IQ1: How does mutation introduce new alleles into a population?

1.1 explain how mutagens operate, including electromagnetic radiation sources, chemicals, and naturally occurring mutagens

MUTAGENS

- Mutagens are substances or processes that can dramatically increase the rate of mutations.
- Mutagenesis is the process of producing a mutation in DNA.
  - Damage to DNA from mutagens can interrupt the cell cycle and cause neoplasms.

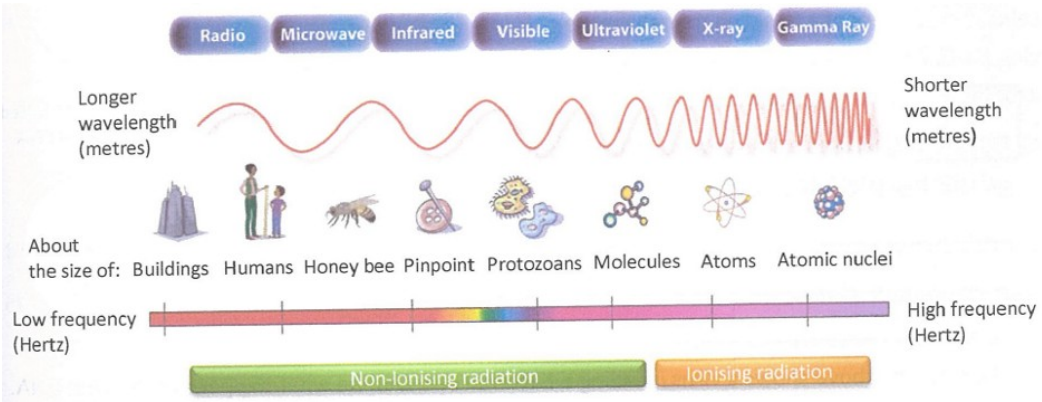
Benign neoplasms	Malignant neoplasms
Cells divide uncontrollably, yet not as rapidly as those of a malignant neoplasm.	Cells divide uncontrollably.
The organism controls the growth of the neoplasm to a certain extent by encapsulation. Cells are contained and do not penetrate the blood and lymph vessels.	Growth of the neoplasm: uncontrolled cell growth breaks out of capsule. Neoplastic cells can spread to other tissues (i.e. they metastasise).
Because the neoplasm grows inside a capsule, it does not destroy the surrounding tissues.	The growing neoplasm destroys the surrounding tissues.

CHEMICAL MUTAGENS

- Divided into three categories based on function:
  - Intercalating agents = chemicals that insert into the bonds between base pairs, altering the shape of DNA and leading to replication errors
  - Base analogues = chemicals structurally similar to DNA bases that can be incorporated into the base sequence, causing dysfunctional DNA
  - DNA reactive chemicals = react directly with DNA and can damage strands
- Can be artificial e.g. mustard gas or natural e.g. tobacco

PHYSICAL MUTAGENS

- Physical mutagens include particle radiation and electromagnetic radiation.
  - Particle radiation = energy emitted by fast subatomic particles e.g. nuclear
  - Electromagnetic radiation = energy emitted from the EM field
- Ionising radiation has enough energy to break chemical bonds → can lead to DNA breaking and reforming incorrectly



1.2 compare the causes, processes and effects of different types of mutation, including point mutations and chromosomal mutations

MUTATION

- Mutations are changes in DNA that result in genetic variation.
  - Can affect a single gene, multiple genes or entire chromosomes.
  - e.g. cystic fibrosis occurs from the deletion of a nucleotide in the CFTR gene, causing dysfunctional proteins.
- Most are detected and repaired by enzymes → unrepaired mutations can be neutral, beneficial or harmful.

POINT MUTATIONS

- Point mutations alter, add or remove a nucleotide from a sequence of DNA or RNA.
  - Affects corresponding bases on opposite DNA strand → changes codons
- Substitution mutations = one nucleotide replaced by another (silent, missense or nonsense)
  - Silent → substitution results in a new codon that codes for the same amino acid, NO effect on final polypeptide.
  - Missense → substitution results in an amino acid replacement, still produces a protein but may be dysfunctional e.g. sickle cell anaemia
  - Nonsense → substitution results in a premature stop codon, usually result in incomplete or non-functional proteins e.g. Thalassemia
- Frameshift mutations = one or two nucleotides added or removed from a sequence, altering the reading frame for every subsequent codon
  - Thus every amino acid they code for is altered – loss of functional protein

CHROMOSOMAL MUTATIONS

- Chromosomal mutations occur during meiosis and affect multiple genes in a chromosome.
  - Duplication mutations = replication of a section of the chromosome
    - Results in multiple copies of the same genes, increasing gene expression
  - Inversion mutations = section of the sequence breaking off, flipping, and reattaching
  - Deletion mutations = remove sections of a chromosome
    - Results in disrupted or missing genes → often fatal
  - Insertion mutations = one section of a chromosome breaks off and attaches to a different chromosome
  - Translocation mutations = a whole chromosome or section of a chromosome is attached to or exchanged with another
    - Interrupt gene regulation → can cause some cancers

1.3 distinguish between somatic mutations and germ-line mutations, and their effect on an organism

SOMATIC

- Somatic cells are body cells that undergo mitosis e.g. skin cells
- Mutations in somatic cells:
  - Generally the result of environmental factors e.g. smoking
  - Occur after fertilisation
  - Do not pass along to other generations
  - Can give rise to a special cancer category of genes called "proto-oncogenes", many of which regulate mitosis → can cause uncontrollable cell division, resulting in neoplasms
  - Can cause mosaicism (multiple genomes within one tissue).
- *The ageing process is linked to the accumulation of somatic mutations.*

GERMLINE

- Germ cells are the cells that produce sex cells or gametes e.g. sperm cells, egg cells
- Mutations in germ cells:
  - CAN be passed along to other generations
  - Increase genetic diversity
  - Are rarer than somatic mutations, since germ cells contain more DNA repair enzymes
- If a gamete mutates and survives to form a zygote, the offspring will be heterozygous for that mutation in all cells – however, the parent organism will not experience any changes to their own phenotype.
- Non-disjunctions occur when chromosomes do not separate in meiosis, giving one gamete two copies of the same chromosome and one gamete no copy.
  - e.g. Down syndrome → 3 copies of chromosome 21

1.4 assess the significance of coding and non-coding DNA segments in the process of mutation

CODING DNA (EXONS)

- Exons are usually expressed as RNA. They come together to make mRNA, which is translated into proteins – i.e. gene codes for producing proteins are carried in the exon regions.
  - All previously mentioned mutations (point/chromosomal) occur in the exons.

NON-CODING DNA (INTRONS)

- Introns do not code for polypeptides, but they, as well as promoter and terminator regions, are essential to the functioning of the cell.
- During transcription, introns are spliced out, allowing exons to join together in a neat and continuous sequence.
  - However, if mutations occur at the junctions or binding sites of introns, splicing may fail to occur, and introns will be kept in mRNA and read as a coding sequence.
    - Can cause mutations e.g. premature stop codons → called pseudo-exons
    - Cause of most well-known genetic disorders e.g. CF
- Mutations to promoter regions can profoundly affect transcription by altering the amount of gene products produced.

1.5 investigate the causes of genetic variation relating to the processes of fertilisation, meiosis and mutation

GENETIC VARIATION

- Genetic variation refers to any changes between individuals' DNA.
  - Often seen in phenotypes e.g. behaviour, physical attributes, metabolism
- Natural selection is the influence of environmental pressures on allele frequencies of a population, which occurs because of genetic variation between individuals, and the survival and reproduction of those individuals with favourable traits.

FERTILISATION

- Fertilisation is the union of a male and female gamete to produce a unique individual.
- Completely random process → any combination of genes from male gamete could succeed in fertilising female gamete, bringing about a range of different combinations.

MEIOSIS

- Meiosis mixes existing genetic material and is a major source of genetic diversity.
- Crossing over is the exchange of genetic material between homologous chromosomes, giving new gene combinations.
- Random assortment creates new combinations of maternal and paternal chromosomes as genes on sister chromatids may assort into any mixture before dividing.

MUTATION

- Mutations are changes to the DNA sequence, which is central to genetic diversity as it is the only source of new alleles in a population.

1.6 evaluate the effect of mutation, gene flow and genetic drift on the gene pool of populations

Variation in one population can be a source of new alleles for another population. The movement of alleles between populations is known as **gene flow**. When gene flow between populations is high, their **gene pools** (total genetic variation) will be similar. When gene flow is low or absent between populations, their gene pools will become increasingly different. If two populations are isolated for long enough, they may eventually become different species. Allele frequencies in a gene pool may also change randomly over time as a result of chance events (e.g. birth and death). This is called **genetic drift**. In small, isolated populations, the random loss of alleles due to genetic drift can have a significant effect, resulting in loss of genetic variation.

- Bottleneck effect = where chance events kill a large percentage of the population, and surviving individuals are NOT better adapted but are there by chance.
  - Alleles may be under or overrepresented in the smaller gene pool.
- Founder effect = small group of organisms not representative of the original population become isolated and start a new population.
  - Similar to bottleneck, however it is caused by colonisation, not catastrophe.

Gene flow involves fertile individuals moving from one population to another which means they are removing specific genes from one population and introducing the genes into another population. This migration can influence allele frequencies.

A gene pool is the complete set of genes in a population at any one time, ie. all alleles at all gene loci in all individuals in the population. Gene flow, e.g. due to immigration or emigration will change the gene pool when new variants move from another area or leave the area. Interbreeding between adjacent populations also alters allele frequency within the gene pool.

Main factors that affect the rate of gene flow between different populations are - 1. **Mobility** of fertile individuals or gametes (eg pollen) high mobility increases the chances of gene flow from one population to another. 2. Presence of geographical **barriers**, e.g. mountain ranges, oceans, deserts. 3. **Behavioura**l barriers, e.g. different courtship rituals in adjacent populations or the time of reproduction.

Gene flow often reduces the number of differences between populations with the higher the gene flow between two populations the fewer the differences and the less likelihood that the two populations will evolve into two species, e.g. pollen released from plants can be blown by the wind over distances to other populations where they fertilise plants introducing new alleles into that population and differences between the populations decrease.

A change in the allele frequencies in a population's gene pool over a number of generations means evolution is occurring. Evolution is a change in the genetic make-up of a population. Changes in allele frequencies provide information about how populations with different size gene pools cope with changing conditions or how populations can change due to genetic drift or gene flow over time.

The **size of the gene pool is most important when considering the survival chances** of a population in a changing environment. A small gene pool means there is little genetic diversity and if conditions alter and there are no variants with features suited to the new conditions the population becomes endangered and may face extinction. A large gene pool makes a population more robust and able to withstand changing conditions and natural selection.

Mutations produce random changes. There is no direct relationship between a particular mutation occurring and evolution. If the environment changes then a random mutation that is present in an individual may make that individual more able to survive the new conditions. A change in the environment will not directly cause a mutation to make an individual better suited to the new conditions.

Genetic drift is the unpredictable random fluctuations in allele frequencies in a gene pool of a population from one generation to the next. Genetic drift is due to a finite size of the population. In a small population there is a greater chance of genetic change due to random fluctuations than selective pressures for adaptation to a particular environment.

Effect	Description	Example
Mutation	Mutations introduce new alleles and new genes into the gene pool. This could be a change in the nucleotide sequence of DNA, a point mutation that affects one base in a gene or a chromosomal mutation where there is deletion, duplication or rearrangement of many loci.	There was one common ancestral globin gene which duplicated and diverged into alpha globin and beta globin around 450 to 500 million years ago.
Genetic drift	Chance events cause unpredictable changes in allele frequencies. In a small, isolated population some alleles may increase in frequency while others decrease in frequency.	When studying ABO blood groups (I^A, I^B and i) it was found that Australian Aborigines lacked the I^B allele which would be due to genetic drift and the founder effect.
Gene flow	Alleles are added to or subtracted from a gene pool due to the movement of fertile individuals or gametes. Gene flow can lead to hybridisation.	Varieties of crimson rosella *Platycercus elegans* have different colour forms from along the Murray River, to southern South Australia and then to the east coast from Victoria up to Queensland. Gene flow changes allele frequencies in adjacent populations.

IQ2: How do genetic techniques affect Earth's biodiversity?

BIODIVERSITY

- Genetic biodiversity = variety of genes found within gene pool of a species
- Species biodiversity = variety of different organisms found within a given area
- Ecosystem diversity = variety of different ecosystems within a region

BIOTECHNOLOGY

- Biotechnology = any technology that is developed from biological processes
  - Historical applications included fermentation and artificial pollination.
  - Future directions include universal flu vaccines, biofuels, and 'de-extinction'.

- Uses in agriculture, medicine and industry:
  - Changing genomes of organisms (genetic engineering e.g. GMO crops)
  - Reproducing favourable traits (reproductive technology e.g. artificial insemination)
  - Solve problems e.g. pollution

- Social implications:
  - Ethically or morally unacceptable/conflicting
  - New technologies that haven't been tested before = hesitation
  - Cost, equality or equity of access
    - BT cotton, terminator genes make product sterile, increases cost to small farmers
  - Genetic pollution

- Advantages:
  - Recombinant DNA in GM insulin bacteria → increases genetic diversity by creating new bacteria species as well as prolonging diabetics' lives
  - Can reduce pollution in industrial processes e.g. GM bacteria cleaning up oil spills, degrading toxic metals and metabolising carcinogenic chemicals in petrol

- Disadvantages:
  - Genetic selection e.g. BT cotton monocultures results in reduced gene pool and thus decreased biodiversity → populations may not have biological fitness to survive catastrophic events
  - Agricultural biotechnology e.g. BT cotton can negatively affect other organisms such as bees
  - Gene transfer can occur naturally in various species, with unknown consequences e.g. growth rate or response to environmental factors → risky but can lead to increased biodiversity

Table 5.1 Issues that impact on society and the environment

Ethical issue	For	Against
Environment and nature Is it ethical to interfere with nature?	■ Many new discoveries are considered to be a threat at first, e.g. nuclear power, but can be used to benefit society and the environment. If we are able to produce products that are of benefit, it would be unethical not to develop them.	■ Is it wrong to 'play God' and tamper with nature? ■ Biodiversity is upset as variation in the gene pool is lowered; this may lead to mass extinctions of 'wild' and/or modified species. ■ We may be changing the natural process of evolution. ■ Is it ethical to mix the genetic material of humans with that of other organisms?
Financial and social justice issues Is it ethical to put a price on (for people to own or patent, for personal gain) genetically modified products, thereby giving only a select group access to these (and denying access to those who cannot afford them)? Respect should be shown for human vulnerability and personal integrity.	■ We could create crops that are more drought-tolerant/resistant to pests and have a higher yield; this is cost-effective since the quality improves and less money needs to be spent (e.g. on pesticides). ■ Financial gain is essential—money can be put back into further research.	■ People in third-world countries may not be able to afford or have access to beneficial GM products, so they may fall even further behind developed countries, widening the poverty gap even more. ■ Patenting and 'ownership' of certain genes or species—single companies have the rights to technologies; other companies do not have access to them (even if they could be beneficial), creating a monopoly.
Medical and health issues If we are able to make products that bring medical benefits and improve the health and quality of life for humans, would it be unethical not to do so, even if we are unsure of the consequences?	■ Foods with higher nutritional value may be developed to supply better nutrition to people in third-world countries. ■ Reduced use of pesticides is better for consumers' health.	■ Potential long-term health risks of GM products are not yet known. ■ People with allergies may have allergic reactions to foods they could previously eat, if those foods include the DNA of other organisms.
Animal and human rights issues Is it ethical to genetically modify foods or other products and make them available to the public, when the public may not have full knowledge of what they are consuming or being exposed to, and they are not given alternatives and the right to choose?	■ GM crops may be used to solve food shortages in third-world countries, producing a higher yield at lower cost.	■ Vegetarians may unknowingly eat food with animal DNA. ■ Transgenic animals could be created as genetically modified 'works of art'.

IQ3: Does artificial manipulation of DNA have the potential to change populations forever?

ARTIFICIAL INSEMINATION

- Artificial insemination is the insertion of male partner or donor's semen through the cervix and into the uterus
  - Adv: many females can be impregnated as semen can be imported globally
- May alter the genetic composition of a population:
  - Using the same sperm for many fertilizations will reduce the genetic variation of the population, thus making the population more vulnerable to the effects of rapid environmental change e.g. disease
  - However using sperm with favourable characteristics may alter the population of the better in that it may allow for stronger and fitter offspring, avoiding many possible unfavourable traits
  - Can be used to increase numbers of endangered species

ARTIFICIAL POLLINATION

- Artificial pollination is a human intervention into the natural process of pollination, where pollen is manually deposited onto the stigma of a female flower
  - Offspring have a greater chance of inheriting desired characteristics e.g. wheat with high volume
- May alter the genetic composition of a population:
  - Biodiversity is an issue as this process is used to breed favourable characteristics, and thus plants with the same favourable characteristics will be repeatedly used for pollination – problems for future generations surviving environmental changes
  - However may also increase genetic diversity as it can be used to deliberately create new varieties of plants

CLONING

- A clone is a genetically identical copy of a gene, cell or organism.
- There are three types: whole organism cloning, gene cloning and therapeutic cloning.

WHOLE ORGANISM CLONING

- Whole organism cloning or reproductive cloning has many applications in science/medicine (e.g. using genetically identical test subjects as controls) and agriculture (e.g. cloning crops with desirable traits by vegetative propagation).
- Cloning animals is more challenging – currently it has been limited to mammals such as cattle, chickens, sheep and dogs.
- Disadvantages of whole organism cloning include high cost of breeding, consumer resistance to cloned food and higher rates of mortality and health issues in cloned animals. Cloning also raises social, moral and ethical concerns.
- Two methods for WOC in animals: artificial embryo twinning and somatic cell nuclear transfer (SCNT).

ARTIFICIAL EMBRYO TWINNING

- Occurs in a petri dish – early embryo is separated into individual cells and allowed to continue dividing. They are then transferred into a surrogate mother.
- Mimics the natural process that leads to identical twins; where both split halves of the embryo develop into two separate, genetically identical individuals (as they developed from the same fertilised egg).

SOMATIC CELL NUCLEAR TRANSFER

- SCNT removes the single set of chromosomes from an egg cell and replaces them with the nucleus of a DIPLOID somatic cell taken from the organism being cloned.
- The egg cell is then induced to divide as though under the natural fertilisation process. Once it is developed it is transferred to a surrogate mother.
- The individual born following pregnancy will be a genetically identical copy of the animal that donated the original somatic cell.
    - This technique was used to breed Dolly the sheep using udder tissue as the somatic cell.
- It can also be used in conservation practices to save critically endangered species e.g. the northern white rhinoceros, with only two females remaining.

GENE CLONING

- Gene cloning produces exact copies of a gene of interest.
- Two techniques can be used: in vivo and in vitro methods.
- <u>IN VIVO</u>
    - Involves the use of restriction enzymes, ligases and vectors to incorporate the desired gene into the DNA of a living organism where it will replicate e.g. GM insulin bacteria
- <u>IN VITRO</u>
    - Polymerase chain reaction (PCR) is used to produce multiple copies of a specific gene (primers bind to template DNA and polymerase extends/elongates primers to amplify small parts of DNA exponentially).
- Applications of gene cloning include whole genome sequencing, characterising genes (i.e. where they are located + functions), production of proteins, gene therapy and developing transgenic organisms.

CHARACTERISING GENES

- Allows us to examine how gene expression is regulated by other nearby genes or the environment and how mutations can disrupt gene expression/cause disease.
- Information about specific genes can be used to develop methods for earlier disease detection and treatments.

GENE THERAPY

- Application of cloning used in medicine – refers to the insertion of a gene into an individual's cells to correct or replace defective gene function that leads to disease.

THERAPEUTIC CLONING

- Involves cloning embryonic stem cells for the research and treatment of disease (using SCNT).
- Stem cells are unspecialised cells that have the potential to develop into any specialised cell (e.g. nerve cells) as well as being used for a variety of functions including growth and repair.
- Has the potential to overcome problems with immunological rejection of cells/tissues if patient's own stem cells are used to create therapeutic cells.

RECOMBINANT PLASMIDS

1. DNA extracted from the cell
2. Transgene is cut using endonucleases (sticky/blunt)
3. Plasmid is cut using same enzyme
4. Transgene and plasmids are placed together - some will just close up and others will incorporate by base pairing
5. Enzyme ligase is added to re-join the sugar/phosphate backbones

BACTERIAL TRANSFORMATION

1. Heat shock - place mixture into cold solution and rapidly heat to disrupt cell membranes so plasmids can enter bacteria
2. Electroporation - electrical current breaks cell membrane so plasmids can enter bacteria

SELECTION/SCREENING

- Bacteria are cultivated on agar with antibiotic and tested to see if incorporation of plasmid with transgene was successful
  - Non-transformed bacteria will not grow because they will have closed before the plasmid entered and thus not contain the antibiotic resistance gene

1. Blue colonies will not have recombinant plasmids as the transgene interrupts the sequence for expressing blue colour
2. White colonies WILL have recombinant plasmids as the gene has been successfully inserted, disrupting the sequence for colour

TRANSGENIC PLANTS - E.G. AGROBACTERIUM IN BT COTTON

- Transferring genes into plant cells can be limited by cell wall - use biolistics or vectors to create transgenic plants
- Method 1 - Vectors
  - Biological vector Agrobacterium can naturally transfer a plasmid into plant cells
  - Agrobacterium usually causes tumours on plant roots due to plasmid with tumour-causing gene - however recombinant plasmids (the vector) carrying the desired gene and NOT the tumour gene are introduced
  - Transformed bacteria allows plasmid to move directly to chromosomes of plants - tissue is then cultured and new transgenic plants grow
- Method 2 - Biolistics
  - Transgene extracted and amplified by PCR
  - Coat nanoparticles of gold/tungsten with transgene
  - Place tissue into vacuum chamber - at correct pressure helium will rupture top valve, shoot down into disc and inject the gene (nanoparticles) into tissue

ASSESSMENT OF BIOTECHNOLOGY

Implication	Issues
Social implication	• Genetic testing can aid the prevention, management and treatment of many diseases. If a couple both have the genetic predisposition for a particular genetic disease they can use assisted reproductive technologies (ART) and in vitro fertilisation (IVF) procedures to choose one of their embryos that does not have the genetic disorder. This reduces the frequency of genetic diseases that are specific to certain populations and will affect the social relationships in these communities. • The results of genetic testing require confidentiality and privacy. Individuals could be subject to social discrimination and stigmatisation making the person marginalised in society. • Knowledge about the health risks due to genetic testing means the person could also have difficulty gaining health insurance or employment due to the likelihood of disease or disability. This in turn could lead to economic difficulties affecting their social standing within their community. • If a person learns they have a particular genetic disorder they may have difficulty coming to terms with this situation and they may need to have psychological counselling. For some disorders there is no cure which the person needs to deal with while other genetic tests only identify the presence of the gene which may or may not be switched on in gene expression leading to the onset of the disease. In both situations the person is concerned about their health and their future and they need social support systems.
Ethical implication	• Prenatal screening can identify if a baby has a particular genetic condition, e.g. chromosomal abnormality. Ultrasound testing does not harm the embryo or foetus. Prenatal diagnostic testing extracts cells, e.g. using chorionic villus sampling (CVS) or by amniocentesis which both have a certain risk of miscarriage. Ethical issues arise if the test is positive for a possible chromosomal abnormality. Sometimes there are false positive results and sometimes there is limited information, e.g. the presence of two cystic fibrosis mutations does not exactly predict the severity of cystic fibrosis in the baby. The couple and their families are given genetic counselling and have to make decisions that have moral and ethical implications. • Genetic testing has been used for sex selection. In Australia it is illegal for sex selection unless there is a medical reason, e.g. if there is a risk of the child having a genetic disorder and the NHMRC has Ethical Guidelines on the use of assisted reproductive technology. Sex selection creates moral, social and economic problems. Some cultures have a preference for sons which leads to discrimination against females and can lead to a distortion of males : females in the population. This can affect employment, crime rates, social attitudes and demographics. • Genetic testing could have an impact on human evolution as it can affect allele frequencies in the gene pool. Depending on how couples decide to use the genetic information harmful genes could stay in the gene pool and could even increase in frequency in some populations depending on the number of children born to the people carrying these genes. This can create moral, social and ethical issues for the families and communities involved in the situation. • There are limitations on the completeness of the information provided by genetic tests. In many instances the final phenotype is affected by both environmental factors and genotype. Thus genetic testing only provides some of the information and other influences can impact on the severity of the condition, the age of onset of first symptoms, the rate of progression of the disorder and other details that are asked if a person has a positive genetic test result. This means that people may be making decisions that have ethical implications based on partial knowledge. • Genetic tests for DNA fingerprinting are being used to solve 'cold case' crimes where forensic evidence was collected years ago and it is only now that the new technologies can identify the perpetrator with evidence that can stand up in legal courts. This has moral and ethical implications for the families of both the victim(s) and perpetrator(s). • The patenting of human genes raises legal, ethical and economic issues. Gene ownership and the marketing and sale of gene products raises many ethical issues about the right for health care, the cost of health care and who pays for treatments and technologies.

Ethical Thoughts

- Philosophy, culture and religion – biotechnology interrupts the natural balance.
- Genetic abnormalities in embryos can be identified leaving parents with the choice to terminate pregnancy. Ending life during pregnancy is controversial.
- Legislations regarding biotechnologies have 'grey areas' e.g. who legally has access to private information (employers, insurers etc.).
- Biotechnology has unknown health effects = bad animal welfare e.g. transgenic pigs grow very quickly which negatively impacts their joints.

Social Implications

Benefits	Disadvantages
Greater access to goods/services.E.g. Recombinant DNA technology removes and inserts genes from viruses into humans as a vaccination.	Patenting: Companies control/own biotechnologies → companies can control prices of biotechnologies and make them unaffordable → social inequality.
Improve nutrition/yield of crops → reduces mass starvation and poverty.E.g. Golden rice (transgenic species) was genetically modified to contain vitamin A. Vitamin A is essential for eyesight and a healthy immune system.	Privacy: Biotechnologies reveal personal information which can be misused. E.g. an insurance company does not grant life insurance for an individual predisposed to a disease detected through genetic screening.
	Unknown health effects.E.g. Genetically modified foods may be toxic or change the consumer's DNA.