Name	Date started	Target end date

GCE A LEVEL — BIOLOGY UNIT 4 QUESTION PACK

1075 (Legacy BY5) · New spec Unit 4 Topic 3 · A2 unit, first sat 2017, 90 marks, 2h paper

REVISE
.wales

BIOLOGY — UNIT 4 · INHERITANCE — MONOHYBRID, CODOMINANCE & SEX-LINKAGE

4.3 Inheritance — Mendelian monohybrid crosses, codominance / incomplete dominance and sex-linkage

Mendel's law of segregation, monohybrid crosses with full dominance, incomplete dominance and codominance (e.g. roan cattle, ABO blood groups), and sex-linked inheritance illustrated by haemophilia and red-green colour blindness.

LEGACY 2008 SPECIFICATION

Estimated time for entire question pack: ~53 min

Derived from the legacy BY5 papers' pace of ~1.6 min/mark, padded for long-prose answers (33 marks over 3 questions).

*You are advised to **not** attempt to complete all of this in one sitting.*

ABOUT THIS QUESTION PACK

This is a **comprehensive practice question pack**, not a single mock paper. It contains every question from the legacy WJEC BY5 papers (2008 modular spec, 2011–2017) that maps onto new-spec A2 Unit 4 Topic 3 (4.3).

Questions are ordered by source paper date.

INSTRUCTIONS

Use black ink or black ball-point pen. Show all working — quality of written communication will affect marks. A calculator is allowed. Diagrams included in answers must be fully annotated.

For Examiner's use only

Q	Source	Max	Mark
1	BY5 Jun 11 Q3	14	
2	BY5 Jun 12 Q3	7	
3	BY5 Jun 13 Q3	12	
	Total	**33**	

Inheritance — Monohybrid, Codominance & Sex-Linkage — what the new spec asks

WJEC GCE A Level Biology (from 2015) · Unit 4: Variation, Inheritance & Options · Topic 4.3.

Mendelian terminology

- Allele — alternative form of a gene at a locus.
- Genotype (alleles carried) vs phenotype (observable trait).
- Homozygous, heterozygous; dominant vs recessive.

Monohybrid cross

- Pure-breeding parents → F_1 all heterozygous, all dominant phenotype.
- $F_1 \times F_1$ → 3:1 phenotype ratio in F_2.
- Law of segregation: alleles separate randomly into gametes.

Codominance / incomplete dominance

- Codominance: both alleles expressed (e.g. AB blood, roan cattle red+white hairs).
- Incomplete dominance: blended phenotype (e.g. pink snapdragon Aa).
- F_2 ratio shifts to 1:2:1 phenotype.

Multiple alleles

- ABO blood groups: I^A, I^B, I^O at one locus.
- I^A and I^B codominant; I^O recessive.
- Four phenotypes (A, B, AB, O) from three alleles.

Sex-linkage

- X chromosome carries genes absent from the smaller Y.
- X-linked recessive (haemophilia, red-green colour blindness): mostly males affected.
- Carrier females (X^HX^h) pass affected X to ~50% of sons.

Test cross

- Cross unknown phenotype with homozygous recessive.
- Reveals whether dominant individual is homozygous or heterozygous.
- Used to verify genotype before breeding programmes.

Crib sheet »

Inheritance — Monohybrid, Codominance & Sex-Linkage in one page

Quick-reference notes — revisit before each question.

Monohybrid

One gene, two alleles. AA × aa → F_1 all Aa.

F_1 selfed → F_2 3 A_ : 1 aa.

Law of segregation.

Incomplete dominance

Aa shows blended / intermediate phenotype.

F_2 ratio 1 : 2 : 1 phenotype = genotype.

Roan cattle (RW) red+white hair mosaic.

Codominance

Both alleles expressed simultaneously.

AB blood group: I^AI^B → both antigens on RBC.

Multiple alleles

ABO: I^A, I^B, I^O.

I^A, I^B codominant; I^O recessive.

4 phenotypes from 3 alleles.

Sex-linkage

X-linked: gene on X only (Y too short).

Males X^hY — hemizygous ⇒ mostly males affected.

Carriers X^HX^h pass on to 50% sons.

Haemophilia

X-linked recessive clotting factor VIII deficiency.

Carrier mother × unaffected father: 25% sons affected.

Females X^hX^h usually non-viable.

Test cross

Unknown × homozygous recessive.

All dominant offspring ⇒ AA; ratio 1:1 ⇒ Aa.

Pedigree

Squares = males, circles = females; filled = affected.

Trace back to deduce dominance / sex-linkage.

Examiner only

3. *(a)* Cattle can have coats which are white, red or an even distribution of white and red hair (Roan). Roan is caused by incomplete dominance between the alleles for red and white hair (heterozygous condition).
Cattle can have horns or be hornless. Horns are a result of a double recessive allele and hornless is caused by a dominant allele.

Key:	
WW = white	H = hornless
RW = roan	h = horned
RR = red	

The genetic diagram shows the cross between a hornless white animal with a horned red animal.

parental phenotype:	hornless white	×	horned red
parental genotype:	HH WW		hh RR
genotype gametes:	HW		h R
genotype offspring:		Hh W R	
phenotype offspring:		hornless roan	

(i) The offspring were then bred together. Complete the Punnett square to show the possible genotypes of the offspring. [4]

Gametes				

Examiner only

(ii) Complete the following table to show the different phenotypes you would expect and the ratio. [6]

Phenotype	*Ratio*

(b) The ancestors of modern cattle originated in the tropics. These animals evolved light coats and darkly pigmented skin by natural selection to adapt them to high solar radiation. Explain what is meant by the phrase 'evolved light coats and darkly pigmented skin by natural selection'. [4]

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(Total 14 marks)

Examiner only

3. A maize plant homozygous for smooth, coloured grain was cross-pollinated with a plant homozygous for wrinkled, colourless grain. The F1 plants all produced smooth, coloured grain. On cross-pollinating the F1 plants, it was found that most of the F2 generation resembled the original plants, 73% producing smooth, coloured grain and 22% producing wrinkled, colourless grain.

(a) Which of the characteristics described above are

(i) dominant .....

(ii) recessive .....

[2]

(b) What conclusion can be drawn about these genes? [1]

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(c) (i) State the probable phenotypes of the remaining 5% F2 plants **not** described above. [1]

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(ii) Suggest how these phenotypes arose. [1]

.....

(d) Using appropriate symbols to represent the alleles, give the genotype of an

(i) F1 plant .....

(ii) F2 plant you described in *(c)* ..... [2]

(Total 7 marks)

USE THE SPACE BELOW FOR YOUR ROUGH WORKING.
IT WILL NOT BE MARKED.

Examiner only

3. Haemophilia is caused by a sex linked gene.

(a) (i) What is meant by the term *'sex linkage'*? [1]

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(ii) Complete the following genetic diagram to show how parents who did not suffer from haemophilia, could have a son with haemophilia but also other children who did not suffer from haemophilia. Use the symbols $\mathbf{X^H}$ for the normal allele and $\mathbf{X^h}$ for the allele which causes haemophilia. [4]

Phenotype of parents	Normal male		Normal female	
Genotype of parents	.....		.....	
Genotype of gametes	.....	.....	.....	.....
Genotype of offspring	.....	.....	.....	.....
Phenotype of offspring	.....	.....	.....	.....

(iii) What is the probability of the couple having a daughter with haemophilia? [1]

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(iv) What is the probability of the couple having another son with haemophilia? [1]

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Examiner only

(b) An organism has two genes A and B which are found on the same chromosome.

Complete the following genetic diagram for a cross between two individuals with genotype Aa Bb but where no crossing over occurs (complete linkage). [3]

Genotype AaBb AaBb

Genotype of gametes ....

Genotype of offspring ....

Ratio of Phenotype .....

(c) In another cross between two individuals with the genotype DdEe, where the genes D and E are on the same chromosome, the offspring showed four different types of phenotype. The phenotype of some of the offspring were far more common than expected and some phenotypes were very rare. Explain these observations. [2]

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END OF QUESTION PACK

3 questions · 33 marks · ~53 min
Source: WJEC BY5 (2008 modular spec, 2011–2017)
Curated for WJEC Biology 2015 spec A2 Unit 4 — Topic 3 (4.3)