Caleb Baines-Baker©

# DNA and Cells:

**DNA:**

- DNA is a molecule that carries most of the genetic information used in the development and function of all life.
- DNA consists of:
    - Individual units called Nucleotides, joined by covalent bonding
    - Nitrogenous Bases joined by Hydrogen Bonds:
        - Adenine and Thymine (2 Hydrogen Bonds)
        - Cytosine and Guanine (3 Hydrogen Bonds)
    - Double-Helix Shape
    - It has directionality:
        - Each DNA strand runs in the opposite direction
        - 5” down to 3”
        - 3” down to 5”
- When cells are not dividing, the chromosomal DNA is dispersed within the nucleus as fibre-like chromatin.
- Chromatin is made up of:
    - A cell’s DNA
    - Proteins, mainly Histone
- Chromatins is packed in a way that allows a large amount of genetic material to be organised in a compact way in the nucleus.

- **DNA Packing:**
    - Chromatin structure is based on successive levels of DNA packing, packing is the role of histone protein.
    - Five types of histone proteins form a complex with DNA, resembling ‘beads on a string’.

- **Chromosomes, Genes and Chromatin:**
    - Chromatin is the stringy form DNA takes during the normal function of the cell.
    - DNA condenses into a chromosome during cell division. Humans have 46 chromosomes, 23 pairs, one pair from each parent.
    - A gene is simply a particular sequence of base pairs that codes for a function or characteristic in an organism.

- **DNA Replication:**
    - DNA must replicate and it must do so perfectly. This is the main reason for CPB.
    - <u>Steps for Replication:</u>
        1. An Enzyme called DNA Helicase unzips a small section of DNA by breaking the hydrogen bonds between the bases.
        2. The junction between the unwound single strand of DNA is known as the replication fork and moves along the parental DNA strand so there is continuous unwinding.
        3. Within the nucleus there are free nucleotides. The enzyme DNA Polymerase attaches free nucleotides to the exposed bases according to the base-pair rule.
        4. DNA Ligase seals the new stretch of nucleotide.
        5. The outcome is two double helix molecules consisting of one parental strand and one new strand, hence the process is known as semi-conservative replication.

- **Directionality and Replication:**
    - Replication fork is the point of branching DNA, created by DNA Helicase.
    - DNA is only synthesised in a 5" to 3" direction.
    - This creates the leading strand:
        - DNA is replicated in a continuous direction by the DNA Polymerase
        - It's in a 5"-3" direction
    - The Lagging Strand:
        - It's in a 3"-5" direction
        - DNA is synthesised in short fragments called *Okazaki Fragments*
        - Essentially, the DNA Polymerase has to work backwards
        - It is not a continuous process

**Protein Synthesis:**

- Gene expression is the conversion of genetic code to proteins
- The mechanism by which this happens in protein synthesis
- It occurs in two stages:
    - <u>Transcription:</u>
        1. DNA Helicase unzips the gene that is to be expressed. One strand is used as the template
        2. At the start of each gene is a promoter sequence. RNA Polymerase binds to this sequence.
        3. RNA Polymerase creates a complimentary strand of Messenger RNA (mRNA) until it reaches a terminator sequence.
        4. This pre-mRNA is modified:
            - Methyl cap is added to 5' end
            - Poly A Tail is added to 3" end
            - The non-codon (introns) are removed and only coding regions (exons) remain in a process known as splicing.
        5. Mature mRNA leaves the nuclear pore for the cytoplasm.

- Translation:
    1. A ribosomal sub-unit recognises an mRNA molecule strand
    2. The ribosome binds to the mRNA at the methyl cap and moves along 'searching' for the star codon (AUG)
    3. A second ribosome sub-unit attaches
    4. The ribosome reads the mRNA the bases at a time: codon
    5. Transfer RNA (tRNA) with a complimentary anti-codon binds to the codon, bringing with it a specific amino acid
    6. Each tRNA carries a specific amino acid
    7. As more codons and read, more amino acids are joined in a polypeptide chain until a stop codon is reached
    8. The polypeptide chain can now be used.

**Epigenetics:**

- The study of how external or environmental factors switch on and off genes.
- This can be caused by the environment adding epigenetic factors to the genome
- The genome is not altered but epigenetic factors can be inherited.
- Histone Modification:
    - Molecules attach to histones and alter gene expression
    - DNA Methylation involves a methyl group attaching to cytosine. Tightly coils DNA around histones and stop RNA Polymerase from bonding to DNA. This inhibits gene expression.
    - DNA Acetylation involves an acetyl group binding to a gene. Unravels chromatin and promotes gene expression.

**Mitosis:**

- **Interphase:**
    - Normal Cell Function
    - Organelle development and growth
    - DNA replication occurs
- **Prophase:**
    - DNA condenses into chromosomes made of 2 identical chromatids
    - Nucleus breaks down
    - Centrioles begin to move to poles of the cell
- **Metaphase:**
    - Centrioles at the poles create microtubule spindle
    - Chromosomes line up along the equator of the cell
    - Chromosomes attach to the spindle at the kinetochore
- **Anaphase:**
    - Chromosomes are split into individual chromatids and become single chromatid chromosomes
    - They travel to opposite ends of the cell, being pulled by the spindle
- **Telophase:**
    - Cleavage, the process of cell membrane splitting
    - Cytokinesis, the cytoplasm splitting into two
    - 2 new nuclei formed
    - Chromosomes unravel

Caleb Baines-Baker©

**Meiosis:**

- Creation of 4 Haploid, non-identical gametes
- Steps of Meiosis:
    - **Interphase (Meiosis I)**
        - Normal Cell Function
        - DNA Replication
    - **Prophase (Meiosis I)**
        - Homologous chromosomes pair up
        - They may cross over and exchange identical sections of DNA
        - This results non-identical chromatids
    - **Metaphase (Meiosis I)**
        - Homologous pairs, pair up and attach to the spindle
    - **Anaphase (Meiosis I)**
        - Chromosomes pairs separate
        - Chromatids don't separate
    - **Telophase (Meiosis I)**
        - Cytokinesis
        - 2 Haploid cells formed
- Meiosis II:
    - **Prophase (Meiosis II)**
        - Chromosomes line up in the middle of the cell
    - **Metaphase (Meiosis II)**
        - Chromosomes attach to spindles
    - **Anaphase (Meiosis II)**
        - Chromatids are pulled apart
    - **Telophase (Meiosis II)**
        - Cytokinesis
        - 4 non-identical haploid cells formed

**Binary Fission:**

- Binary Fission is the asexual reproduction process by which all prokaryotes replicate
- Steps of Binary Fission:
    - The circular chromosomes replicate
    - The chromosomes move to opposite ends of the cell
    - The cell elongates
    - At the midpoint of the cell, proteins allow the formation of cell membranes components
    - Cell splits into two identical daughter cells

Caleb Baines-Baker©

# Inheritance, Variation and DNA Technology:

**Gene Mutations:**

- Substitution:
    - One Nucleotide is replace with another
    - Can be:
        - Synonymous (Silent): Codes for same amino acid, therefore no effect
        - Missense: Results in a different amino acid
        - Nonsense: A new 'stop' codon is coded for
- Insertions and Deletions:
    - The insertions or deletions of a nucleotide
    - Causes 'Frame Shift' Mutation – the reading frame for the codons is changed effecting all amino acids from the mutation point.

- Mutations can be:
    - Neutral- No Effect
    - Deleterious- Negative effect on survival
    - Advantageous- Benefits survival

**Chromosomal Mutations:**

- Changes in the chromosome's structure
- They occur fur to issues in meiosis or due to mutagens
- They result in may genes being effected
- **Deletion:**
    - A section breaks off and is removed
    - Many genes are absent and its usually fatal
- **Inversion:**
    - Section breaks off and joins the wrong way around
- **Translocation:**
    - Section breaks off and re-attaches to the wrong chromosome
- **Duplication:**
    - A section is duplicated
- **Non-Disjunction:**
    - The incorrect separation of chromosomes during meiosis

Caleb Baines-Baker©

**Sources of Variation:**

- Fertilisation:
    - Each Parent contributes half of the DNA
    - Each parent is unique and their pairing is random
    - Which gametes unite, is also random

- Meiosis:
    - Independent Assortment
    - During meiosis each homologous pair separates randomly and independently of each other

- Crossing Over:
    - Also known as Chiasmata Formation
    - Matching regions of homologous pairs break and reconnect to other chromosomes
    - This process is genetic recombination and results in chromatids with maternal and paternal genes.

**Mendel's Law:**

- We inherit 1 chromosome from each parent for all the homologous pairs. 22 Autosomes, 1 Sex Chromosome
- Therefore we have 2 copies of each gene
- These genes have variations known as alleles. i.e Brown Hair or Blonde Hair
- Alleles are either Dominant (R) or Recessive (r) to one another
- The combination of alleles is your genotype and the physical representation of that is the phenotype.

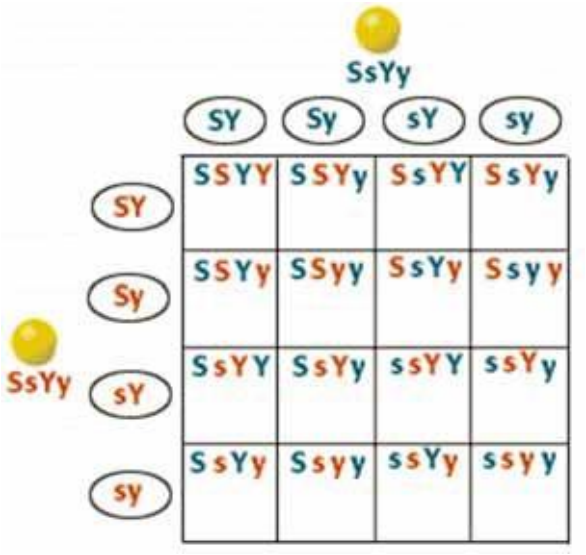
  RR-Homozygous Dominant (Pure Breed), Dominant Phenotype is shown
  rr- Homozygous Recessive, Shows recessive phenotype
  Rr- Heterozygous, Shows dominant trait

**Sex Linked Diseases:**

- Men have an X (1500 genes) and Y (18 genes) chromosomes and such as are hemizygous for a number of traits.
- Women have 2 X chromosomes and their 23$^{rd}$ pair is homozygous
- If a man has 1 recessive allele on the X, there is nothing on the Y to 'cancel' it out
- Examples; Red-Green Colour-blindness, Haemophilia.

Caleb Baines-Baker©

**D-Hybrid Cross:**




- Phenotype Ratio is the ratio in which the outcomes of the di-hybrid cross will create
- Polygenetic Trait- Characteristics controlled by many genes, e.g. Hair, Eye Colour, Skin, Height

**Biotechnology:**

- The use of organisms to make and develop products
- Genes can be switched on/off, removed, added or introduced from other species
- These organisms are called Genetically Modified (GM) organisms or Transgenetic organisms
- **Restriction Enzymes:**
    - The ability to cut segments of DNA is accomplished using restriction enzymes
    - They cut DNA at specific points into segments called restriction segments
    - The location at which an enzyme cuts DNA is the restriction site
    - Different enzymes have different restriction sites
    - Sticky ends are more effective to reattach nucleotides to the sequences rather than blunt ends

**Recombinant DNA Technology:**

- Steps:
    1. Plasmids are removed from a selected host bacterial cell. Plasmids act as a vector.
    2. DNA containing the gene of interest is removed from the cell
    3. A restriction enzyme cuts out the gene of choice, creating sticky ends
    4. The same restriction enzyme cuts open the plasmid – creating complimentary sticky ends to the fragment
    5. Restriction fragment (selected gens) attaches to exposed sticky ends of plasmid with H-Bonds creating recombinant plasmids
    6. DNA Ligase makes these bonds permanent
    7. Recombinant plasmids are added to bacteria in a process called transformation
    8. The bacteria reproduce and produce the desired protein due the expression of the inserted gene.

Caleb Baines-Baker©

**Polymerase Chain Reaction (PCR):**

- PCR is a technique used to increase the amount of DNA available. It used Taq Polymerase, which makes new DNA molecules from free nucleotides.
- **Components required:**
    - DNA to be copied
    - Taq Polymerase buffer solution
    - Supply of nucleotides
    - Two primers – a starting point from which the Taq Polymerase can add new nucleotides
- **Steps of PCR:**

1. Denaturing: The double stranded DNA is heated to 95$^{o}$C, breaking the H-Bonds between the bases causing the two strands to denature
2. Annealing: Temp. is decreased to 50$^{o}$-60$^{o}$C, allowing the primers to anneal (join) to complimentary sequences at opposite ends of each strand. The reduced temp. is necessary for base pairing and H-Bonds.
3. Extension: Temp. is raised to 72$^{o}$C, the optimum temp. for the Taq Polymerase. Starting from the primers, new DNA strands are synthesised using Taq Polymerase and the available nucleotides.

- At the end of this phase there are two copies of the original template
- This cycle is repeated until sufficient quantities of DNA are obtained
- Each cycle doubles the DNA. In just 20 cycles, more than 1 million copies can be made.

Caleb Baines-Baker©

# Evolution:

**Principles of Natural Selection:**

- Every species is fertile enough that if all offspring survive to reproduce, the population will grow.
- Despite periodic fluctuations, population remains roughly the same size.
- Resources such as food are limited and are relatively stable over time.
- A struggle for survival ensues.
- Individuals in a population vary significantly from one another.
- Mutations are the ultimate source of genetic variation as it introduces new alleles into a population.

**Speciation:**

1. **Variation:** There is variation within a species in a common gene pool.
2. **Isolation:** A barrier is formed, dividing the population into two. Interbreeding does not occur, causing separate gene pools to form.
3. **Selection:** Natural Selection acts on the populations. Different pressures act on each population and allele frequency changes.
4. **Speciation:** Over long periods, changes in allele frequency may be great enough to prevent interbreeding.

**Random Genetic Drift:**

- Another mechanism that operates in small populations.
- It is a change in allele frequency due to random reproduction and events.
- It has no regard to whether phenotypes offer an advantage or cause a disadvantage.

**Artificial Selection:**

- The process by which humans use breeding to selectively develop individuals with desired phenotype.
- We select individuals that will reproduce based on which traits we desire.
- The traits selected are not based on whether they gain a survived or reproductive advantage, unlike natural selection.

**Fossil Evidence:**

- A clear arrival and extinction of particular groups of organisms at specific points in the fossil record.
- A clear increase in complexity of organisms-vertebrae, jaws, feathers, etc.
- **Transitional Fossil:**
  - Remains of an extinct life form that exhibits traits common in the ancestor and descendant.
- We can see how living organisms have ancestors with extinct, fossilised organisms- we can also seed how much or how little they have changed.
- There were organisms that were widespread and dominant, but now extinct. This includes the once dominant trilobites.

Caleb Baines-Baker©

**DNA Evidence:**

- **DNA Comparison:**
  - The amount of DNA shared between species can indicate a relationship.
  - The more DNA shared, the closer that relationship. (More Recent Common Ancestor)
- **Endogenous Retro-Viruses:**
  - Viruses have inserted their genome into the common ancestors of great apes.
  - We share a number of ERV's with many closely related species.
- **Mitochondrial DNA:**
  - Mitochondrial DNA is only inheritable from our mothers.
  - It is a great way to show migratory groups because it changes very little over time.
- **Protein Sequences:**
  - The sequence of amino acids in proteins can change and not alter the function of the protein, therefore the body will not repair the changes.
  - More changes in protein sequences between 2 organisms- the weaker the relationship, further away from common ancestor.
  - We can compare the amino acid sequence of ubiquitous proteins, proteins found in all life that performs a basic function.
  - By looking at the differences in the sequences we can establish how recent the common ancestor between the 2 species existed.
  - 'Cytochrome C' is one of these ubiquitous proteins-ours is identical to all of the great apes.

**Comparative Anatomy and Embryology:**

- Homologous Structures are bones/organs/etc. that appears in different animals, underlining anatomical commonalities demonstrating descent from a common ancestor. The forelimb on Turtles, Dolphins, Human, Horse, Bat and Birds share a similar structure revealing a common ancestor between the organisms.
- All vertebrate embryos develop very similar in the early stages. These similarities include:
  - Well Developed Tail
  - Absence of Limbs
  - Pharyngeal Slits
  - A Two-Chambered Heart
- The Vagus Nerve is a nerve from the brain, goes under the aortic arch and to the larynx. This path is strange as it takes a complex route through the body. The Vagus Nerve in fish control the gills, this path makes more sense when compared to fish and reveals the similarities between fish and other organisms.

**Population Bottleneck:**

- A population bottleneck is when a population contracts to a significantly smaller size over a short period of time due to some random environmental event.
- In a true population bottleneck, the odds for survival of any member of the population are purely random, and are not improved by any particular inherent genetic advantage.
- The bottleneck can result in radical changes in allele frequencies, completely independent of selection.

Caleb Baines-Baker©

**Founder's Effect:**

- The founder effect is the loss of genetic variation that occurs when a new population is established by a very small number of individuals from a larger population.
- As a result of the loss of genetic variation, the new population may be distinctively different, both genotypically and phenotypically, from the parent population from which it is derived.
- In extreme cases, the founder effect is thought to lead to the speciation and subsequent evolution of new species.

Caleb Baines-Baker©

# Homeostasis, Thermoregulation and Removal of Nitrogenous Waste:

**Homeostasis:**

- Homeostasis refers to the property of a system in which a variable is actively regulated to remain constant.
- The maintenance of a stable, optimal and internal environment.
- Best known mammalian examples include:
  - Temp.
  - pH
  - Conc. Of Na, K, Ca, Glucose, $CO_2$ and $O_2$.
- Changes to the internal environment are detected by the endocrine and nervous systems, and are known as Stimuli.
- If a factor increases or rises away of optimal, a response is initiated:
  - Disrupt Signal
  - Remove Stimulus
  - Alter or Counteract Stimulus

  } Can be voluntary or involuntary

**Thermoregulatory:**

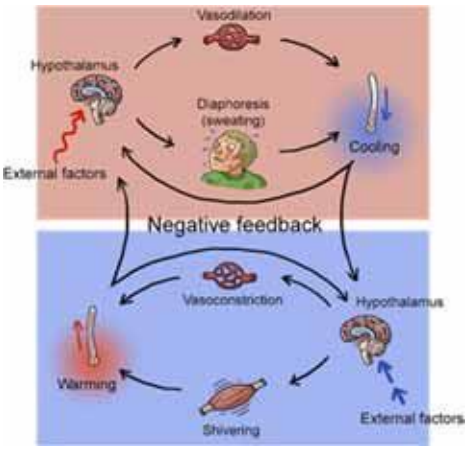
- Structural features, behavioural responses and physiological mechanisms to regulate body temperature.
- <u>Endothermic:</u> Maintain body at favourable temperature, due to energy released by metabolism.
- <u>Ectothermic:</u> Rely upon environmental heat sources- metabolism of little importance.
- <u>Homoeothermic:</u> Able to maintain constant temperature.
- <u>Poikilothermic:</u> Fluctuating temperature due to ambient temperature.

<u>Heat Loss Mechanisms:</u>

- *Structural:*
  - Increase surface to volume ratio to increase radiant heat loss
  - Long, less rounded limbs
  - Large appendages like ear to act as radiators
  - Less fur, or moulting during summer.

- *Physiological:*
  - Vasodilation of arterioles – increase heat loss due to radiation from skin
  - Sweating – evaporation of sweat removes large amounts of heat
  - Decrease of Metabolic Rate – Decrease in Metabolic Rate activity, decrease heat production
  - Decrease piloerection to flatten fur

- *Behavioural:*
  - Shelter during heat of day – Crepuscular/Nocturnal
  - Panting
  - Increase surface area – wings/limbs out.



Caleb Baines-Baker©

Heat Gain Mechanism:

- *Structural:*

- Insulation – fur/feathers/fat, which trap warm air around the body
- Surface Area – Decrease surface area to volume ratio, rounded limbs and small appendages

- *Physiological:*

- Vasoconstriction
- Decrease in Sweating
- Increase in Metabolism
- Counter-Current Heat Exchange:
  - Keeps Appendages
  - Blood travelling to foot/fin via artery, warms blood travelling in the vein
  - This reduces the temp. gradient and minimises heat loss

- *Hibernation:*

- In very cold conditions, an increase in metabolism rate may be insufficient to maintain body temp.
- Animals may instead hibernate
- During this, metabolism falls to a point that just sustains life.
- This conserves energy and reduces the need for food
- State of Torpor; Heat Gained = Heat Loss

**Removal of Nitrogenous Waste:**

Terrestrial Vertebrates:

- Water is essential for life because:

- All metabolic processes occur in water
- All nutrients and ions dissolve in it

- The level of water in the body requires osmoregulation
- In vertebrates it is performed by the kidney
- There are many ways terrestrial vertebrates may assist osmoregulation:
  1. Avoiding the Sun
     - Crepuscular/Nocturnal
     - Minimise water loss in cooling process
  2. Avoid Drinking:
     - High water retention
     - Dry Faeces
     - High Carb, Low Fat Diet
     - All water gained from food
  3. Avoid water loss through body:
     - Thick Skin
     - Less Sweat Glands
     - Very long, efficient nephrons – very little water in urine.

Caleb Baines-Baker©

Aquatic Animals:

- Issues: (Fresh Water)
  - They are hypertonic to the environment
  - Water moves into their body via gills
  - Diffusion of solutes out
- Adaptations:
  - Large amounts of urine
  - Actively absorb salt through gills
  - Prevent water from entering cells – enters blood/ is excreted
  - Scales/Mucous to minimise exposure to water
- Issues: (Marine)
  - They are hypotonic to the environment
  - Osmosis of water out of the gills
  - Diffusion of solutes in
- Adaptations:
  - Drink high volume of water
  - Actively remove salt from gut to blood for excretion
  - Special glands actively excrete salt from gills
  - Small volume of urine
  - Ability to retain more urea

Removing Nitrogenous Waste:

- Metabolic processes, such as deamination, produces nitrogenous waste
- Nitrogen forms highly toxic ammonia NH3
- Ammonia requires a lot of water to remove – frequent urination
- Depending on water availability, vertebrates have adapted ways to remove ammonia

Fish/Amphibians:

- Excrete ammonia
- They have constant access to water
- No need for water conservation mechanisms

Mammals:

- Convert ammonia to urea
- Less toxic than ammonia
- Uses energy to convert ammonia into urea
- Contains 2 Nitrogen (Less water to excrete, removes more nitrogen per molecule)

Reptiles/Birds:

- Convert urea in uric acid
- Less toxic than urea
- Uses more energy to convert urea into uric acid
- 4 nitrogen per molecule (even less water required to remove)

Caleb Baines-Baker©

**Xerophytes:**

- Species of plant that have adapted to survive in environments with low water availability
- They have a number of physiological and morphological adaptations to survive

Morphological Adaptations:

- Reduction in Leaf Surface
- Reduction in Air Flow
- Reflectivity
- High Sclerophylly
- Stomata under leaf
- Diallagy

Physiological Adaptations:

- Limit Water Loss
- Store Water
- Increase Water Uptake
- Tolerance

**Halophyte:**

- Plants that grow in saline environment
- The habitat is 'physiologically dry' as water moves out of the plants via osmosis- osmotic potential of the soil is more negative than the plant.
- Another issue is salt diffusing into the plant.

Physiological Adaptations: (Salt Accumulators)

- Absorb and tolerate salt to maintain a more negative pressure than the soil
- Have specialised salt glands on leaves for storing salt
- Minimise $Na^+$ and $Cl^-$ ions in cytoplasm- stored in vacuoles

Physiological Adaptations: (Salt Excluders)

- Defoliate when stored sodium reaches toxic levels, desalinating the plant
- Roots covered in waxy coating to minimise movement of ions into roots
- Actively pump out excess salt from roots to soil

- Morphologically, their adaptations are similar to Xerophytes.

Caleb Baines-Baker ©

***Diseases – Pathogens, Spread and Medication:***

| | Life Cycle/Method of invasion | Symptoms | Mode of transmission |
|---|---|---|---|
| Tuberculosis | ▪ TB bacteria reach alveoli<br>▪ Body's immune system responds and consumes the bacteria<br>▪ Bacteria isn't destroyed and continues to replicate killing immune cells. | ▪ Chest pain<br>▪ Prolonged cough, bloody phlegm<br>▪ Scars lungs<br>▪ Fever, fatigue | ▪ Aerosol droplets from cough, sneezes and speech. |
| Tetanus | ▪ Bacteria enters a break in the skin<br>▪ Release toxins which interfere with muscle contractions | ▪ Muscle spasms, beginning in jaw<br>▪ Stiffness<br>▪ Swallowing difficulty | ▪ Not spread from person to person<br>▪ Found in soil and other dirty environments |
| Crown of gall | ▪ Rhizobium infection of many agricultural plants<br>▪ Swims in soil and attaches to plant cells at roots<br>▪ Bacteria inserts a section of its genome into plant genome | ▪ Cause plant cells to make enzymes which bacteria use for nitrogen<br>▪ Also cause hormone secretions that cause gall (tumor) creation<br>▪ Plants appear stressed/dehydrated | ▪ Through soil<br>▪ Can spread from plant to plant via cuts in stem. |
| Chytridiomycois<br>○ Mobile zoospores infect amphibian<br>○ Burrow into skin and mature<br>○ Mature spores release more zoospores, re-infecting the host and other individuals | ▪ Reddening of skin<br>▪ Convulsions of limbs<br>▪ Hemorrhage, ulcers<br>▪ Inability to breath, hydrate, osmo/thermoregulation | Mobile zoospores infect amphibians skin |
| Malaria<br>○ Female mosquito transmits to host<br>○ Travels to liver cells and asexually reproduces<br>○ Clones then infect red blood cells and continue to reproduce<br>○ RBC burst and release male and female forms | ▪ Flu like<br>▪ Shiver/fever<br>▪ Fatigue | ▪ Mosquitos act as a vector<br>▪ Transmit to mammals while feeding |
| Phytophthora - Dieback<br>○ Water mold in soil and plant tissue<br>○ When suitable zoospores travel to and infect roots<br>○ Mycelia grow through root - absorbing carbs and water<br>○ Release more zoospores: infects neighboring plant | ▪ Rest roots movement of water and nutrients<br>▪ Wilting, yellowing, retention of dead foliage<br>▪ Death | ▪ Through soil as mobile zoospores |
| Influenza<br>○ Binds to cells in nose, throat & lungs<br>○ Viral RNA enters cell nucleus and copies are made<br>○ New viruses are constructed in cytoplasm<br>○ Host cell dies | ▪ High fever<br>▪ Fatigue<br>▪ Aches<br>▪ Severe cold like symptoms | ▪ Directly from droplets from an infected person<br>▪ Airborne: person inhales aerosols produced by sneezes, etc.<br>▪ Hard to eye, hard to nose etc. |
| Ross River Virus<br>○ Similar to all RNA virus life cycles | ▪ Arthritis and joint pain<br>▪ Rash, enlarged lymph By vector, Bat nodes | ▪ By vector: southern salt marsh mosquito |
| Australian bat lyssavirus<br>○ Related to rabies<br>○ Zoonotic<br>○ Know little about it | ▪ Rabies like<br>▪ Inflammation of meninges and brain<br>▪ Paralysis, violent movements<br>▪ Coma<br>▪ Death | ▪ By Vector, Bats. |

Caleb Baines-Baker©

**Spread of Disease:**

- The spread of disease is related to a number of interrelated factors;

  - *Growth of Pathogen:*
    - Some reproduce faster than others
    - Faster it reproduces, quicker a person becomes contagious

  - *Density and Living Conditions of Host Population:*
    - High Density – Faster, Easier Spread
    - Increased chance of mutation
    - Lack of Health Care – More contagious people
    - Increase in vectors

  - *Mode of Transmission:*
    - *Direct/Indirect (body fluids of air)*
    - *Vector Required?*
    - *Range of Mechanisms*

  - *Regional and Global Movement:*
    - *Fast and Simple global and regional movements, increase the likelihood of pandemics.*

**Strategies to Minimise Outbreaks:**

- *Quarantine:*
  - Stop infected individuals from contacting healthy individuals to stop spread.
  - Individuals can be isolated for a period of time until incubation and symptomatic periods have past.

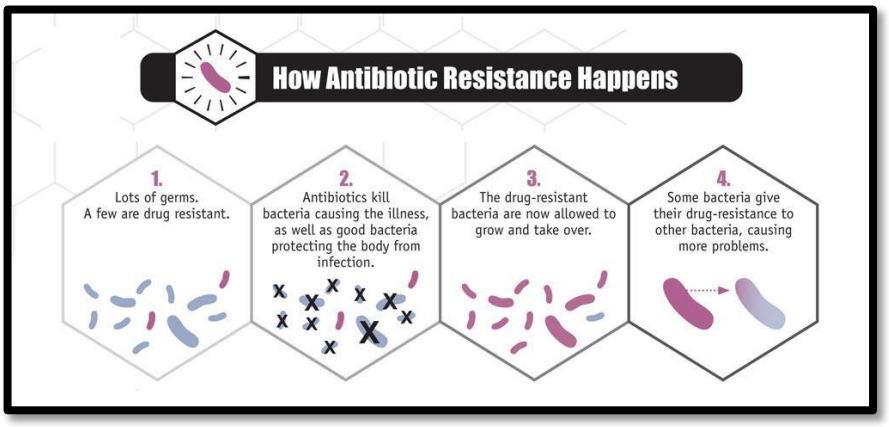
- *Vaccine:*
  - Vaccines are biological preparations that provide immunity to particular diseases
  - It typically contains a weakened or dead pathogen
  - The pathogen stimulates the immune system to recognise it as a threat and destroy and 'remember' the pathogen
  - If infected again the body easily kills it

- *Anitvirals:*
  - *Medication used for treating viral infections*
  - *Most are viral specific, through some are broad spectrum*
  - *Difficult to make due to the possibility of affecting target cells*
  - *Work in two main ways;*
    - *Stop Entry Into Cells – Bind to host cell or virus*
    - *Stop Viral Synthesis – Deactivate enzymes that allow transcription, Cut Viral genome using enzymes and Block genome sections that promote translation.*

Caleb Baines-Baker©

- Penicillin and Cephalosporin:
  - Prevent synthesis of the cells walls and inhibit reproduction
- Streptomycin:
  - Interferes with the protein synthesis of the bacterial cells

- Antibiotic Resistance:
  - Under certain conditions, it may result in preferential growth of resistant bacteria, while growth of susceptible bacteria is inhibited by the drug.
  - Several molecular mechanisms of antibacterial resistance exist. Intrinsic antibacterial resistance may be part of the genetic makeup of bacterial strains.
  - Acquired resistance results from a mutation in the bacterial chromosome or the acquisition of extra-chromosomal DNA. Antibacterial-producing bacteria have evolved resistance mechanisms that have been shown to be similar to, and may have been transferred to, antibacterial-resistant strains.
  - The spread of antibacterial resistance often occurs through vertical transmission of mutations during growth and by genetic recombination of DNA by horizontal genetic exchange.




**Structure of Pathogens:**

- Virus:
  - Very small, contain RNA or DNA, surrounded in a protein coating
- Bacteria:
  - No membrane bound organelles, cellular membrane and lack of a ‘true’ nucleus, mitochondria and chloroplast
- Fungi:
  - Chitin cell wall, tubular membrane and digestive enzymes
- Protist:
  - Unicellular organisms, come in a variety of shapes.