1. Thank you all for coming this morning.

My name is Dr Philip Leftwich / and I will be giving a short presentation / delivered as though I am introducing the concept of non-mendelian inheritance to level 5 students.

1. All my lectures are recorded for you to playback at any time / I have made these slides, and a full transcript publicly available on my GitHub page. All diagrams and images are accompanied with alt-text to improve accessibility.
2. Before we start on today’s topic let’s have a quick warm up and I can show you the two main ways we can communicate.

First: we have the Teams Chat – which is a text box on the right hand side of this screen – using it now, why don’t you let me know how you are feeling today? Or if you prefer you could express yourself with a GIF!

For example – I’m a little nervous this morning – so this is how I’m expressing myself!

You can ask questions at any time today using this teams chat– and then I can review these at the end!

The other way I’d like to interact with you is with some questions and polls, so if you would go to slido.com on your computer or phone and when prompted enter the code 733 633

Just to check we are all happy with how slido works – could you let me know, in one word, how you would describe your past week?

Brilliant – we will use slido again at certain points during this session, so keep that tab open

1. We have three main learning outcomes today – by the end of this presentation you …1,2,3.
2. Now before we introduce the concept of NON-mendelian inheritance, I want to briefly recap the three laws of STANDARD mendelian inheritance that we covered last time.

1. The Law of Dominance. When an individual has two different alleles for a gene, one will be dominant over the other. This means that in a heterozygote only the dominant phenotype is expressed, and recessive phenotypes are expressed only if the organism is homozygous for the recessive allele.

1. Second is The law of segregation – in a diploid organism when gametes are produced they each acquire only one of the two alleles. So offspring receive one allele from each parent, and which allele they receive is random.
2. Finally we have the Law of independent assortment – alleles of different genes are sorted into gametes independently. That is the allele a gamete receives for one gene doesn’t influence the allele it will receive for another gene.
3. And we saw last time how we can demonstrate all three of these laws in one of Mendel’ classic experiments with pea plants.

PEAS observe that the parental genotypes are heterozygous for two genes involved in pea shape and colour, and the phenotypes are round and yellow you should recall that Mendel observed that yellow is dominant to green and a round shape is dominant to wrinkled.

These alleles segregate randomly during gamete formation, and the two traits are inherited independently of each other so that all the possible combinations of alleles occur with equal probability but because of the law of dominance – we see expression of the four possible phenotypes 1) round, yellow 2) round, green 3) wrinkled, yellow 4) wrinkled and green in a classic

1. Nine
2. Three
3. Three
4. One!!!!!! Ratio – where the phenotype displaying both recessive traits is observed at the lowest frequency
5. And we can see that really clearly if we look at this as simply two non-interacting monohybrid crosses, where the probability of each plant being yellow or green is 3:1 and this is independent of the probability of each plant being round or wrinkled- which is also 3:1. The probability of a plant having yellow and round seeds is ¾\*3/4 or 9/16.
6. These laws/rules form the foundation of our understanding of inheritance – But we also now know of lots of exceptions and exemptions which we need to understand in order to fully explain complex inheritance patterns. These examples of variation are known as non-Mendelian inheritance and include…
7. Partial or Incomplete dominance – is where two alleles produce an intermediate phenotype when both are present, rather than just one determining the phenotype. For example if a snapdragon plant with red flowers is crossed to a white-flowered plant, the offspring have pink flowers, they are producing some pigment – but not as much as their red-flowered parent
8. In an inbreeding cross – the genotype ratio of 1:2:1 is identical to a standard monohybrid cross, but because neither allele is dominant, the phenotype ratio is the same as the genotype ratio in contrast to the standard 3:1 ratios we observed earlier.
9. Co-dominance - Now what happens if the two alleles of a single gene both produce a distinct gene product?

then we get a different situation to either dominant/recessive or incomplete dominance. In this case we see equal expression of both alleles – and this is known as codominance .The MN blood groups in humans illustrates this phenomenon, this glycoprotein is found on the surface of red blood cells and comes in two forms designated M and N. There are two alleles in the MN system, and so there are three possible genotypes MM, MN and NN, producing three distinct blood types. In the MN blood type, both antigens are expressed equally.

1. A mating between two heterozygous MN parents may produce all three blood types in the same 1:2:1 ratio as observed with incomplete dominance. The distinguishing feature is that for codominance there is clear evidence of expression of both alleles in a heterozygote. This is different to incomplete dominance where there isn’t clear evidence that both alleles express something. For example with our snapdragons, R1 homozygotes are red because they have two copies of the R1 allele and produce lots of red pigment, the heterozygotes might be pink simply the R2 allele does nothing at all and because they only have one copy of R1 / so produce half as much pigment.
2. ABO blood group is another good example of codominance with a few extra twists! Like the MN bloodtypes these are characterized by antigens on the surface of red blood cells, but they are controlled by a completely different gene. As in the MN system A and B alleles show a codominant mode of inheritance to each other but have a classic dominant/recessive relationship with the O allele. Once we start to include multiple alleles in a population, modes of inheritance can rapidly become difficult to predict, and in this example we can see that each combination of alleles produces a unique phenotype.
3. Alright time for a quick test of understanding – if you could go back to Slido and answer this question – we can check whether you can tell the difference between incomplete and co-dominance.
4. In many cases a given phenotype may be affected by more than one gene. And Gene interaction is the idea that the products of multiple genes may contribute to the development of a common phenotype.
5. For example – the wildtype fut1 allele is found in almost all humans, it directs the conversion of a precursor molecule (of Galactose and N-acetyl glucosamine) into the H antigen by adding a molecule of fucose to it. This H antigen is then found on the surface of almost all human red blood cells
6. The A and B alleles are then able to direct the addition of sugar residues to the H antigen. The A allele adds N-acetyl galactosamine to produce the A blood group antigen.
7. While the B allele adds an additional Galactose to produce the B antigen. If the individual is homozygous for the O allele then neither the A or B antigen is produced, but importantly this is also true if they don’t have a functional FUT1 allele.
8. We can see an example of this in action with a cross between two individuals where one is homozygous for the A allele, and the other is homozygous for the B allele. And both are heterozygotes carrying a rare recessive mutation in the FUT1 gene. From this cross we would expect to see all offspring carry the AB blood type, but at a 3:1 ratio we find those individuals which have no wild-type FUT1 allele. This prevents them from producing H antigens, and as a result they have a type O phenotype even though they carry both A and B alleles.
9. Alright question time – so if you would please head back to slido

can you tell me…

This is a good opportunity to check our understanding of todays lecture. In these examples we actually only see examples where the standard rules of dominant and recessive alleles don’t apply. In each of these examples we still see alleles segregating and different genes assorting independently. Even in the epistasis example, the genes are interacting to produce a phenotype but are not genetically linked.

In our next lecture we will look at examples of segregation distorters and genetic linkage.

Lethal alleles

X-linkage

Sex-linked and sex-limited inheritance

Penetrance

Imprinting

Meitoic drives (segregation distorter)

Genetic linkage

transposons

1. Before students leave a lecture / I like to ask them to provide “Exit Tickets”

* Reflection
* Caught what I taught
* Capture questions they still have about the lesson

Can be delivered and captured in a variety of ways

1. Signpost to expected reading to bolster learning
2. I would direct students to a short quiz to be completed after they have done some extra reading. Completion of this assignment on Blackboard awards the “Mendel Rules” badge!

This is a gamification idea designed to produce a reward for a learning achievement – it provides a way of motivating and then tracking formative engagement, and provides students with a measure of their progress – as each badge clearly outlines the skills required to obtain it.

1. Thank you!!!!