin to repair a serious burn
    - growing new heart muscle to repair an ailing heart
    - growing new kidney tissue to rebuild a failing kidney
- the vast majority of researchers and medical professionals are against reproductive cloning in humans

5- Ecology and evolution

5.1- Communities and ecosystems

5.1.1- Define *species, habitat, population, community, ecosystem and ecology.*

- Species: a group of organisms that can interbreed and produce fertile offspring
- Habitat: the environment in which a species normally lives or the location of a living organism
- Population: a group of organisms in the same species who live in the same area at the same time
- Community: a group of populations living and interacting with each other in an area
- Ecosystem: a community and its abiotic environment
- Ecology: the study of relationships between living organisms and between organisms and their environment

5.1.2- Distinguish between *autotroph* and *heterotroph.*

- Autotroph: an organism that synthesizes its organic molecules from simple inorganic substances
- Heterotroph: an organism that obtains organic molecules from other organisms

5.1.3- Distinguish between *consumers, detritivores* and *saprotrophs.*

- Consumer: an organism that ingests other organic matter that is living or recently killed
- Detritivore: an organism that ingests non-living organic matter
- Saprotroph: an organism that lives on or in nonliving organic matter, secreting digestive enzymes into it and absorbing the products of digestion

5.1.4- Describe what is meant by a food chain, giving three examples, each with at least three linkages (four organisms).

- Food chain: a sequence showing the feeding relationships and energy flow between species (the direction of each arrow shows the energy flow)
- Examples
    - grass→ grasshopper→ toad→ hognose snake→ hawk
    - algae→ mayfly larva→ juvenile trout→ kingfisher

- diatoms→ copepods→ herring→ seal→ great white shark

5.1.5- Describe what is meant by a food web.

- Food web is an interconnecting series of food chains
- Since an organism eats more than just one type of food, food chains don't tell the whole story

5.1.6- Define *trophic level.*

Trophic level: refers to an organism's position in a food chain

5.1.7- Deduce the trophic level of organisms in a food chain and a food web.

- T1: producer
- T2: primary consumer
- T3: secondary consumer
- T4: tertiary consumer

5.1.8- Construct a food web containing up to 10 organisms, using appropriate information.

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5.1.9- State that light is the initial energy source for almost all communities.

Light is the initial energy source for almost all communities.

5.1.10- Explain the energy flow in a food chain.

- Energy is transferred from one organism to the next when carbohydrates, lipids or proteins are digested
- Energy loss occurs between trophic levels because
  - Not all of the organism is swallowed as a food source
  - Not all of the food swallowed can be used in the body
  - Some organisms die before being eaten by an organism in the next trophic level
  - There is heat loss because of cell respiration at all trophic levels

5.1.11- State that energy transformations are never 100% efficient.

Energy transformations are never 100% efficient.

5.1.12- Explain reasons for the shape of pyramids of energy.

- Pyramid of energy in $kJm^{-2}y^{-1}$
- Since energy is lost, each level is always smaller than the one before
- Pyramid of energy is not pyramid of population sizes at each trophic level

5.1.13- Explain that energy enters and leaves ecosystems, but nutrients must be recycled.

- Energy enters and leaves ecosystems but nutrients must be recycled
- Energy enters in the form of light and is converted to chemical energy by the producer and is transferred to consumers in various trophic levels
- Organisms can't recycle heat energy
- Energy enters as light and exits as heat
- On the other hand, organisms must recycle nutrients necessary for life to exist
- These nutrients are available to organisms by eating and decomposition

5.1.14- State that saprotrophic bacteria and fungi (decomposers) recycle nutrients.

Saprotrophic bacteria and fungi (decomposers) recycle nutrients.

5.2- The greenhouse effect

5.2.1- Draw and label a diagram of the carbon cycle to show the processes involved.

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5.2.2- Analyse the changes in concentration of atmospheric carbon dioxide using historical records.

- Since plants and decomposers are more active in the summer months so more carbon dioxide is extracted from the atmosphere (less in the atmosphere)

- digestive enzymes also catalyse hydrolysis reactions
- enzymes don't cause reactions but they make them more likely to occur at physiologically normal temperatures

6.1.3- State the source, substrate, products and optimum pH conditions for one amylase, one protease and one lipase.

	Salivary amylase	*Pepsin (a protease)*	*Pancreatic lipase*
Source	Salivary glands	Stomach cells	Pancreas cells
Substrate	Amylose (starch)	Proteins (polypeptides)	Lipids
Products	Maltose and sucrose	Amino acids	Glycerol and fatty acids
Optimum pH	7	3	7

6.1.4- Draw and label a diagram of the digestive system.

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6.1.5- Outline the function of the stomach, small intestine and large intestine.

- Stomach
  - peristalsis causes food to be forced down your oesophagus to your stomach
  - food is held in the stomach for a while to mix with gastric juice
  - gastric juice is a mixture of 3 secretions from the inner lining of the stomach
    - pepsin: protease enzyme most active in acidic pH, hydrolyses proteins
    - hydrochloric acid: helps break down food and creates the acidic pH important for pepsin
    - mucus: lines the inner stomach wall to prevent damage from the hydrochloric acid
  - the muscular wall of the stomach creates a churning motion to mix the food and gastric juice
  - the valve at the lower end of the stomach opens and food enters the small intestine
- Small intestine
  - first part is called the duodenum
  - 3 accessory organs secret juices into the small intestine to continue the process
    - bile from liver and gall bladder
    - trypsin (a protease), lipase, amylase and bicarbonate (BALT) from pancreas
  - the inner wall of the small intestine is made of villi
  - each villi contains a capillary bed (part of circulatory system) and a lacteal (part of lymphatic system)
  - the function of villi is to greatly increase the surface area for absorption of molecules
  - the lacteal absorbs fatty acids and the capillary bed absorbs the others
  - nutrient molecules enter the circulatory system to enter a body cell through another capillary bed
- Large intestine
  - undigested food enters the large intestine from the small intestine
  - this also contains much of the water that is consumed
  - the primary function of the large intestine is water absorption
  - it's beneficial to keep water in the alimentary canal for as long as possible because it keeps food moving in a fluid environment
  - many naturally occurring bacteria like E. coli are also in the small intestine (examples of mutualistic organisms within us)
  - we provide them with nutrients, water and a warm environment while they synthesize vitamin K and maintain a healthy environment in the large intestine
  - any food undigested by us or the bacteria is eliminated from the body as solid waste or faeces

6.1.6- Distinguish between *absorption* and *assimilation*.

- absorption: when molecules pass through the villi
- assimilation: process of bringing the nutrient to a body cell and then using it

- HIV is human immunodeficiency virus, which eventually results in a set of symptoms called AIDS (acquired immune deficiency syndrome)
- only certain cells in the body have protein in their membranes that HIV recognizes
- one cell that HIV infects is the helper-T cell
- the HIV virus has a latency period (infection occurs but cells remain alive) so it is many years until AIDS develops
- helper-T cells communicate which cells need to undergo the cloning process and begin antibody production
- with HIV, individuals can't fight off pathogens they did before and the symptoms of AIDS start to appear

6.3.8- Discuss the cause, transmission and social implications of AIDS.

- it's very difficult to find a vaccine or cure for the infection caused by the virus
- HIV hides away inside its host cells for many years
- during this time, the body continues to fight against other pathogens but not against HIV which is already inside a body cell waiting for a signal to be activated
- HIV mutates relatively quickly and so the body's immune responses or vaccines might not even recognize it after it has mutated several times
- HIV was often associated with sexual activity and drug abuse which lead to some reluctance to allocate money towards HIV research
- HIV is transmitted from person to person by body fluids (including exchanges during sex and drug injections)
- at one time, blood for transfusions wasn't tested for blood-borne diseases like HIV
- blood is routinely tested in countries with reasonable medical care
- AIDS was originally labelled as a disease affecting homosexuals and drug abusers but it is rapidly spreading by way of heterosexual encounters
- individuals who have been diagnosed as being HIV positive might be discriminated against in terms of employment, insurance, education access, social acceptance and many other forms of discrimination
- not every country has the education and medical facilities to deal with the disease and in some countries inadequate medical care sometimes leads to an increase in infection rates

6.4- Gas exchange

6.4.1- Distinguish between *ventilation, gas exchange* and *cell respiration.*

- ventilation
  - breathing air in and out
  - each breath in and out replenishes the gases within the lung tissues so that diffusion continues
  - oxygen diffuses into the lung tissue and carbon dioxide diffuses out
- gas exchange
  - the diffusion of gases
  - occurs in the lungs where oxygen moves from the air of the lungs into the bloodstream and carbon dioxide moves from the bloodstream into the air of the lungs
  - the opposite occurs in a capillary bed somewhere else where oxygen diffuses out of the bloodstream and into a body cell and carbon dioxide diffuses out of the body cell and into the capillary bed
- cell respiration
  - biochemical pathway in which chemical bonds within a glucose molecule are broken to release energy, which is stored in molecules of ATP
  - in aerobic organisms, the process requires oxygen molecules
  - each of the six carbons of glucose are given off as carbon dioxide
- steps
  - ventilation: oxygen diffuses into alveolus
  - gas exchange: oxygen diffuses into lung capillary and then diffuses out of body capillary

6.6- Reproduction

6.6.1- Draw and label diagrams of the adult male and female reproductive systems.

Male p185

Female p186

6.6.2- Outline the role of hormones in the menstrual cycle, including FSH (follicle stimulating hormone), LH (luteinizing hormone), oestrogen and progesterone.

- hypothalamus produces GnRH, which targets the anterior lobe of the pituitary gland, resulting in the release of two hormones called FSH and LH
- FSH stimulates the development of follicles
- LH stimulates the follicles to become mature-Graafian follicles-and ovulate and then develop into corpus luteum
- ovary produces oestrogen which increases makes endometrium highly vascular
- the corpus luteum produces progesterone which maintains the highly vascular endometrium
- high levels of oestrogen and progesterone are a negative feedback signal to the hypothalamus so it does not produce more GnRH preventing the ovulation of more follicles

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6.6.3- Annotate a graph showing hormone levels in the menstrual cycle, illustrating the relationship between changes in hormone levels and ovulation, menstruation and thickening of the endometrium.

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- FSH level rises to stimulate follicle development and estrogen secretion by the cells of the follicle
- more estrogen which makes endometrium highly vascular
- estrogen rises to peak and stimulates the secretion of LH
- LH rises to peak and causes ovulation
- negative feedback: LH causes follicle cells to produce less estrogen and more progesterone
- LH causes follicle to develop into corpus luteum
- the corpus luteum secretes the progesterone, which causes the endometrium to prepare for an embryo
- negative feedback: high progesterone and estrogen levels inhibit the secretion of FSH and LH
- if no embryo is formed, progesterone and estrogen levels fall (menstruation), allowing the secretion of FSH, LH
- FSH level rises again to stimulate follicle development

6.6.4- List three roles of testosterone in males.

- determines the development of *male genitalia* during embryonic development
- ensures development of *secondary sex characteristics* during puberty
- maintains the *sex drive* of males throughout their lifetime

6.6.5- Outline the process of in-vitro fertilization (IVF).

- women injected with FSH for 10 days to develop many follicles
- HCG injected to loosen oocytes
- oocytes harvested surgically
- man ejaculates sperm cells into a container
- eggs and sperm cells mixed in culture dishes
- overnight in incubator
- 2/3 embryos selected and placed in uterus

6.6.6- Discuss the ethical issues associated with IVF.

Positive: 5	*Negative: 4*
• people who want to have children can with IVF • people who have a strong desire to have children will probably be loving parents	• embryos produced during culturing but not implanted are frozen or destroyed • genetic screening could lead society to choosing

- Quaternary organization
    - Involves multiple polypeptide chains which combine to form a single structure
    - Not all proteins have a quaternary structure
    - *All the bonds* from the primary, secondary and tertiary structures are involved
    - Some proteins contain non-polypeptide groups to form conjugate proteins

7.5.2- Outline the difference between fibrous and globular proteins, with reference to two examples of each protein type.

Fibrous protein	*Globular protein*
• Long, narrow shape • Insoluble in water • Ex. Collagen in connective tissue for structure • Ex. Actin in muscle for contraction	• 3D shape • Soluble in water • Ex. Haemoglobin delivers oxygen to body tissues • Ex. Insulin regulates blood glucose levels

7.5.3- Explain the significance of polar and non-polar amino acids.

- Non-polar amino acids are found in regions of proteins that are linked to a hydrophobic area of the cell membrane; hydrophobic R groups
- Polar amino acids are found in regions of proteins that are exposed to water and therefore have hydrophilic properties; hydrophilic R groups

- Membrane proteins have polar amino acids towards the interior and exterior of the membrane, making them water soluble
- amino acids on the inside of membrane protein are non-polar, making the structure stable
- These amino acids create hydrophilic channels in proteins through which polar substances can move
- non-polar amino acids cause proteins to stay embedded in the membrane

- Polar and non-polar amino acids are important in determining the specificity of an enzyme
- The fitting of the substrate to the active site of an enzyme involves the general shape and polar properties of the substrate and of the amino acids exposed in the active site

7.5.4- State four functions of proteins, giving a named example of each.

Function	*Example*
Structure	Collagen
Contraction	Actin
Transportation	Haemoglobin
Regulation	Insulin

7.6- Enzymes

7.6.1- State that metabolic pathways consist of chains and cycles of enzyme-catalysed reactions.

Metabolic pathways consist of chains and cycles of enzyme-catalysed reactions.

7.6.2- Describe the induced-fit model.

- Some enzymes can bind to several substrates
- The active site is the region of the enzyme that binds to the substrate or substrates, causing the reaction to occur much faster than it normally would
- The lock-and-key model doesn't describe enzyme action properly
- Enzyme changes shape when substrates combine with their active site
- This is the induced-fit model
- The interaction of the substrate results in the conformation of the enzyme, providing an induced fit

- Lysis
  - the hexose biphosphate splits into two 3-C TP molecules
- Oxidation
  - The TP molecules undergo oxidation
  - NAD^+ is reduced to NADH
- ATP formation
  - Inorganic phosphate is added to each TP
  - The two phosphate groups are then added to ADP to form ATP, forming pyruvate
- In the end 4 ATP formed (net 2 ATP formed), 2 pyruvate formed, 2 NADH formed
- Occurs in the cytoplasm of the cell
- Controlled by enzymes

8.1.3- Draw and label a diagram showing the structure of a mitochondrion as seen in electron micrographs.

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8.1.4- Explain aerobic respiration: the link reaction, the Krebs cycle, the role of NADH + H^+, the electron transport chain and the role of oxygen.

- Link reaction
  - Each pyruvate enters the matrix via active transport
  - Oxidative decarboxylation: carbon dioxide is formed
  - NAD^+ is reduced to NADH
  - Acetyl is formed and combines with coenzyme A to form acetyl CoA
  - When ATP is low, acetyl CoA enters the Krebs cycle
  - In the end 2 carbon dioxides, 2 acetyl CoA are formed and 2 NADH are formed
- Krebs cycle
  - The Krebs cycle will run two times for each of the acetyl CoA produced by the link reaction
  - CoA is gone
  - 6C is 6C and becomes 5C by losing carbon dioxide and reducing NAD^+ to NADH
  - 5C becomes 4C by losing carbon dioxide and reducing NAD^+ to NADH
  - To convert the 4C to oxaloacetate, ADP becomes ATP, FAD becomes $FADH_2$ and NAD^+ becomes NADH
  - In the end, 4 carbon dioxides formed, 6 NADH formed, 2 $FADH_2$ formed and 2 ATP formed
  - This reaction is substrate-level phosphorylation
  - Occurs in the matrix of the mitochondria
- Electron transport chain
  - In the inner membrane of the mitochondria
  - Has a series of electron carriers
  - NADH supplies the first carrier with 2 electrons
  - The 2 electrons pass along the chain because they give up energy each time they go from one carrier
  - Electrons are given to oxygen at the end of the electron transport chain
  - Oxygen also accepts 2 protons to form water
  - $FADH_2$ allows the production of 2 ATP while NADH allows the production of 3 ATP

8.1.5- Explain oxidative phosphorylation in terms of chemiosmosis.

- Chemiosmosis involves the movement of protons to provide energy so that phosphorylation can occur
- Called oxidative phosphorylation because it involves an electron transport chain
- ATP synthase uses energy of an ion gradient to allow the phosphorylation of ADP to ATP
- Protons are pumped from the matrix to the intermembrane space as electrons are transported along the chain
- The protons move passively through ATP synthase into the matrix
- ATP synthase takes the energy produced by this movement and uses it to convert ADP to ATP

- Many desert plants shed their leaves in the driest months and become dormant

9.2.11- Outline the role of phloem in active translocation of sugar (sucrose) and amino acids from source (photosynthetic tissue and storage organs) to sink (fruit, seeds, roots).

- Active translocation
- Sugar from the source is loaded into the phloem sieve tube, causing water to enter by osmosis
- This causes a pressure and results in the movement of phloem sap
- Sugar is then removed at the sink from the phloem sieve tube at the sink, causing water to leave the tube by osmosis
- This diminishes the pressure
- The water is carried back from the sink to the source

9.3- Reproduction of Angiospermophytes

9.3.1- Draw and label a diagram showing the structure of a dicotyledonous animal-pollinated flower.

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9.3.2- Distinguish between pollination, fertilization, and seeds dispersal.

- Pollination
  - Process by which pollen is placed on female stigma
- Fertilization
  - When male and female sex cells unit to form a diploid zygote
- Seed dispersal
  - Process by which an embryo is dispersed to distant locations

9.3.3- Draw and label a diagram showing the external and internal structure of a named dicotyledonous seed.

- Testa
- Micropyle
- Cotyledons
- Embryo shoot
- Embryo root

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9.3.4- Explain the conditions needed for the germination of a typical seed.

- Water is needed to rehydrate the dried seed tissue
- Oxygen is needed to allow aerobic respiration to produce ATP
- Appropriate temperature is needed for enzyme action

9.3.5- Outline the metabolic processes during germination of a starchy seed.

- The starchy seed absorbs water
- Gibberellin is formed in the seed's cotyledon
- This stimulates the production of amylase, which catalyses the breakdown of starch to maltose
- Maltose diffuses to the embryo to release energy (when converted into glucose) and for growth
- food stores aren't needed when light can reach leaves and plant can perform photosynthesis

9.3.6- Explain how flowering is controlled in long-day and short-day plants, including the role of phytochrome.

- 2 types of pigment phytochrome
- P_r (red absorbing 660 nm) is converted to P_{fr} (far-red absorbing 730 nm) rapidly in daylight
- and then P_{fr} is rapidly converted back when there's more far-red light
- in daylight, there's much more red light than far-red light so phytochrome exists in the active P_{fr} form
- P_{fr} is gradually converted to P_r in the dark (how the length of darkness is timed)
- P_{fr} is a promoter of flowering in long-day plants
- and an inhibitor in flowering in short-day plants

10- Genetic 2

10.1- Meiosis

10.1.1- Describe the behaviour of the chromosomes in the phases of meiosis.

- Prophase I
  - chromosomes coil
  - each chromosome already contains 2 chromatids
  - homologous chromosomes pair up (each pair of homologous chromosomes is called a bivalent)
  - non-sister chromatids cross over and DNA is exchanged
- Metaphase I
  - spindle microtubules are attached to the centromeres of the chromosomes
  - random orientation: the bivalents line up randomly along the equator of the cell
  - crossing over is terminated and now the chromatids are not identical
- Anaphase I
  - spindle microtubules pull chromosomes to opposite poles of the cell
  - this results in the independent assortment of genes that are not linked
- Telophase I
  - chromosomes uncoil
  - the 2 resulting cells are haploid but each chromosome is still made up of 2 chromatids
- Prophase II
  - DNA coils
- Metaphase II
  - random orientation: the individual chromosomes line up at the equator randomly
  - spindle microtubules attach to each sister chromatid at the centromere
- Anaphase II
  - the centromeres of each chromosome split
  - spindle microtubule pull each sister chromatid, now an individual chromosome, to the opposite poles
  - because of random orientation, the chromatids could be pulled to either newly forming daughter cell
- Telophase II
  - DNA uncoils

10.1.2- Outline the formation of chiasmata in the process of crossing over.

- during prophase I, the process of synapsis brings together 2 homologous chromosomes
- in this bivalent, one chromosome is from the father and one from the mother
- the mixing of genetic material between the 2 non-sister chromatids occurs when the chromatids intertwine and break (the locations of the breaks must be identical on either non-sister chromatid)
- the 2 segments connect to the opposite chromatid
- the places where they connect are called the chiasmata

10.1.3- Explain how meiosis results in an effectively infinite genetic variety in gametes through crossing over in prophase I and random orientation in metaphase I.

- crossing over
  - the 2 sister chromatids of a given chromosome are no longer identical
  - now they have different combinations of paternal and maternal alleles at various loci
  - the resulting gametes won't have the same alleles even though they both received chromatids from the same chromosome, because of the crossing over
- random orientation
  - there is random orientation of bivalents in metaphase I

    - The B cells produced secrete antibodies that recognize HCG as an antigen
    - The antibodies bond to an enzyme that catalyses colour change when the antibody encounters HCG
- Use in treatment
    - Targeting cancer cells with drugs attached to monoclonal antibodies
    - The monoclonal antibody is chemically modified to carry a toxin specific for the type of cancer cell or carry a radioisotope for pin-point radiation therapy

11.1.6- Explain the principle of vaccination.

- You can't be immune to a pathogen without being exposed to it at least once
- We have developed vaccines that act as the first exposure to the pathogen
- A vaccine is developed by weakening a pathogen and then injecting it into the body
    - Select a particularly weak strain of pathogen
    - Heat the pathogen
    - Or chemically treat the pathogen
- The leucocytes will recognize the pathogen as "not self" and the primary immune response takes place
    - Memory B cells are formed which will produce antibodies very quickly if there's a later infection
- Vaccination doesn't prevent infection but with exposure to the pathogen the secondary immune response is quicker and more intense than the primary immune response
- In this way, most people have only very mild symptoms

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11.1.7- Discuss the benefits and dangers of vaccination.

Benefits	*Dangers*
Total elimination of disease	Possible toxic effects of mercury in vaccines
Prevention of pandemics and epidemics	Possible overload of the immune system
Decreased healthcare costs	Possible links with autism (no)
Prevention of harmful side-effects of diseases	Allergic reactions and autoimmune responses.

11.2- Muscles and movement

11.2.1- State the roles of bones, ligaments, muscles, tendons and nerves in human movement.

- Bones
    - Provide a hard framework to support the body
    - Allow protection of softer tissue and organs
    - Act as levers for body movement
    - Form blood cells in the bone marrow
    - Allow storage of minerals like calcium and phosphorous
- Tendons
    - allow the attachment of skeletal muscles to bones
- Muscles
    - Provide the force necessary for movement
- Ligaments
    - Connect bone to bone
    - Strengthen the joint
    - Provide stability
- Nerves
    - Allow constant monitoring of positions of the joint parts
    - Prevent over-extension of joint parts

11.4.3- State the role of LH, testosterone and FSH in spermatogenesis.

- LH: stimulates Leydig cells to produce testosterone
- testosterone and FSH: stimulate the meiotic divisions of spermatogonia into spermatozoa

11.4.4- Annotate a diagram of the ovary to show the location and function of germinal epithelium, primary follicles, mature follicle and secondary oocyte.

- germinal epithelium: diploid germ cells which grow larger to become primary oocytes
- primary follicles: primary oocytes surrounded by single layer of follicle cells
- Graafian follicle: secondary oocyte and 2 rings of zona pellucida with fluid between
- secondary oocyte: haploid oocyte after meiosis I (n)

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11.4.5- Outline the processes involved in oogenesis within the ovary, including mitosis, cell growth, the two divisions of meiosis, the unequal division of cytoplasm and the degeneration of the polar body.

- oogenesis in the ovaries
- produces 4 haploid cells but 3 polar bodies and 1 ovum
- oogonia (2n) undergo
    - mitosis
    - growth- now primary oocytes (2n)
    - meiosis I
        - prophase I: primary follicle (primary oocyte surrounded by ring of follicle cells)
        - finish during menstruation:
        - large secondary oocyte (n) and small polar body (n)
    - meiosis II
        - stops at metaphase II
        - follicle cells divide, 2 rings are created with fluid in between
        - now Graafian follicle
- ovulation: Graafian follicle bursts as the fluid increases
- secondary oocyte is released from ovary
- polar body degenerates

11.4.6- Draw and label the structure of a mature sperm and egg.

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11.4.7- Outline the role of the epididymis, seminal vesicle and prostate gland in the production of semen.

- sperm stored in epididymis until they can swim
- seminal vesicles and prostate gland produce a fluid (semen) which mixes with the sperm to increase the volume of ejaculation
- semen contains fructose and mucus

11.4.8- Compare the processes of spermatogenesis and oogenesis, including the number of gametes and the timing of the formation and release of gametes.

Spermatogenesis- 7	*Oogenesis- 7*
Millions of sperm produced/day	One secondary ooctye ovulated/menstrual cycle
4 gametes produced per germinal cell (spermatogonia) which begins meiosis	1 gamete produced per germinal cell (oogonia) which begins meiosis (plus 3 polar bodies)

E.6- Further studies of behaviour

E.6.1- Describe the social organization of honey bee colonies and one other non-human example.

Honey bees

- colonies
- larvae destined to be queens are fed royal jelly during their entire development instead of just the first few days
- one queen bee
    - lays eggs
    - produces pheromones which calm the colony and cause other females to be sterile
- workers are sterile females
    - search for nectar and pollen
    - make wax and honey
    - feeds the larvae
    - protects the hive
- drones are fertile males
    - develop from unfertilized eggs
    - mate with queen

Chimpanzees

- highest order is in a community of 40-60 members
- smaller group within a community is called a party of 5 members
- the more food there is, the larger the groups that travel together
- hierarchy
    - highest ranking male is 20-26 years old
    - determined by physical fitness and fighting ability
    - males dominate over females
    - dominance among females corresponds with age
- males stay in the same community they were born in and females might migrate to other communities
- male bonding
    - cooperative behaviour needed to keep out intruders, hunt and share food
- parental care is responsibility of mother for survival of infants
    - young get food, warmth, protection and learn skills from mother
- communication
    - facial expressions and vocalizations

E.6.2- Outline how natural selection may act at the level of the colony in the case of social organisms.

- natural selection in the case of social organisms acts on the colony as a whole
- the selected genes are those which promote social organization
- the "worker" gene in the case of working bees

E.6.3- Discuss the evolution of altruistic behaviour using two non-human examples.

- kin selection: behaviour which results in a decrease in fitness of the altruist and increase in fitness of a close relative

- Belding's ground squirrel
    - when a predator (e.g. hawk) approaches, one ground squirrel gives a high-pitched call which alerts the rest of nearby danger