Co-dominance

- WT protein will make WT phenotype. Mutant gene product will generate a mutant genotype.
- Heterozygote will have a half-way phenotype between WT and mutant (co-dominance). Both gene products exert their effects on the cell & the heterozygote exhibits phenotypes of both homozygotes.
- For example: Blood groups: Antigens (gene product) present on RBCs; Three alleles.

Incomplete dominance

Where the mutant allele exerts some effect but not equally balanced with the wild type allele. This mutant gene product might have some mutant phenotype creating activity but it is not as equally strong as the wild type.

Penetrance and Expressivity

- **Variable penetrance**: All organisms have the same genotype yet only SOME (i.e. half) show the phenotype.
- **Variable expressivity**: All organisms have the same genotype but EXPRESS phenotype to different EXTENTS.
- It is all about the genes being expressed and what the alleles do and what the gene products end up doing.
- Can have **both variable penetrance and variable expressivity** coming out by the one allele or mutant.

Life Cycles of Bacteriophage I (L2)

Bacteriophage Genetics

- Bacteriophage (phage) are viruses that infect bacteria.
- Phage that infect *Escherichia coli* can be either **virulent** or **temperate.**
  - **Virulent** phage include the 'T' series phage (T1, T2, T3, T4 etc.)
  - **Temperate** phage include: phage λ & ϕ80
- Different phage may carry different forms of genetic material: e.g. dsDNA in T-series and λ, ssDNA, RNA. Can be **circular** (covalently closed circles) or **linear**.

Lytic Cycle: Phage λ

- Adsorption of phage to host cell. λ phage recognises & attaches to the host (*E. coli*).
- Insertion of phage nucleic acid (i.e. DNA) into host. From head ---> tail & into *E. coli*. Empty phage shell outside.
- Circularisation of phage DNA (linear DNA in the head of phage circularises inside *E. coli*).
- Recruitment of host machinery. Phage DNA replicates & is expressed (some upon entry into *E. coli* to take over *E. coli* machinery to translate & transcribe genes, e.g. RNA polymerase, and direct it to phage DNA replication).
- Production of phage components. All genes that make proteins to make new λ are expressed (*E. coli* genes aren't).
  - Phage produces enzymes to breakdown *E. coli* (host) & its DNA that disintegrates & weakens.
- Assembly of phage from components.
- Packaging of DNA into phage (heads).
- Lysis: Release of progeny phage (>100). Eventually *E. coli* is weak enough that it bursts & phage progeny come out.

Bacteriophage

- Plaque: The area on a "lawn" of bacteria (on agar plate) where all the cells have been lysed (broken open).
  - **Clear plaques:** Almost all *E. coli* have been lysed (phage are **lytic**: kill all bacteria in contact with).
  - **Turbid plaques:** Some *E. coli* have been lysed (living & growing *E. coli*). Some phage are **temperate** that undergo life cycles that can co-exist with or kill bacteria. There are **lysogens** (*E. coli* with integrated λ DNA). The phage is not expressed in its independent form.
- Each plaque derives from an initial single phage infection.
- Phage within each plaque ($>10^6$) are all clones (genetically identical). All phage are clones (except spont. mutation).
- Most temperate phage infections follow the lytic cycle to produce clear plaques on a bacterial lawn.
- The lysogenic state can be reversed where the integrated phage DNA comes out & trigger lytic cycle.

Lysogenic Cycle e.g. λ

- Adsorption of phage to host cell. λ infects the cell, detects proteins on the surface of *E. coli*, attaches to cell.
- Insertion of phage nuclei acid (DNA) into host. At the molecular level 'decide' whether to go down lytic pathway, make progeny & kill the *E. coli*, or to go down lysogenic pathway & co-exist with the *E. coli*.
- Circularisation of phage DNA.
- Expression of c1 repressor. The 'decision' is based on how much expression of c1 gene on λ genome. c1gene encodes transcription factor (proteins that recognise a specific DNA sequence, bind & either active or repress gene expression). The c1 gene makes c1 protein which has a specific binding site on the λ chromosome.
- Repression of genes involved in the lytic cycle. Bound c1 repressor blocks expression of genes either side of it on the λ chromosome, thus blocking the lytic cycle (stops expression of genes to make more phage & lyse cell). It is **now** undergoing the lysogenic pathway.
- Production of integrase from λ *int* gene. Blockage of lytic genes also leads to expression of **lysogenic** genes: **int**. (integrase), a recombination enzyme that aids cross over of two specific sequences of DNA (not genes) & operates on third genetic element on λ chromosome: *attP* (attachment phage); on *E. coli* chromosome there is a similar sequence: *attB* (attachment bacterial). These three sequences are homologous .
- Recombination between bacterial & phage DNA. int. can recruit some of *E. coli* machinery & the complex can form: int. can bind, form a single cross over between the two *att* sites, joining λ to *E. coli* chromosome.
- (Stably) integrated phage DNA known as a **prophage.** This *E. coli* (**lysogen**) can continue to divide (this is seen in **turbid plaques**). Integration of temperate phage into the bacterial chromosome occurs at **specific sites**.