- Aerobic respiration in mitochondria
- Anaerobic respiration in the muscle cell sarcoplasm
- Transfer from creatine phosphate in the sarcoplasm – transfers phosphate group to make ATP from ADP+Pi

Fight or flight:

Physiological changes –

- Pupils dilate – iris radial muscle contracts
- Heart rate increases
- Arterioles to digestive system and skin constrict – smooth muscle relaxes
- Arterioles to muscles dilate
- Smooth muscle in airway relaxes
- Hairs stand up
- Ventilation rate increases contraction of intercostal muscles

A threat activates the hypothalamus – increases sympathetic nervous system stimulation and triggers release of adrenaline from the adrenal glands in the medulla (nervous and endocrine systems)

Adrenaline:

- Binds to complementary receptor
- Activates G protein
- Adenyl cyclase activated
- ATP converted to cAMP
- cAMP activates enzymes by changing their 3D structure

Biotechnology

Biotechnology: the industrial use of living organisms to produce food e.g. mycoprotein from the fungus fusarium, drugs e.g. penicillin from penicillium or enzymes e.g. detergents

Why microorganisms are used in biotechnological processes:

- Grow rapidly
- Produce pure products
- Easy to genetically engineer
- Processes occur at low temperature and pressure – cheaper/safer
- Can grow on waste materials
- No animal welfare issues

Standard growth curve of a microorganism in a closed culture:

- Choose plasmid that is resistant to two antibiotics ampicillin and tetracycline – genetic markers
- Plasmids cut by restriction enzymes – restriction site in middle of tetracycline resistance gene – if insulin gene is taken up = gene for tetracycline resistance doesn't work
- Bacteria grown on agar plate
- Some cells transferred to plate with ampicillin on – only bacteria that has taken up a plasmid will grow
- Cells transferred to plate with tetracycline on – those that don't grow must have the insulin gene
- Those that grow on the ampicillin but not the tetracycline must have insulin

Golden rice:

- Reduce vitamin A deficiency in Asia
- Reduce blindness

Why is it bad?

- Reduce genetic diversity in rice
- One disease would kill all the rice
- Spread genes to wild population
- Seeds are expensive
- Might not grow where it is needed
- Might not have enough vitamin A in
- Unknown effects

Gene therapy: used to treat genetic orders

Somatic cell gene therapy: This has to be repeated regularly as it effects somatic cells

1. Adding genes – Engineering a functioning copy of the gene into the relevant specialised cells – polypeptide is synthesised – cells function normally
2. Killing cells – eliminating certain populations of cells. Make cancerous cells express genes to produce proteins that make them vulnerable to attack by the immune system e.g. antigens

- Reduce symptoms of cystic fibrosis
- Extend lifespan/save lives

Why is it bad?

- Procedure could be painful
- Virus vector could cause viral disease
- Needs to be repeated many times
- Immune system may reject the new copy
- Tested on animals
- Unknown effects

Germline cell gene therapy:

- Germline cells = stem cell of an early embryo. Engineering a gene into a sperm, egg or zygote means all the cells will contain the engineered gene when it grows into an organism. Can be passed on to patient's children

Xenotransplantation: transplanting organs from other species

Problems:

- Animal welfare groups strongly oppose killing animals for human use
- Religious beliefs
- Medical concerns – disease transfer

Ethical concerns:

- Unnatural
- Microorganisms may escape and transfer genes to other microorganisms
- Widespread antibiotic resistance
- Genes in plants may pass to wild relatives – less genetic variation
- Genes could pass to weeds
- Pest resistance could pass to other plants – disrupts food chains
- Animal welfare issues
- Religion e.g. cows are sacred to Hindus
- Effects are unpredictable
- Individuals that have germline cell gene therapy have no say
- Designer children

Genetically modifying bacteria:

- Use restriction enzyme to cut out DNA coding for the gene you want – find using a gene probe
- Or obtain mRNA, use reverse transcriptase to make cDNA
- Or sequence the gene you want to work out the base code to make this DNA sequence
- These have sticky ends
- Cut open plasmid using same restriction enzyme
- Complementary base pairing of sticky ends, sealed (join sugar-phosphate backbone) with DNA ligase
- Forms recombinant DNA
- Mix with bacteria and Ca ions, give a heatshock

Meiosis and Variation

Meiosis: cell division after two gametes have fused

Interphase: DNA replicates so each chromosome consists of two identical sister chromatids

Meiosis I:

1. **Prophase I** –
    - Chromatin condenses and supercoils – shorter and thicker
    - Chromosomes come together in homologous pairs to form a bivalent (one maternal and one paternal)
    - Non-sister chromatids wrap around each other and attach at chiasmata
    - Swap sections of chromatids as they cross over