5.1 – DNA REPLICATION

D1.1.1	DNA replication as production of exact copies of DNA with identical base sequences
D1.1.2	Semi-conservative nature of DNA replication and role of complementary base pairing
D1.1.3	Role of helicase and DNA polymerase in DNA replication
D1.1.4	Polymerase chain reaction and gel electrophoresis as tools for amplifying and separating DNA
D1.1.5	Applications of polymerase chain reaction and gel electrophoresis

DNA SYNTHESIS

Describe what is meant by DNA replication being semi-conservative

_____

_____

_____

Outline the role of helicase and DNA polymerase in the replication of DNA

Helicase	DNA Polymerase

State the stage within the cell cycle when DNA is replicated

_____

_____

Contrast the organisation of DNA within chromosomes prior to and following DNA replication

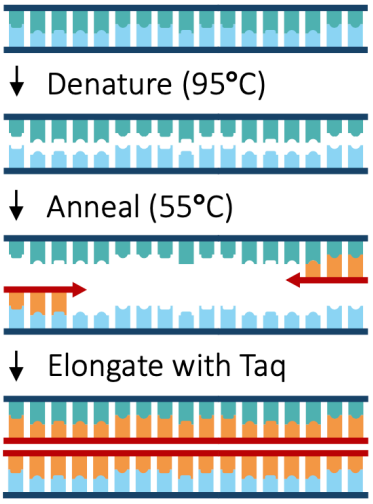
_____

_____

_____

POLYMERASE CHAIN REACTION

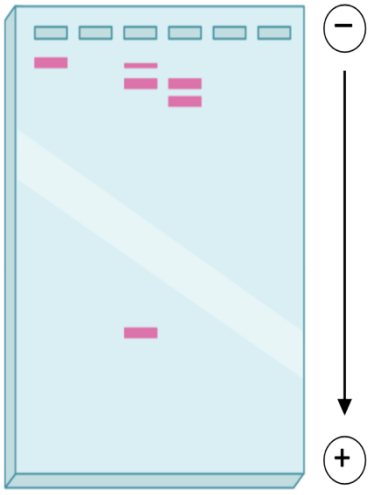
Describe the purpose and process of the polymerase chain reaction (PCR)



Identify the components that must be included in a PCR test tube before it is placed in a thermal cycler

GEL ELECTROPHORESIS

Describe the purpose and process of gel electrophoresis (DNA / proteins)



Outline the role of short tandem repeats (STRs) in DNA profiling and state two potential applications

5.2 – CELL DIVISION

D2.1.1	Generation of new cells in living organisms by cell division
D2.1.2	Cytokinesis as splitting of cytoplasm in a parent cell between daughter cells
D2.1.3	Equal and unequal cytokinesis
D2.1.4	Roles of mitosis and meiosis in eukaryotes
D2.1.5	DNA replication as a prerequisite for both mitosis and meiosis
D2.1.6	Condensation and movement of chromosomes as shared features of mitosis and meiosis
D2.1.7	Phases of mitosis
D2.1.8	Identification of phases of mitosis
D2.1.9	Meiosis as a reduction division
D2.1.10	Down syndrome and non-disjunction
D2.1.11	Meiosis as a source of variation

MITOSIS VS MEIOSIS

Differentiate between the purpose of cell division via mitosis and meiosis

_____

_____

_____

_____

Contrast the properties of the daughter cells produced by mitosis and meiosis

	MITOSIS	MEIOSIS
Type of cell produced		
Number of divisions		
Number of cells made		
Ploidy of daughter cells		
Genetic variability		

INTERPHASE

Outline the events that must occur in the nucleus and cytoplasm to prepare for division (i.e. interphase)

_____

_____

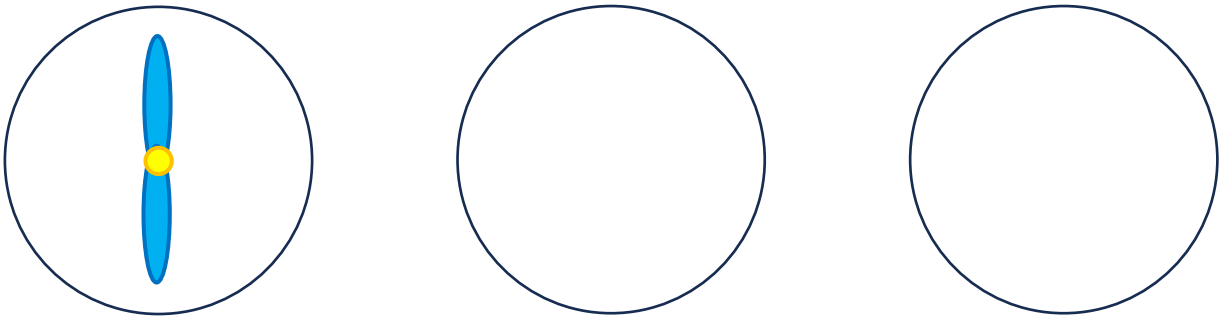
_____

_____

CHROMOSOMES

Draw a diagram of a supercoiled chromosome after interphase and after cell division

Before Interphase **After Interphase** **After Division**



Identify the role of histone proteins in the condensation of DNA

_____

_____

_____

Outline the use of microtubules and motor proteins to move chromosomes within the cell

_____

_____

_____

_____

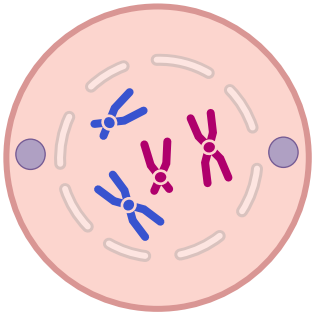
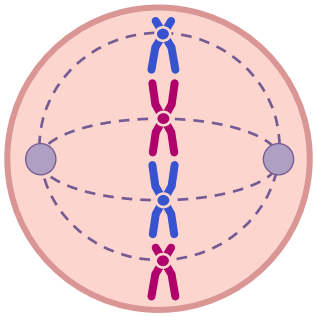
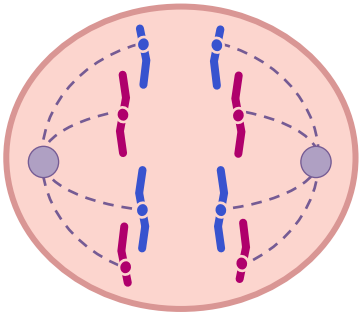
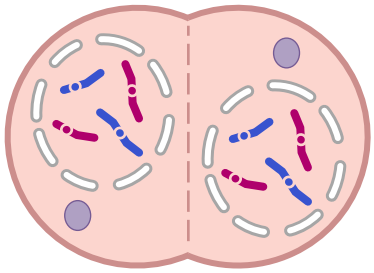
Distinguish between sister chromatids and homologous chromosomes

_____

_____

MITOSIS

Describe the process of mitotic division within eukaryotic cells

STAGE	DESCRIPTION
PROPHASE 	
METAPHASE 	
ANAPHASE 	
TELOPHASE 	

MEIOSIS

Distinguish between the first and second meiotic divisions

Meiosis I:

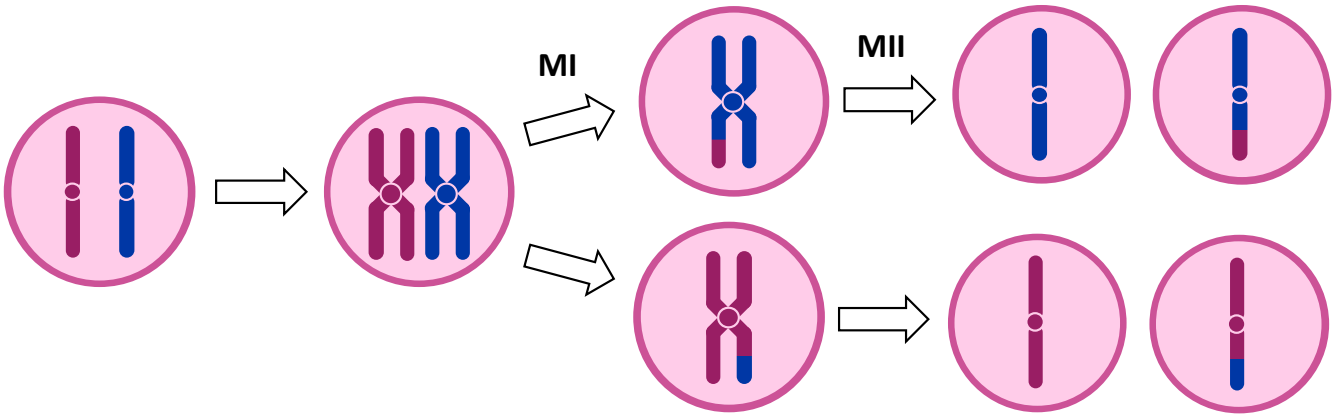
_____

_____

Meiosis II:

_____

_____



GENETIC VARIATION

Describe how meiosis promotes genetic variation via crossing over and random assortment

Crossing Over:

_____

_____

_____

_____

Random Assortment:

_____

_____

_____

_____

NON-DISJUNCTION

Define non-disjunction and describe how it contributes to aneuploidy

_____

_____

_____

_____

_____

Provide a specific example of an aneuploidy in humans

_____

_____

CYTOKINESIS

Contrast cytokinesis in animal and plant cells

ANIMAL CYTOKINESIS	PLANT CYTOKINESIS

Outline two specific examples of unequal cytokinesis (uneven division of the cytoplasm)

1. _____

   _____

2. _____

   _____

5.3 – INHERITANCE

D3.2.1	Production of haploid gametes in parents and their fusion to form a diploid zygote as a means of inheritance
D3.2.2	Methods for conducting genetic crosses in flowering plants
D3.2.3	Genotype as the combination of alleles inherited by an organism
D3.2.4	Phenotype as the observable traits of an organism resulting from genotype and environment
D3.2.5	Effects of dominant and recessive alleles on phenotype
D3.2.6	Phenotypic plasticity as the capacity to develop traits suited to the environment experienced by an organism, by varying patterns of gene expression
D3.2.7	Phenylketonuria as an example of a human disease due to a recessive allele
D3.2.8	Single-nucleotide polymorphisms and multiple alleles in gene pools
D3.2.9	ABO blood groups as an example of multiple alleles
D3.2.10	Incomplete dominance and codominance
D3.2.11	Sex determination in humans and inheritance of genes on sex chromosomes
D3.2.12	Haemophilia as an example of a sex-linked genetic disorder
D3.2.13	Pedigree charts to deduce patterns of inheritance of genetic disorders
D3.2.14	Continuous variation due to polygenic inheritance and/or environmental factors
D2.1.15	Box-and-whisker plots to represent data for a continuous variable such as student height

MENDELIAN INHERITANCE

Use modern genetic terms to contextualise the findings of Mendel's pea plant experiments

Mendel's Conclusions	**Modern Understanding**
Organisms have inheritable factors	
There are versions of each factor	
Parents pass on only one version	
Parents contribute equally to inheritance	
Only one version of a factor is expressed	

Describe the advantages of using flowering plants to investigate genetic crosses

_____

_____

_____

GENETICS TERMINOLOGY

Distinguish between genotype and phenotype

_____

_____

Differentiate between homozygous and heterozygous

_____

_____

Define phenotypic plasticity

_____

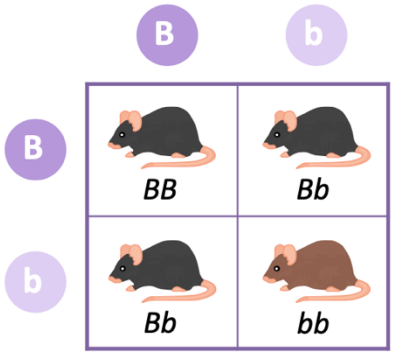
_____

_____

COMPLETE DOMINANCE

Outline the steps that are involved in the generation of a Punnett grid

1. _____
2. _____
3. _____
4. _____



Distinguish between a dominant and recessive allele

_____

_____

Describe the causes and consequences of phenylketonuria (autosomal recessive genetic disorder)

_____

_____

_____

_____

MULTIPLE ALLELES

Define codominance

_____

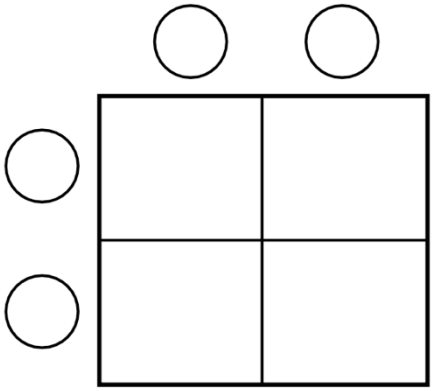
_____

Identify the genotypes for ABO blood groups

Hint: *Use superscripts for codominant alleles*

Blood Group	Potential Genotypes
A	
B	
AB	
O	

Outline how two parents could have a child with any of the different ABO blood groups



Parents: _____

Offspring: _____

Define incomplete dominance with reference to a specific example (i.e. marvel of Peru)

_____

_____

_____

SEX DETERMINATION

Describe sex determination in humans

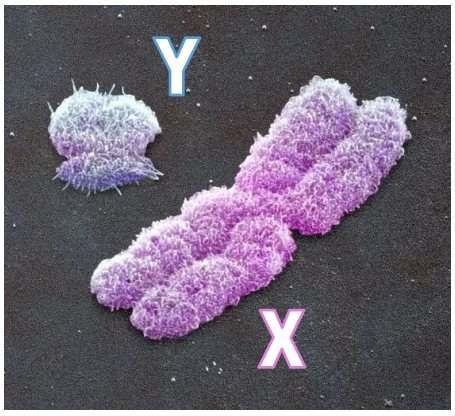
_____

_____

_____

_____

_____



Identify the term used to describe the chromosomes that do ***not*** *determine the sex of an organism*

_____

SEX LINKAGE

Define sex linkage with reference to a specific example

_____

_____

Explain why X-linked recessive traits are more common in males

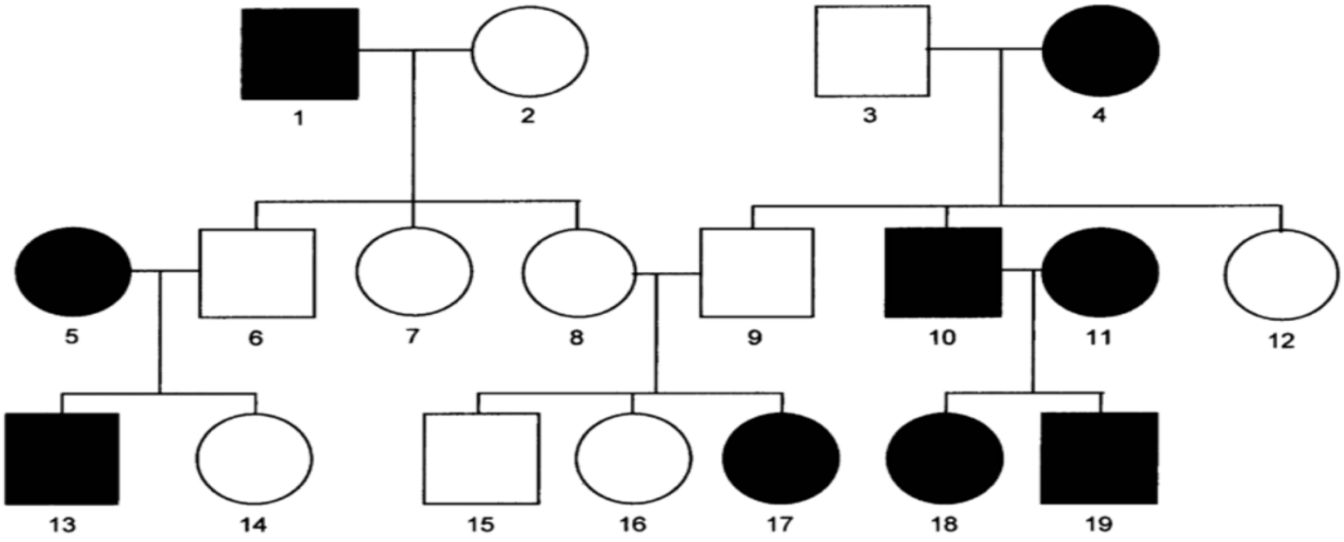
_____

_____

_____

PEDIGREE CHARTS

Identify the genotype of all individuals included within the pedigree chart



Circle the mode of inheritance, providing an appropriate justification for the selection

Dominant / Recessive: _____

_____

Autosomal / X-linked: _____

_____

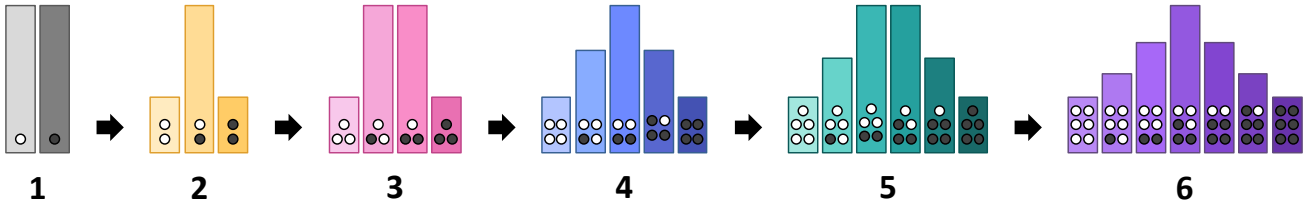
Explain the genetic basis for the prohibition of marriage between close relatives in many societies

_____

_____

POLYGENIC INHERITANCE

Explain how polygenic inheritance and environmental factors lead to continuous variation (with example)

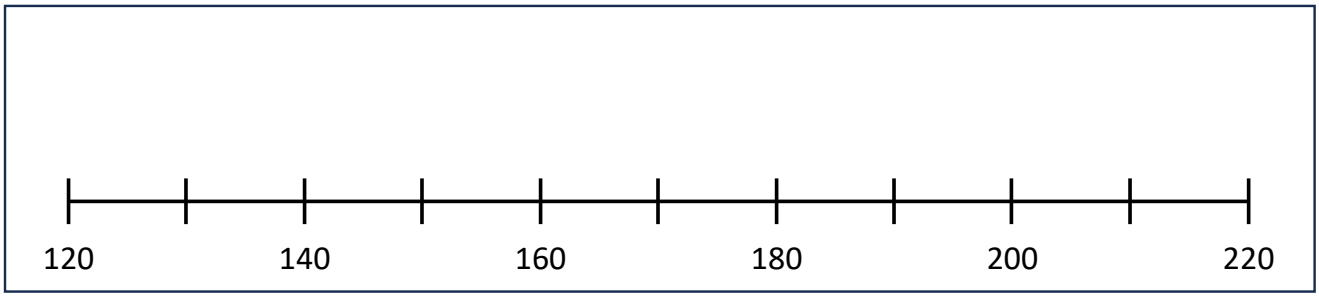


Number of Genes Contributing to a Single Trait ● *Dominant Allele* ○ *Recessive Allele*

BOX-AND-WHISKER PLOTS

Construct a box-and-whisker plot based on the following data

Human Height (cm): 120 , 134 , 156 , 160 , 164 , 168 , 172 , 174 , 175 , 177 , 180 , 184 , 200 , 208



Calculate the following values: mean, median, first quartile, third quartile, interquartile range (IQR)

Mean	Median	First Quartile	Third Quartile	IQR

Identify, with a reason, if there are any outliers in the data provided

5.4 – DNA REPLICATION (AHL)

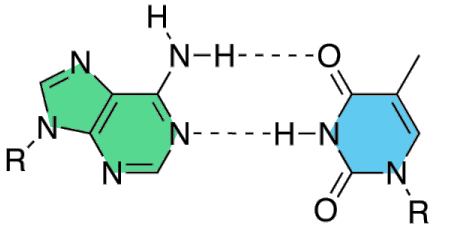
A1.2.11	Directionality of RNA and DNA
A1.2.12	Purine-to-pyrimidine bonding as a component of DNA helix stability
A1.2.13	Structure of a nucleosome
A1.2.14	Evidence from the Hershey-Chase experiment for DNA as the genetic material
A1.2.15	Chargaff's data on relative amounts of pyrimidine and purine bases across diverse life forms
D1.1.6	Directionality of DNA polymerases
D1.1.7	Differences between replication on the leading strand and the lagging strand
D1.1.8	Functions of DNA primase, DNA polymerase I, DNA polymerase III and DNA ligase in replication
D1.1.9	DNA proofreading

GENETIC MATERIAL

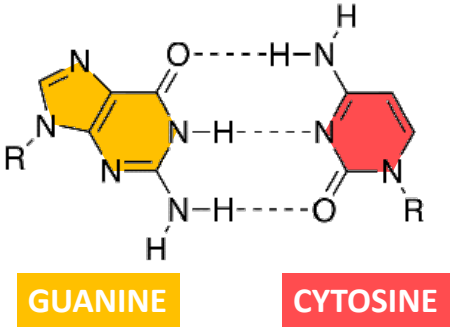
Outline how the Hershey-Chase experiment demonstrated that DNA was the genetic material of a cell

BASE PAIRING

Explain how purine-to-pyrimidine bonding promotes DNA stability



Describe the findings of Chargaff's data on the frequency of bases



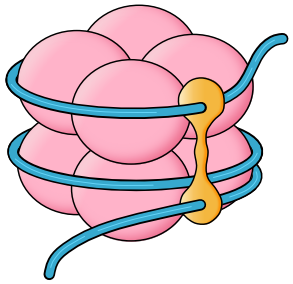
DNA ORGANISATION

Outline how new nucleotides are attached to an existing sugar-phosphate backbone

_____

_____

Describe histone protein organisation within the structure of a nucleosome



_____

_____

_____

DNA REPLICATION

Describe the role of the different enzymes in DNA replication (following strand separation by helicase)

DNA Primase: _____

_____

DNA Polymerase III: _____

_____

DNA Polymerase I: _____

_____

DNA Ligase: _____

_____

Distinguish between DNA synthesis on the leading strand and the lagging strand

_____

_____

_____

Outline the role of DNA polymerase III in the proofreading of DNA

_____

_____

5.5 – GENE LINKAGE (AHL)

D3.2.16	Segregation and independent assortment of unlinked genes in meiosis
D3.2.17	Punnett grids for predicting genotypic and phenotypic ratios in dihybrid crosses involving pairs of unlinked autosomal genes
D3.2.18	Loci of human genes and their polypeptide products
D3.2.19	Autosomal gene linkage
D3.2.20	Recombinants in crosses involving two linked or unlinked genes
D3.2.21	Use of a chi-squared test on data from dihybrid crosses

UNLINKED GENES

Describe how homologous chromosomes randomly assort during meiosis

_____

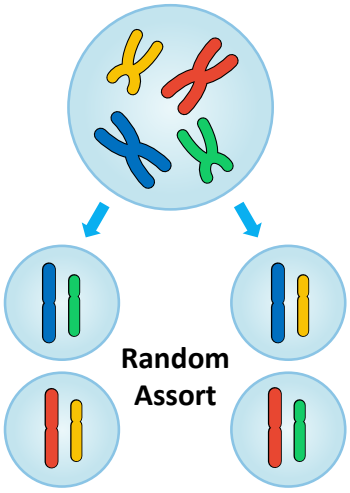
_____

_____

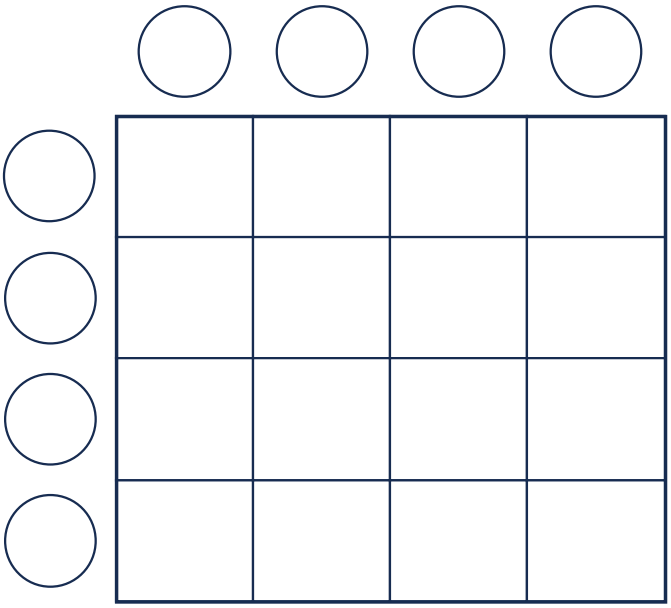
_____

_____

_____

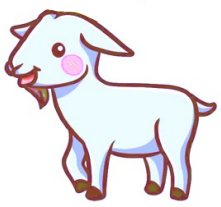


Deduce the phenotypic ratios of a dihybrid cross between two unlinked genes: ***HhBb × HhBb***



Let: H = horned h = hornless

B = brown b = white



Phenotypic Ratios:

_____

_____

Define locus

_____

LINKED GENES

Define linkage groups and explain why linked genes may fail to assort independently

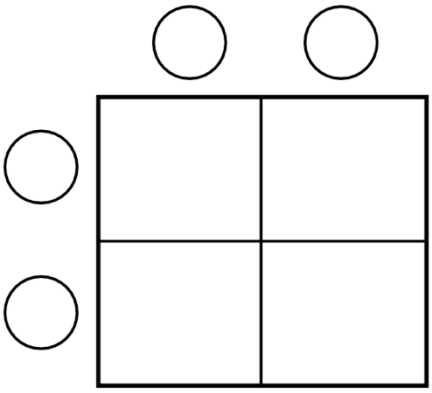
_____

_____

_____

_____

Deduce the phenotypic ratios of a dihybrid cross between two linked genes: $\frac{AG}{ag} \times \frac{ag}{ag}$



Let: A = spotted a = smooth

G = green g = yellow

Phenotypic Ratios:

_____

_____

Outline how crossing over can lead to recombinant phenotypes

_____

_____

_____

_____

Identify the factor that determines the likelihood of recombination occurring between chromosomes

_____

_____

Describe the use of the chi-squared test to determine whether two characteristics are linked or unlinked

_____

_____

_____

_____

_____

CHI-SQUARED TEST

Complete the chi-squared test to determine whether two genes are linked or unlinked

Two heterozygous long green pea plants are crossed (LlGg × LlGg), yielding the following frequencies:

296 = long green 19 = long yellow 27 = short green 85 = short yellow

1. Identify Hypotheses

Null Hypothesis: _____

Alternative Hypothesis: _____

2. Calculate Frequencies

Dihybrid Ratios:

	LG	**Lg**	**lG**	**lg**
LG				
Lg				
lG				
lg				

Frequencies:

Phenotype	**Observed**	**Expected (Total × Ratio)**
Long green		
Long yellow		
Short green		
Short yellow		

3. Calculate Chi-Squared Value

	Long green	Long yellow	Short green	Short yellow
$\frac{(O-E)^2}{E}$				

4. Determine Statistical Significance

Degree of Freedom	**Probability of Exceeding Critical Value**						
	0.90	0.75	0.50	0.25	0.10	0.05	0.01
1	0.016	0.102	0.455	1.32	2.71	3.84	6.63
2	0.211	0.575	1.386	2.77	4.61	5.99	9.21
3	0.584	1.212	2.366	4.11	6.25	7.81	11.34

Conclusion: _____

_____

5.6 – BIOTECHNOLOGY (AHL)

D1.3.8	Gene knockout as a technique for investigating the function of a gene by making it inoperative
D1.3.9	Use of the CRISPR sequences and the enzyme Cas9 in gene editing
D1.3.10	Hypotheses to account for conserved or highly conserved sequences in genes

GENE KNOCKOUTS

Outline the use of gene knockout technology in determining the function of a gene

_____

_____

_____

CRISPR-CAS9

Describe the use of CRISPR-Cas9 in gene editing (using specific examples)

_____

_____

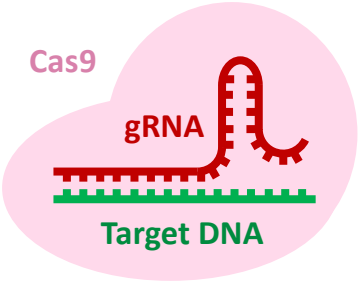
_____

_____

_____

_____

_____



gRNA-Cas9 complex

gRNA targets the virus

Cas9 excises viral DNA

DNA is 'knocked out'

CONSERVED GENES

Distinguish between conserved sequences and highly conserved sequences in genes

_____

_____

Identify two hypotheses to account for the presence of conserved sequences within genes

1. _____

2. _____