- Hydrophilic parts- edge of the polypeptide- close to water
- interactions cause twisting of the amino acid chain, changing the shape of the protein.

Proteins 3: Fibrous and Globular proteins

Fibrous: long regular, repetitive sequence of aa, usually insoluble in water &metabolically inactive

- These features enable them to form fibres, structural function.
-

Properties + functions of fibrous proteins

1. **Collagen:** provides mechanical strength like Artery walls & Tendons (bone &muscle)
2. **Elastin:** cross-linking + coiling makes structure strong + extensible like skin- stretch & lungs- inflate
3. **Keratin:** rich in cysteine- disulfide + hydrogen bonds- strong like Finger nails, hair, claws

Globular: relatively spherical shape, soluble (phobic + philic interactions, causing philic R groups- on the outside), and metabolic roles within organism

- specific shapes- allowing them to take up roles as enzymes, hormones and haemoglobin.

Properties + functions of globular proteins

1. **Haemoglobin: 4** polypeptide chains- 2 α-glucose + 2 β-glucose
- Each chain has its own tertiary structure- fit together = one haemoglobin molecule
- Each chain- **haem group- prosthetic group (non-protein)-iron ion**
- A protein associated with this kind group is called a **conjugated protein**

Function- oxygen binds- each haem group & is released- haemoglobin- reaches the tissues.

2. **Insulin**: 2 polypeptide chains- increase rate of consumption

3. **Pepsin:** enzyme- digests protein in stomach- single polypeptide chain

Computer modelling: predicts shape of a protein molecule from its primary structure

- Scans amino acid against database of possible match sequence
- useful for investigating the different levels of structure in a protein molecule.

Anaphase 2:

- Centromeres divide
- Chromatids of each chromosome pulled apart by motor proteins, dragged along tubulin threads of spindle, towards opposite poles

Telophase 2:

- Nuclear envelope forms around each of the 4 haploid nuclei
- 2 cells divide into 4 haploid

How meiosis produces genetic variation:

- Non sister chromatids cross over in prophase 1- shuffles alleles
- Random arrangement of chromosomes in anaphase 1- random distribution of maternal and paternal chromosomes of each pair
- Random arrangement of chromosomes in anaphase 2- further random distribution of genetic material
- Haploid gametes produced, undergo random fusion with gametes from another organism (same species)

Diversity in animals and plants

Multicellular organisms are large compared to single-celled, and thus have smaller **SA/V ratio**, so cells are not in direct contact with external environment

Stem cell: unspecialized cell able to express all of its genes and divide by mitosis

Differentiation: stem cells becoming specialized into different type of cells.

- Some genes switched off and others expressed more so:
- Proportion of organelles change
- Shape of cell changes
- Contents of cell changes

Erythrocytes(RBC):

- high SA/V ratio-biconcave shape, O2 diffuses across membrane easily
- flexible, well developed cytoskeleton to change shape- twist and turn though narrow capillaries
- lack in organelles like nucleus, mitochondria, R/SER- more space for hemoglobin

Neutrophils(WBC):

- Twice size of erythrocytes
- Multilobed nucleus
- Attracted to and travel toward infection sites
- Ingest bacteria and some fungi by phagocytosis

Sperm cells:

- Lots of mitochondria- ATP energy for undulipodium (tail) to move towards the ovum
- Small, long and thing-move easily
- Sperms head has digestive enzymes to enter ovum
- Contain haploid male gamete

Xylem and phloem in the leaf

- Vascular bundles form the **midrib & veins**- leaf
- **Dicotyledonous** leaf- branching network of veins- smaller as they spread away from **midrib**
- **vein**- xylem is located **ontop of the phloem**

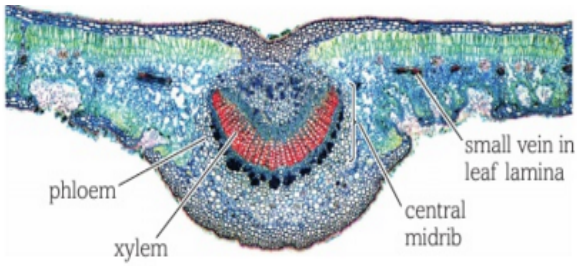


Figure 4 Transverse section of leaf, showing a tissue plan.

3.3.2 Transport tissues

Xylem -Tissue- transporting water & mineral ions from roots up to leaves & rest of plants

- **Vessels**- carry water & dissolved mineral ions
- **Fibres**- help **support** the plant
- Living **parenchyma cells**- act as **packing tissue** to **separate & support** the **vessels**

Xylem vessels

- As they develop- **lignin impregnates**- walls of the cells- **waterproof**- **kills** the cells
- The end **walls & contents** of the **cells decay**- leaving a **long column of dead cells**- no contents-a tube called the **xylem vessel**
- **Lignin strengthens** vessel walls & prevents **collapsing** – keeps **vessels open**- even when water- short supply
- **Lignin thickening** forms **patterns** in the **cell wall- spiral, annular (rings) or reticulate (a network of broken rings)-** prevents the vessel too rigid & allows some **flexibility** of the stem/branch
- In some places- **lignification incomplete**- leaving **gaps** in **cell wall**
- **gaps** form **pits** or **bordered pits- two adjacent vessels aligned**- allow water to leave one **vessel & pass** into next one
- allow water to leave the xylem & pass into **living parts** of the plant

Adaptations of xylem to its function

Xylem vessels can carry water & mineral ions from the root- very top ofplant because:

- Made from **dead cells aligned** end to end- a **continuous column**
- **Tubes- narrow** so **water column** does not break **easily** & **capillary action- effective**
- **Bordered pits**- **lignified walls** allow water **move sideways** from one vessel to another
- **Lignin deposited** in the walls in **spiral, annular/ reticulate patterns** allow xylem to **stretch** as the plant **grows** & enables **stem or branch to bend**

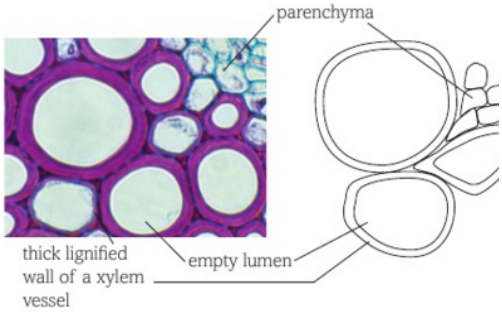


Figure 1 Transverse section of xylem, with high-power drawing.

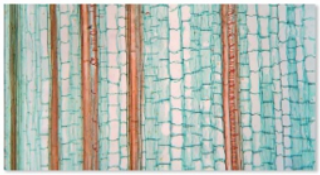


Figure 2 Xylem in longitudinal section, showing spiral thickening.

Flow of water is not delayed because:

1. no **cross-walls**
2. no cell **contents,** nucleus or cytoplasm
3. **Lignin thickening** prevents the walls- **collapsing**

Direct transmission: passing a pathogen from host to new host with no intermediary

1. **Direct physical contact**- touching infect person/ contaminated surface
   - ✓ Hygiene- washing hands regularly- after toilet, disinfecting cuts, condoms
2. **Faecal- oral transmission**- eating/ drinking things -contaminated by pathogen
   - ✓ Wash fresh food, treatment of water- purifying & cleaning
3. **Droplet infection-**tiny water droplet in air- carry pathogen
   - ✓ Cover your mouth- sneeze & cough – use tissue and dispose correctly
4. **Transmission by spores-** air or soil
   - ✓ Use mask & wash skin after soil contact

- **Overcrowding**- many living and sleeping together
- **Poor ventilation**
- **Poor health & poor diet**- person having disease- spread easily

Transmission of plant pathogen

- Pathogens in soil- enter roots (especially if damaged by animals or storm)
- Fungi produce spores- reproduction- airborne transmission via wind
- Enters plant- affects vascular tissue
- Leaves shed- carry's pathogen back into soil
- Also enter fruit seeds and infect offspring's

- Indirect- spores/bacteria attached to burrowing insects- when attacking infect plant
- Insect can attack healthy plant- infecting it

Plant defenses against pathogens

Passive defenses- before infection- prevents **entry** of pathogen – physical & chemical barriers

Physical defenses:

1. **Callose**- large **polysaccharide** that is deposited in **sieve tubes**-blocks flow- prevents pathogen spread
2. **Tylose formation**- a **balloon-like swelling** projection that fill **xylem vessel**- blocks vessel prevents pathogen spread- High concentration of chemical– **terpenes**- toxic to pathogen
3. **Waxy cuticle**- prevents water collection on surface- pathogen needs water- survive
4. **Cellulose cell wall**- physical barrier & activate chemical defenses- pathogen detected
5. **Stomatal closure**- guard cells close stomata- pathogen detected
6. **Lignin thickening of cell walls**- waterproof and indigestible
7. **Bark**- chemical defenses

Chemical defenses: terpenoids, phenols, alkaloids, defense proteins, hydrolytic enzymes

Necrosis- deliberate cell suicide- cells die around infection- prevent spread

Primary defenses against disease

1. **Skin**- Physical barrier- layer of dead cells
2. **Mucous membrane**- **special epithelial tissues** covered by mucus- protects body openings exposed to environment- mouth, ears, anus, genitals, nostrils. **Goblet cells**- (glands) secretes mucus traps pathogens – **cilia**- tiny hair organelle- waft layer of mucus
3. **Coughing and sneezing**- response to irritation- microorganism/ toxins release- reflex – sudden explosion of air to **expel** foreign matter

- Many characteristics can be affected by the environment
- skin colour in different light intensities
- Hawthorn trees grow branches sideways in windy conditions

'Genes load the gun; environment pulls trigger'

- ❖ changes in environment directly affects genes that are active
- ❖ small height family- even with good diet- unlikely to be tall- genes limits your height

Applying statistical techniques:

Standard deviation: measure of the spread around mean

- ➢ low st.dev- data has a narrow range- closely grouped to means- more reliable
- ➢ high ts.dev- data has a larger range- less well grouped- less reliable

$$s = \sqrt{\frac{\sum(x - \bar{x})^2}{n - 1}}$$

x= individual value
x(dash)= mean value
n= number of data points
s(st. dev)= +/- the mean value

normal distribution: values within +/- standard deviation

EG: mean= 84.6 s= +/- 8.98 OR 75.62/93.58 normal distribution is 75.63-93.57
Anything outside normal distribution is viewed as anomalous

Student's t-test: test used to compare 2 means

$$\frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

- ➢ makes sure no significant difference between means of two set
- ➢ t-test: sees whether to reject or accept hypothesis

S1^2- standard deviation of first set of data n1-number of data points in first set of data

T value: 5% its significant and is there for rejected

Correlation coefficient

Correlation coefficient: measure of how closely 2 sets of data are correlated. Value of 1- perfect correlation

D= difference between ranks
N= number of pairs of value(ranks)

$$r_s = 1 - \frac{6\sum d^2}{n\left(n^2 - 1\right)}$$

- ➢ Use critical values to see if r_s indicates a correlation
- ➢ R_s< critical value – no correlation (negative correlation)
- ➢ R_s> critical value- positive correlation (closer to 1)

- If any insects have **resistance they survive**
- The survivors are the only individuals that can **breed**
- All **offspring** have resistance to the pesticide
- **Resistance spreads** through the **population quickly**

Insects eat crops, carry diseases- vector, bioaccumulation of pesticide build up in food chain- humans can receive large doses of insecticides

Micro-organisms

- Antibiotics are a **strong selective pressure** on microorganisms
- Any **susceptibl**e microorganisms will die
- If any microorganisms have **resistance they survive**
- The survivors are the only individuals that can **breed**
- All **offspring** have resistance to the antibiotic
- **Resistance spreads** through the **population quickly**

To reduce antibiotic resistance:

- ✓ Always complete the course of antibiotics
- ✓ Only take antibiotics when necessary (Not for viral infections)

Problems with antibiotic resistance:

- MRSA 'superbug' has developed resistance to an ever increasing range of stronger and stronger antibiotics.
- This is an evolutionary arms race and medical researchers are struggling to develop new effective drugs, but the bacteria are rapidly becoming resistant.

Mammalian Nervous system

1.CNS

- spinal cord and brain
- White matter- myelinated (outer region of spinal c), grey matter- non myelinated (central)
- spinal protected by vertebral column- between each vertebrate- action p enter/exit

2.PNS

Sensory NS- carry action p from sensory receptor- Dendrons of sensory fibres enter CNS

Motor- Somatic NS

- single motor neurone carry action p from CNS to effector- skeletal muscles-
- voluntary conscious control
- myelinated neurones- rapid response

Motor-Autonomic NS

- at least 2 neurones carry action p from CNS to effectors- cardiac/smooth muscles of blood vessel walls/ airways& wall of oesophagus
- non myelinated neurones connected at ganglia
- involuntary/unconscious- responsible for homeostatic mechanisms
- Sympathetic- prepare body for activity
- Parasympathetic- conserves energy
- antagonistic systems- action of one opposes other
- change to internal condition- stress- changes balance of stimulation between 2 systems- leads to a key response

Sympathetic	Parasymapthetic
Noradrenaline	Acetylcholine
Short pre-ganglionic neurone	Long-variable- depends- position of effector
Long-variable- depends- position of effector	Short post-ganglionic neurone
Active- times of stress	Active- sleep/relaxed
Nerves lead to separate effector	Nerves divide up and lead to diff effectors
Orgasm Heart rate increase Saliva production inhibited Pupil dilates	Sexual arousal oppisite

Cerebrum

- 2 cerebral hemisphere- connected by corpus callosum
- Outermost layer- cerebral cortex
- conscious thought/action/ emotional response/ memory/ judgement

Cerebral cortex

- Association areas- compare sensory inputs with past experience- give appropriate response
- Motor areas of left side controls effectors on right side of body
- size of motor area allocated to certain effectors- relates to complexity of movement

- Smaller fragments travel further- fragments sorted by length
- nucleotide base at end of fragment read according to its radioactive label
- time consuming and costly process

2. 1st DNA sequencing machine
- automated- based on Sanger's method- fluorescent dyes used for terminal bases instead
- need of technicians to read autoradiograms

3. High throughout sequencing- pyrosequencing- synthesing
1. a long DNA to be sequenced cut by nebuliser – 300-800 bps
2. lengths degraded into single stranded DNA (ssDNA)- template strands- immobilised
3. Sequencing primer, DNA, DNA polymerase, ATP sulfurylase, luciferase
4. 1 out of 4 nucleotides A/C/T/GTP is added at any ne time+ light generated is detected
5. GTP- dephosphorylates to Guanine (all bases)
6. APS+ pyrophosphate- ATP and in the presence of ATP- luciferase converts luciferin to oxyluciferin
7. Light generated detected by camera- light patterns- indicate amount of ATP- DNA sequence
8. 10 hour run- 400 million bases read

Bioinformatics- research to store data generated

Against genetic screening of population- high cost to gov/NHS, invasion of privacy/ discriminates employer's/insurance companies/anxiety future health, many diseases have no treatment

Applications:
- humans 99% of genes with chimpanzee
- FOXP2 gene in human, mice & chimpanzee- human one is mutated allows speech
- genetic similarities- track evolutionary relationships of species
- humans share 99.9% of DNA with each other
- single nucleotide polymorphisms- alter protein/ the way RNA regulates expression of another gene
- epigenetics- study of how methylation of certain chemical groups of DNA- regulating gene expression in eukaryotic cells
- Synthetic biology- design & build useful devices to store and process information, food production, biomedicine
- Epidemiology- study &analysis of the patterns, causes, effects of health & disease conditions

DNA profiling- DNA analysis- confirms identity of an individual
- DNA obtained from individual- mouth swab/blood/hair
- DNA cut by restriction enzymes- at specific recognition site- into fragments
- separated by gel electrophoresis & stained- smaller one's travel further
- banding pattern seen & compared to another individual- cut with same restriction enzyme
- related individuals- more similar banding patterns

Types of DNA analysed
- Polymorphism analysis- Short tandem repeats- variable lengths- number of STRs varies from person to person
- STR sequences separated by electrophoresis
- DNA technique very sensitive- avoid contamination
- VNTR- variable no. tandem repeats- noncoding-varies in people- similarities=resemblance

4. Transfection- DNA inserted into bacteriophage- transfects host cell
5. Recombinant plasmid into Agrobacterium tumefaciens infects plants
6. Small piece if gold coated in DNA- shot into plant cells- gene gun

Grow in fermenter- multiply & reproduce- separate & reproduce

Bacteria & archaea- restriction enzymes- endonuclease (some need Mg ion-cofactor)

Prokaryotic DNA- protected by being methylated at recognition sites

Replica Plating

1. Human insulin gene is inserted- into tetracycline resistant gene in bacteria
2. Dip a block covered with sterile velvet into colonies on Ampicillin agar and touch onto surface of tetracycline
3. Recombinant plasmid will not grow therefore, missing ones have recombinant Plasmid in them
   - ✓ less rejection/side effect/reliable supply/ less ethical dilemmas/ faster

PCR	**Genetic engineering (in vivo)**
Quicker- few hours	Long- weeks- bacteria growth
Less equipment- tube & heat block	More- multirole test tubes/agar plates
Less space- regrowth medium, DNA & enzyme	More space- many plates- incubated/refrigerated
Safer- DNA & enzyme	Whole cells- contamination
More prone to mutation- Taq polymerase occasionally inserts wrong bases/ early mutation- reproduced	Less prone
PCR- primers- Taq p- high temp	Less expensive material fro growing bacteria cheap
Limited size for cloning	Gene unknown- longer piece of DNA cloned
Use lower quality DNA- forensic	

Knowledge of genes benefit medicine

- gene therapy
- see which individual's carries
- gene testing
- faster diagnosis
- embryo selection
- develop drugs- more effective & direct effect on organs

Genetically modified tech

Cloning and biotechnology

Natural clones

Cloning- process leads to formation of clones- genetically identical organisms/cells

Adv	Disadv
Same env suitable for parent & offspring	Offspring overcrowding
Rapid- increase pop- take adv of suitable env	No genetic diversity- all pop vulnerable to env changes
Reproduction- doesn't need 2 parents	Selection is impossible

Vegetative propagation- reproduction from vegetative parts of a plant- usually over wintering organ

- Runners/stolen- stems grow on surface of ground- can form roots at certain points (rhizomes- underground)
- suckers- new stems grow from root of plant
- Bulb- underground swollen stem- stores food & bud
- Corms- same as bulb but solid
- Leaves- immature plants drop off leaf- take root
- Tubers- underground stem grows into plants

water flea & greenfly- reproduce asexually to produce clones

Clones in plant

Tissue culture- growing new tissues/organs/plants from tissue cut from a sample plant

- root cutting- section of root buried below surface- new shoots
- scion cutting- dormant woody twigs
- leaf cutting- leaf placed in moist soil- develop new stems/roots
- Pluripotent/totipotent/undifferentiated- undiff cells give rise to many diff cell types

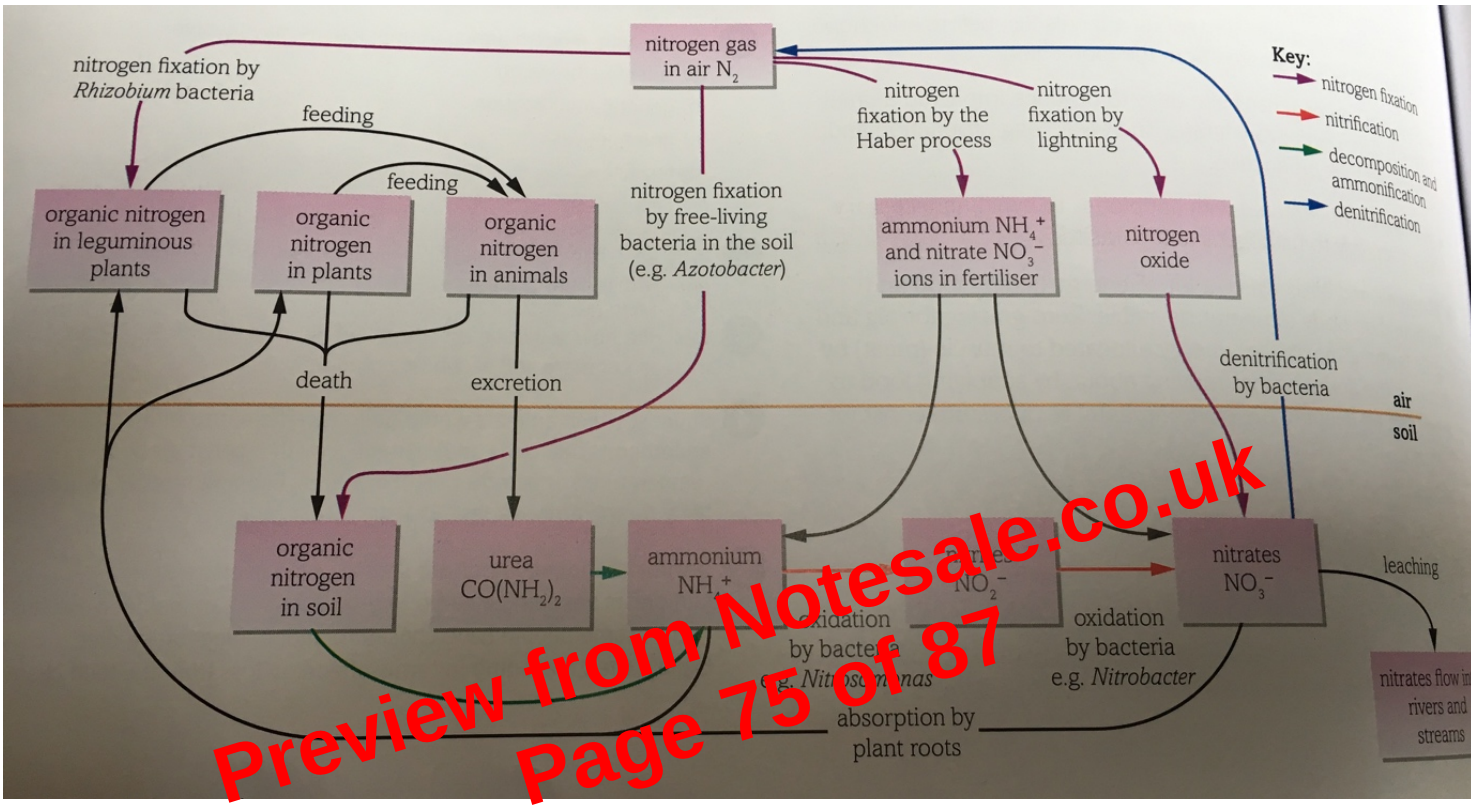
Micropropagation:

1. Small piece of plant tissue- explant- often meristem- Virus infection free or small leaf
2. explant sterilised- dilute alcohol- kill bacteria/fungi- (they thrive in these conditions)
3. explant- sterile growth medium-agar- nutrient rich- gluc/aa/phosphates & high conc of growth hormone
4. stimulates cells to divide by mitosis- callus & divided to small clumps of undiff cells
5. placed in diff growth medium- 1. 100 auxins:1cytokinins- stimulate roots & 2. 4:1 stimulate shoots
6. tiny pantalets form- transferred to greenhouse- grown in compost/soil

Adv	Disadv
Rapid- shorter generation time	Tissue culture- labour intensive
Plants lost ability to breed sexually/ hard to grow from seeds	Expensive to set up facilities
Clones have desired characteristics- eg disease resistance	Tissue culture fail- microbial contamination

- Manipulation of energy transfer from producer to consumer
- Animals harvested young, when most of their energy is used for growth
- Steroid used to increase growth
- Selective breeding used to produce breeds with higher growth rates
- Animals treated with antibiotics to prevent loss of energy due to pathogens
- Limiting movement reduces energy loss due to heat, maximising the mass

Recycling within ecosystems



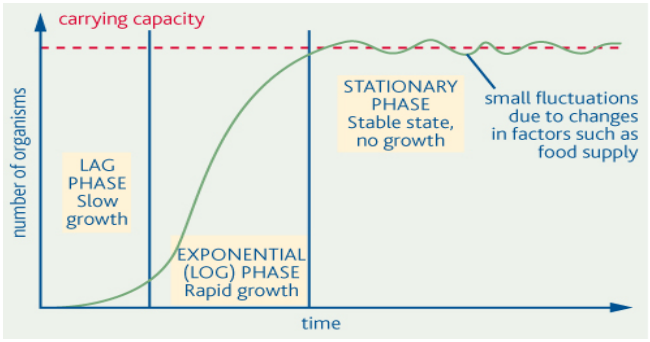
Bacteria/fungi- saprotrophic decomposers

- secrete enzyme onto dead/waste material- digest into small mol.- absorbed into body- mol. stored/respired to release energy
- decomposers crucial- to recycle trapped nutrient in dead organisms

Bacteria- ammonification, nitrogen fixation, nitrification & denitrification

- Nitrogen fixation-plants need fixed N2- ammonium ions/ nitrate ions- occurs when lightening strike/ Haber process to make filter
- N2 fixing bacteria- Azotobacter live freely in soil & fix N2(g) in air within soil- manufacture aa
- Rhizobium- live inside root nodules- beans- provides plant with N2g and receive C compound- glucose – mutualistic relationship
- Ammonification- bacteria- putrefaction of proteins in dead/waste organic matter- chemoautotrophic bacteria- nitrosomonas- obtain energy by oxidising ammonium to nitrites
- Nitrification- Nitrobactor oxidising nitrites to nitrates
- oxidising needs oxygen so well aerated soils
- Nitrates absorbed by plants- make nucleotide bases & aa – nucleic acids & proteins

What determines population size?



Lag phase- few individuals acclimatising to their habitat- rate of reproduction and growth in pop. size small

Log phase- high resources/ good conditions- reproduction quicker as rate of rep> mortality- size increases quickly

Stationary phase- pop size levelled out to carry capacity (max pop size a habitat can be maintained over a period in a specific habitat)- rate of rep= mortality- pop is stable

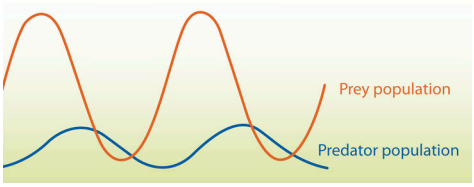
Limiting factor- factor whose magnitude slows down rate of a natural process

Density dependent-factor influences population ~~ harvest strongly as population size increases~~
- availability of resources/oxygen/food/water/light/nesting sites/predation/parasites

Density independent- act strongly irrespectively of size of population
- ~~ ~~ kills same proportion of individuals in population irrespective of size

k- strategist- species whose population size determined by carrying capacity
- limiting factors exert and a more significant effect on pop. size reaching carrying capacity- causes pop. to level out
- birds/mammals/large plants- low reproduction rate/slow development/long lifespan/large body mass/ late reproductive age

r- strategist- species whose population size increases so quickly- exceeds carrying capacity of habitat before limiting factors start to effect size
- mice/spiders/weed- opposite
- Quick pop. growth- pioneer r- strategists colonise disturbed habitat before k- then disperses to other habitat when limiting factors have effect
- Boom, peak above carrying capacity, bust



Interactions between populations

1. predator pop. increases- more prey eaten
2. prey pop. deceases- less food available for predators- less can survive- pop. size reduces
3. fewer predators- fewer prey eaten- pop. increases
4. with more prey- pred pop. can increases- cycle start again

- The goat has been one of the most damaging species- eats Galapagos rock purslane & outcompetes giant tortoise in grazing
- Cats hunt a number of species including the lava lizard & young iguanas
- The Charles Darwin Research Station has introduced many measures to prevent and limit this
- Quarantine systemo Culling of dominant alien speciesо 36% of coastal areas designated as 'no take' zones
- It is essential to find a balance between the environmental, social and economic concerns

The Antarctic

1. Krill
    - food for whales, seals, penguins, squids
    - make nutritional supplements- animal feed
    - advancement in tech- large krill pop. areas are harvested
    - predators can't find krills elsewhere- over exploitation- catastrophic impact on predators
    - Thus, fishing conducted evenly across all areas- up to catch limit

2. Protected areas
    - International whaling commission- illegal to hunt & kill whales &monitoring whaling activity needs to be maintained- ensure preservation
    - current imitative to expand network of marine protected areas- Ross sea- high biodiversity- attracts fish industry

3. Albotrosses and petrels
    - birds threatened by poaching for eggs, hunting, pollution, non-native predators
    - long-line fishing- line attached with baited hooks lies behind boat- where birds swallow hook- bird scaring & at night to avoid birds feeding time- to reduce bird catch

Lake District

Financial incentive for farmers to reduce chemical uses/take care for meadows/native woodland

Threat to biodiversity	Solution
Cliff &rock- support rich diversity of plant life- nesting site for golden eagle & falcon- destroyed by climbers/walkers	Seasonal restriction- on walking when birds are nesting Walkers- educated to be aware & footpaths well maintained
Mire- swampy ground- poor nutrients, waterlogged- lichens/mosses flourish- provides breeding ground for birds- under threat by burning/grazing/intensive agriculture	Mires managed more sympathetically- rewetted with artificially controlled water levels Areas- rare plants- grazing controlled
Coniferous plants support limited biodiversity	More varied planting & felling patterns- gives a mosaic if smaller stands- diff aged trees
Hay meadow- support rich diversity of flowers/grasses- used for haymaking &silage production- uses artificial fertiliser & being cut- loss of species biodiversity	Farmers paid to maintain hay meadows

- Biuret reagent made of a mixture of copper sulphate and potassium or sodium hydroxide

Calorimeter

- The colorimeter shines a beam of light through the sample
- A **photoelectric cell** picks up the light that is passed through the sample (on the other side)
- provides a reading of the amount of light- passed through – transmitted or absorbed
- more copper sulphate (benedict reagent) used- less light will be blocked/absorbed- more transmitted.
- Digital reading gives a measure - amount reducing sugar in Benedict's reaction

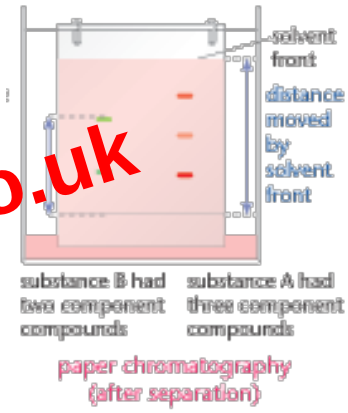
Creating a calibration curve:

- Take series of concentrations of reducing sugar
- Benedict's test on each sample
- Use calorimeter to record % transmission of light through each sample
- % transmission (y-axis) and Glucose concentration (x-axis) (positive curve)

Use of biosensors:

- take samples difficult to measure- convert into electrical signal
- binding event- molecules enter receptor into- goes through a transducer surface
- generates an electrical signal into a signal conditioner

❖ calorimeter/biosensor- calibrated- need to know strength of electrical signal with known conc/value- can't interpret signal



Chromatography

- Separates mixtures into its constituents
- Chromatography paper
- Solvent- water for polar molecule and ethanol for non-polar molecule
- Draw pencil line at the base- spot the mixture on the pencil line
- Place in solution, leave for a while
- Remove and let it dry

- Also use thin-layer chromatography (TLC) plate.
- Use UV light-glows TLC plate except spots of mixture has travelled to.
- TLC plate very polar. Polar solutes stick to surface travel slower, non polar solutes travel quickly

Urine tests for athletes- illegal drugs

$$Rf = \frac{\text{Distance moved by spot}}{\text{Distance moved by solvent}}$$

Uv light, ninhydrin- binds to aa- visible brown spots. iodine crystals forms gas and binds to molecules- spot

10. Data logger

- ph changes effect of lipase in milk
- spirometer/ECG
- temp affects lipase- over time more fatty acids/glycerol produced from triglyceride- increase ph denature lipase- reaction stops