10.2.U2 Unlinked genes segregate independently as a result of meiosis.

1. Mendel’s Law of Independent Assortment
2. Describe the situation in which two or more genes will sort and therefore segregate independently of each other.

10.2.A2 Completion and analysis of Punnett squares for dihybrid traits. AND 10.2.S1 Calculation of the predicted genotypic and phenotypic ratio of offspring of dihybrid crosses involving unlinked autosomal genes.

1. Distinguish between dihybrid and monohybrid crosses.
2. When Mendel came upon his law of independent assortment, he was studying sweet-pea colour and shape. These traits are carried on separate chromosomes. The colour yellow (Y) is dominant over green (y). Smooth peas (S) are dominant over rough (s).
	1. State the possible genotypes for the following phenotypes:

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| *Yellow, Smooth* |  | *Green, Smooth* |  |
| *Green, rough* | yyss only | *Yellow, rough* |  |

Use the Punnett grid to predict the ratio of phenotypes of offspring in a cross between two peas which are heterozygous for both genes (SsYy x SsYy).


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| SY |  |  |  |  |
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| **Phenotype** | Smooth Yellow | Smooth green | Rough Yellow | Rough Green |
| **Ratio** |  |  |  |  |

5. A researcher has some smooth yellow peas. He wants to find out if they are homozygous or heterozygous for these dominant characteristics, so he performs a test cross.

* 1. State the genotype and phenotype of the plant that must be used as the test cross.

Genotype: Phenotype:

* 1. Complete a series of Punnett grids for this cross. Deduce the phenotype ratios expected in the following crosses.
		1. Heterozygous for both colour and shape?

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| **Phenotype** |   |   |   |   |
| **Ratio** |  |  |  |  |

* + 1. Homozygous for both colour and shape.

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| **Phenotype** |   |   |   |   |
| **Ratio** |  |  |  |  |

* + 1. Heterozygous for colour, homozygous for shape.

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| **Phenotype** |   |   |   |   |
| **Ratio** |  |  |  |  |

* + 1. Homozygous for colour, heterozygous for shape.

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| **Phenotype** |   |   |   |   |
| **Ratio** |  |  |  |  |

* 1. In the cross, the student found 120 yellow-smooth and 124 green-smooth. Deduce the most likely genotype for the unknown pea. Explain your answer.
1. Morgan’s experiments (1909 - 1914) with fruit flies produced results that could not be explained by Mendel’s work on heredity as it stood. Morgan’s key insight came after breeding a white-eyed male mutant with red eyed female flies. Complete the table to outline his observations and where the explain the conclusion:

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| Observation | Deduction – consistent or inconsistent with Mendelian theory? |
| The 1st generation offspring all had red eyes |  |
| The 2nd generation contained a small number (roughly 25% of flies) with white eyes |  |
| However all the white-eyed flies were male |  |

10.2.U1 Gene loci are said to be linked if on the same chromosome. AND 10.2.S2 Identification of recombinants in crosses involving two linked genes.

1. Mendel’s law of independent assortment makes the assumption that genes for a pair or group of traits are being carried on separate chromosomes, and therefore the presence of one allele in a gamete is not connected to the presence of another. However, with hundreds of genes per chromosome, it is likely that some genes will be physically linked and therefore alleles will be inherited together.
	1. Define linkage groups.
	2. State the consequence of gene linkage in terms of the movement of alleles in anaphase I.
	3. The term linkage is used in various ways in genetics. Distinguish between autosomes and sex chromomes.
	4. Distinguish between gene linkage and sex linkage.
	5. The notation shows genes of Zea mays (corn). It is described as “heterozygous at both loci”. These are both traits related to the corn kernels.

Key: C = colour, c = no colour; W = waxy, w = no wax.

* 1. Draw some other possible combinations of these linked genes:

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| Homozygous dominant at both loci |  |
| Homozygous recessive at locus 1. |  |
| *your choice* |  |

* 1. Complete a punnet grid to show the possible phenotypes produced by a cross between the corn that is heterozygous at both loci. Use correct notations and show your working.

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| **Phenotype** |   |   |   |   |
| **Ratio** |  |  |  |  |

* 1. List the combinations of alleles which are not possible in the cross above (unless recombination takes place at Prophase I).