Leaving Certificate Higher Level Genetics Questions

<u>2011</u>

7. (a) Explain **each** of the following terms:

> (i) Interphase
>
> (ii) Haploid
>
> (iii) Inbreeding.

(b)   A maize plant, heterozygous for the recessive alleles hairless tassel (h) and short anther (l), is self-fertilised and the seeds are collected. The genes for tassel type and anther length are not linked. Use a cross to illustrate what proportion of the offspring you would expect to show

> (i) hairy tassel
>
> (ii) short anther
>
> (iii) hairy tassel **and** short anther.

(c)   Roan coat colour in Shorthorn cattle occurs as a result of incomplete dominance.

> Use a cross to show how roan coat colour arises from homozygous parents.

(48 marks)

<u>2010</u>

7.   (a)   Explain **three** of the following terms:

> (i)   *freemartin condition*
>
> (ii)   *hermaphrodite*
>
> (iii)   *artificial selection*
>
> (iv)   *pedigree animal*

(b)   In guinea pigs the allele for black coat (B) is dominant over the allele for brown coat (b). A pair of guinea pigs produces a litter of eight piglets; four of the litter are black and four are brown.

> (i)   Give the phenotypes and genotypes of the parents.
>
> (ii)   Using a Punnett square and labelling all genotypes and phenotypes, illustrate this cross.
>
> (iii)   What name is given to this type of cross?

(c)   (i)   Explain how polyploidy arises in plants.

> (ii)   Name **and** give an example of **one** type of polyploidy.

(d)   Account for the importance attached to *index of calving difficulty* in A.I. sire catalogues.

<u>2009</u>

7.   (a)   Explain any **two** of the following terms:

> *Lethal gene*
>
> *Recessive gene*
>
> *Sex-linked gene*

(b)   Suggest reasons why the fruit fly (*Drosophila*) is a suitable subject for genetics experiments.

(c) In Maize **G** represents green and **g** represents albino. 55 maize seeds are sown and the results show 42 green plants and 13 albino plants. Show by means of suitable crosses how this result might occur starting with homozygous parents.

(d) Briefly outline the principal stages of embryo transfer.

2008

7. (a) Explain **four** of the following terms, as used in genetics;
         mutation, sex linkage, diploid, multiple alleles, back-crossing.

    (b) The gender of offspring is determined by the male parent in mammals.
         Illustrate this statement in terms of chromosomes.

    (c) A broad-leaved red-flowered snapdragon was crossed with a narrow-leaved white flowered snapdragon and all the offspring were broad-leaved with pink flowers.
         (i)   Suggest why all the offspring were broad-leaved.
         (ii)   Suggest why all the offspring had pink flowers.
         (iii) List the phenotypes that may result from a cross between two plants heterozygous for both traits.

2007

7. (a) Distinguish between each of the following:
         (i)   inbreeding and crossbreeding,
         (ii) performance testing and progeny testing.

    (b) In peas, the allele for round seed (**R**) is dominant over the allele for wrinkled seed (**r**). Outline the cross between a heterozygous round-seeded plant and a wrinkled-seeded plant. In your answer show the gametes produced and the genotypes and phenotypes of the offspring.

    (c) Write brief notes on **three** of the following:
         (i) F_1 hybrids
         (ii)   polyploidy
         (iii) embryo transplantation
         (iv)   genetic modification

2006

7. (a) Explain each of the following:
         (i) The appearance of roan coat colour in Shorthorn cattle.

(ii)   Lack of variation in plants that are propagated by cloning.

(iii)   Continuous variation in many characters associated with higher organisms.

(iv)   Why some defective phenotypes are more common in males than in females.

(b) In certain species of plants, the allele for straight stamen (**S**) is dominant to the allele for incurved stamen (**s**) and the allele for plain petal (**P**) is dominant to the allele for striped petal (**p**). If pollen from a homozygous straight stamen plain petal flower pollinates a flower with incurved stamens and striped petals:

(i)   State the genotype of the seeds formed.

(ii)   Describe the phenotype of flowers produced when the seeds germinate and grow.

(iii)   What ratio of offspring phenotypes could result from a cross between the F_1 hybrid plant in (ii) and a plant that is recessive for both traits?

(c) Outline the significance of meiosis in reproduction.

2005

7.   (a)   (i)   Outline briefly the production of F_1 hybrid seeds.

(ii)   State **one** advantage of using F_1 hybrid seeds.

(b) In sweet peas, a cross between a red-petalled plant and a white-petalled plant produces pink-petalled flowers in the progeny. Explain why this happens and show the cross using a diagram

(c) Describe the micro-propagation of plants and give one advantage of this technique.

2004

7.   (a)   Explain the following terms as used in genetics: haploid, sex linkage, incomplete dominance.

(b) In guinea pigs the genes for hair colour and length are located on non-homologous chromosomes. The allele for black (**B**) is dominant to the allele for brown (**b**) and the allele for short hair (**S**) is dominant to the allele for long hair (**s**). If two guinea pigs, both heterozygous for hair colour and length, were mated, state:

(i)   the phenotype that might appear in the offspring.

(ii)   the ratio of these phenotypes.

(c)   (i)   Outline the significance of meiosis in reproduction.

(ii)   What is meant by the term mutation? State **one** factor that can cause mutations.

2003

7.   (a)   Red flower colour in sweet pea plants is a homozygous dominant condition (**RR**).
Pink flowering sweet pea plants were crossed with pink flowering sweet pea plants.

The seeds from these plants were collected and sown, and the new plants produced flowers as shown:

Number of plants with red flowers   27

Number of plants with pink flowers   56

Number of plants with white flowers   29

(i)   State genotype of the original pink flowering parents.

(ii)   Explain how the three flower types shown above resulted from a cross between two pink flowered plants.

(iii)   What offspring would result if a pink flowering sweet pea plant were crossed with a red flowering sweet pea plant? Describe this cross and state the genotype and phenotype of the offspring produced.

(iv)   State **one** advantage for using plants in studies of genetics.

(b) Cells contain chromosomes.

    (i)   If an animal somatic cell has 22 pairs of chromosomes state

        (1)   the number of chromosomes found in a gamete

        (2)   whether the gamete is haploid, diploid or triploid.

    (ii)   A female cow is homozygous for sex chromosomes (**XX**), and a male bull is heterozygous (**XY**) for sex chromosomes. Describe with the aid of a diagram the inheritance of sex chromosomes in cattle.

2002

7.   (a) When Gregor Mendel carried out experiments on pea plants he discovered that purple flower (**PP**) colour was <u>dominant</u> to white flower (**pp**) colour. He called white colour <u>recessive</u>. He also discovered that green pod (**GG**) colour was dominant to yellow pod (**gg**) colour.

    (1)   Explain the <u>underlined</u> terms.

    (2)   State the phenotypes of the following pea plants: PPGG, PpGg, ppGg.

    (3)   Mendel crossed a pea plant homozygous for purple flower colour and green pod colour with a pea plant homozygous for white flower colour and yellow pod colour. Describe the above cross and state the genotype and phenotype of the offspring (**F₁**) produced.

    (4)   Mendel further crossed the offspring (**F₁**) with a pea plant homozygous for white flower colour and yellow pod colour.
Describe this cross and state the genotypes and phenotypes of the offspring (**F₂**) produced.

(b) Diagram 1 represents the chromosomes contained in an animal cell. Copy diagram 2 into your answer book and using the same chromosomes shown in diagram 1 complete the diagram to show clearly metaphase of mitosis.
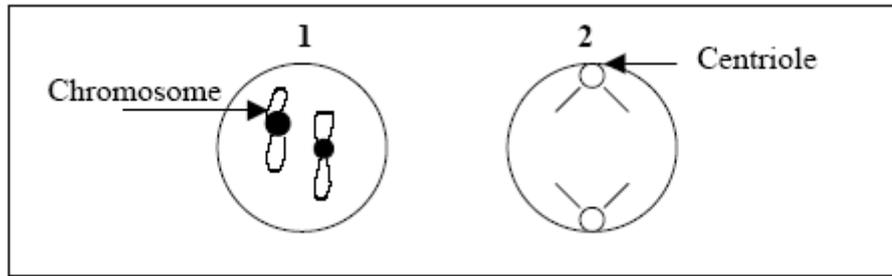
2001

7. (a) In poultry, feathered legs (**FF**) are dominant over clean legs (**ff**) and white plumage (**WW**) is dominant over black plumage (**ww**). What will be the genotypes and phenotypes of the offspring of each of the following crosses?
   (i) FFWW x ffww
   (ii) FFww x ffWW
   (iii) FfWw x FFWW

   (b) Explain each of the following:
   (i) crossing-over during meiosis,
   (ii) incomplete dominance,
   (iii) continuous variation within a population of organisms,
   (iv) multiple alleles.

2000

7. (a) Explain each of the following: phenotype, back-cross, allele.

   (b) Explain why Mendal selected pea plants in his experiments on heredity.

   (c) Use labelled diagrams to show the difference between mitosis and meiosis.

   (d) In maize seeds smooth kernel (**K**) and starchy endosperm (**S**) are both dominant traits. A plant which is homozygous dominant for both traits is crossed with a plant which is heterozygous for both traits. State the phenotype and genotype of the seeds on a plant resulting from this cross.

   (48 marks)

1999

7. (a) Explain each of the following: centrosome, genotype, hybrid.

   (b) Explain Mendel's second law of inheritance using a suitable dihybrid cross.

   (c) Describe, using a suitable example, the importance of the practice of back-crossing in genetics.

1998

7. (a) Explain, using suitable examples, why it is important to be able to distinguish between a homozygous and a heterozygous condition in breeding plants.

   (b) In maize, the gene for hairy tassel (**HH**) is dominant to the gene for hairless condition. The gene for full endosperm (**EE**) is dominant to the gene for shrivelled endosperm. If a cross is carried out between plants, heterozygous for both characters (tassel and endosperm) state the phenotype and genotype of the progeny expected from this cross.

   (c) Mention two alleles which are studied to demonstrate Mendel's Law of Independent Assortment.

   (48 marks)

1997

7. (a) Distinguish between Performance testing and Progeny testing.

   (b) Explain, using your knowledge of genetics and with the aid of a diagram, how F_1 hybrids are produced by plant breeders.

   (c) Explain, using suitable examples, the concept of incomplete dominance and multiple alleles in genetics.

   (d) Outline a cross to explain the difference that occurs in the phenotype of the styles of maize plants which may be identified as being long, short or intermediate in length.

   (48 marks)

1996

7. (a) Name two forms of cell division and give examples of where each occurs in plants or in the animal body.

   (b) Explain each of the following:-
      (i)   Diploid number of chromosomes;
      (ii)   Gene mutation;
      (iii) Cloning as practised by Plant Breeders;
      (iv)   Progeny testing.

   (c) The gene controlling yellow kernel in maize (**YY**) is dominant over its allele colourless kernel (**yy**). Describe the phenotype and genotype expected in the kernels of seeds collected from a cross between a maize plant which is heterozygous for yellow kernel and one which is completely recessive for colourless kernel

   (48 marks)

Q.7

a.   **Interphase:** before prophase/a resting stage before or after cell divisions/between meiosis 1 and meiosis 2/between meioses (cell divisions)/cell organelles duplicate.

Haploid; condition where cell contain half the usual no of chromosomes/1 copy of each chromosome/1 set of chromosomes/23 chromosomes in man/n

Inbreeding: allowing related animals to breed   3 x 4 Marks

b.

Parental genotype HLhl x HLhl or HhLl x HhLl   2+2 Marks

x	HL	Hl	hL	hl
HL	HHLL	HHLl	HhLL	HhLl
Hl	HHLl	HHll	HhLl	Hhll
hL	HhLL	HhLl	hhLL	hhLl
hl	HhLl	Hhll	hhLl	hhll

8 Marks

i. Hairy = 12/16 (or correct fraction or %)
ii Short = 4/16
iii Hairy and short = 3/16
Accept first number alone in each case where 16 boxes are shown   *3 X4 Marks*

C.
RR = red WW(rr) = white RW(Rr) = roan

Eg; RRxWW = RW or RR x rr = Rr   3X4 Marks

2010 Marking Scheme

7. (a) FREEMARTIN:

a heifer calf/ which was a twin with a bull calf/ hormones/ should not be used for breeding/ it will be infertile/ identified by unusually small genitals   2m+2m

HERMAPHRODITE:

both sexes in the one individual/ common in lower organisms/ liverfluke tapeworms
or other example/ both organs function in lower animals/ occurs occasionally in
farm animals/ should not be kept for breeding   2m+2m

ARTIFICIAL SELECTION:

used by breeders/ quicker than natural selection/ mutations are induced in plants/
using radiation, colchicines, cold shock &c/ in animals by selective breeding or
desirable characteristics/ recently by genetic modification   2m+2m

PEDIGREE ANIMAL:

purebreeding or homozygous (animals)/ achieved by selective breeding or
desirable characteristics/ whose lineage is recorded/ in a breed society
herdbook or register/ these animals have "papers"/ and herd book (studbook)
number/ used in A.I. stations (or breeding)   2m+2m

(b) (i) Parents phenotypes: black x brown   1m+1m

         Parents genotypes: Bb   x   bb   1m+1m

    (ii)

	B	B
	Bb	bb
b	Black	Brown

Punnet square: 2m
Gametes: 3 (1m)
Genotypes: 2 (1m)
Phenotypes: 2 (1m)

    (iii) Test cross or back cross   3m

(c) CALVING DIFFICULTY INDEX:

     because it is a result of progeny test/ therefore highly accurate and scientific/
     important to know for heifers/ or small breed females (Jersey, Aberdeen Angus
     &c)/ cow can't be left calf on their own (supervised or vet present)/ cows may
     require a section/ and subsequent sections/ low figure indicates easier
     calving/ cost or loss to farmer   4m+4m

2009 Marking Scheme

7. (a) *Lethal gene*:

        a gene which when expressed in the phenotype will cause death of the organism

        Recessive gene:

        a gene whose expression is masked in the presence of a dominant gene **or** only

expresses itself when present with another recessive gene

Sex-linked gene:

a gene carried on the X chromosome or on the Y chromosome **or** gene carried on

the sex chromosome(s)   <u>any two</u>   3m+5m

(b) Large no. of offspring/ short reproductive time/ a few easily identifiable traits/ cheap/

do not require specialist equipment/ small number of chromosomes/

large chromosomes   4 (3m)

(c) Parents' genotypes   GG   x   gg   1m+1m

Parents' gametes   G*   x   g*   1m+1m

F1 offspring   Gg*   1m

These hybrids when crossed give the genotype permutations below

Parents genotype   Gg   x   Gg *   1m

Parents gametes   G* g*   x   G   g   1m+1m

Punnett Square

x	G	g
G	GG*	Gg*
g	Gg*	gg*

(GG*/Gg* row) 1m+1m
(Gg*/gg* row) 1m+1m

F2 offspring   Result – 3 Green: 1 albino (accept ratio alone)   4m

<u>2008 Marking Scheme</u>

7. (a) mutation – change in genetic code

sex linkage – gene located on sex (X) chromosome

diploid – chromosomes in pairs/ 2n/ normal number of chromosomes

multiple alleles – more than two alleles of a gene (or diagram)

back-crossing – cross between hybrid (or heterozygous) organism and original

(or parent or homozygous recessive) organism (or diagram)   4 (3m)

(b) XX is female/ XY is male   2 (3m)

male parent donates X or Y gamete, female parent donates X/

if male donates X then offspring XX (female)/ if male donates Y then offspring

XY (male) (or shown by diagram)   2 (3m)

(c) (i) allele for broad leaf dominant   3m

(ii) incomplete or partial dominance/ co-dominant/ lack of dominance   3m

(iii) Broad Red/ Broad Pink/ Broad White/ Narrow Red/ Narrow Pink/

Narrow White   6 (3m)

7. (a) (i) inbreeding is crossing between relatives   3m

            cross breeding involves a cross between non-relatives or varieties   3m

     (ii) performance testing compares growth rate of animals under similar conditions   3m

            progeny testing rates offspring relative to parents   3m

(b)

Parents	Rr	X		rr	2m+2m
Gametes	R r			r	2m+2m+2m
Offspring					
Genotype	Rr		rr		2m+2m
Phenotype	Round		Wrinkled		2m+2m

(c) <u>any three</u>   3 (3m+3m)

    (i) *progeny of cross/ between individuals that are genetically different

       or between purebred lines or between homozygous parents/ desirable

       characteristics/ seed production

    (ii) *having three or more sets of chromosomes (or 3n+)/ infertile/ example

    (iii) sperm from superior male/ hormone treatment/ eggs removed from high

       performance animal/ fertilised in vitro/ embryo cloned/ *implanted in other

       animal or organism

    (iv) *altering genotype (genes) of an organism/ duplication or insertion of

       genes from one species into another/ may benefit growth or survival of

       organism/ example or GMOs or GM foods

7. (a) (i) incomplete (lack of or co-) dominance   3m

    (ii) asexual reproduction (mitosis)/ genotype identical to parent plant   3m

    (iii) many genes or many alleles control or affect a characteristic   3m

    (iv) recessive gene/ linked to sex (X) chromosome (no corresponding allele

      on Y chromosome)   2 (3m)

(b) (i) SsPp   or   PpSs   6m

    (ii) Straight stamen + plain petal   6m

    (iii) Straight + plain : straight + striped : incurved + plain : incurved + striped   6m

       1 : 1 : 1 : 1   6m

(c) reduces (halves) the chromosome number/ haploid (n)/ produces gametes/

    diploid (2n) state/ restored at fertilisation/ crossing over produces variation/

    independent assortment allows variation   <u>any three</u>   3 (3m)

7. (a) (i) individual plants with certain characteristics chosen/ breeding from

      these plants takes place/ over a number of generations (inbreeding)/

      to produce homozygous inbred lines/ two inbred lines crossed for F1

      seeds   <u>any three</u>   3 (3m)

(ii) hybrid vigour/ higher yield/ known traits/ uniform offspring   <u>any one</u>   6m

(b)   due to incomplete dominance   3m

Parents	RR	X	rr	(RR X WW)	2 (3m)
Gametes	R		r	(R W)	2 (3m)
F1		Rr		(RW)	3m
Phenotype		Pink		Pink	3m

(c)   small pieces of plant cut/ grown on sterile medium/ form clump (callus)/ container/ plant hormones/ plant name/ develop into plants   <u>any three</u>   3 (3m)

large number of plants in a short time/ genetically identical plants/ relatively inexpensive/ disease free   <u>any one</u>   3m

2004 Marking Scheme

7. (a)   <u>haploid:</u> half full (single) set of chromosomes/ state of gametes/ N/ result of meiosis   4m

<u>sex linkage:</u> gene located on sex chromosome or characteristic associated with one sex   4m

<u>incomplete dominance:</u> one allele not dominant over other/ heterozygous condition results in mix of phenotypes or example   4m

(b) (i) black short/ black long/ brown short/ brown long   4 (4m)

(ii) 9:3:3:1   4m

[allow marks if genotypes appear in correct numbers in sixteen boxes]

(c) (i) produces gametes/ produces haploid cells/ crossing over (chiasma) occurs/ allows for variation/ reduces chromosome number/ reduction division   2 (4m)

(ii) change (error) in genetic material/ change in base sequence in DNA/ change in chromosome number   <u>any one</u>   4m

x rays/ radiation/ UV light (sunlight)/ mustard gas/ radon/ cigarette smoke/ asbestos/ colchicine   <u>any one</u>   4m

2003 Marking Scheme

7. (a) (i) Rr (allow W for recessive allele)   3m

(ii) incomplete dominance (or explanation)   4m

(iii) Parents   Rr   X   RR

Gametes   R r   R

F1 genotype	RR	Rr	
F1 phenotype	Red	Pink	9 (2m)

  (iv) fast results/ easy to manipulate/ contrasting traits/ large number

       of offspring   <u>any one</u>   3m

(b) (i) (1) 22   (2) Haploid   2 (3m)

(ii) Parents	XX	X	XY		
Gametes	X		X	Y	
F1 genotype	XX	XY			
F1 phenotype	female	male			7 (2m)

2002 Marking Scheme

7. (a) (1) *Dominant* = gene prevents working or recessive gene (allele)/

          expressed gene or allele   3m

          Recessive = gene prevented in working by dominant gene (allele)

          not expressed/ hidden   3m

(2) PPGG	Purple Flower + Green Pod	2m
PpGg	Purple Flower + Green Pod	2m
ppGg	White Flower + Green Pod	2m

(3) Parents	PPGG	X	ppgg		
Gametes	PG		pg		
Genotype		PpGg			
Phenotype		Purple and Green			6 (1m)

(4) Parents	PpGg			X	ppgg		
Gametes	PG,	Pg,	pG,	pg	pg		
Genotypes	PpGg,		Ppgg		ppGg	ppgg	
Phenotypes	Purple &		Purple &		White &	White &	
	Green		Yellow		Green	Yellow	15 (1m)

(b)
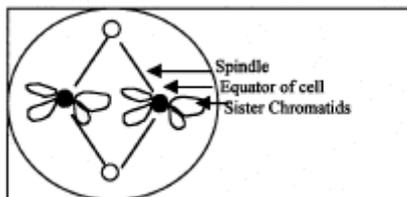

                                                 Diagram   (0m, 2m, 4m)

                                                 Labels   2 (4m)

2001 Marking Scheme

7. (a) (i) F1 genotype	FfWw	4m
F1 phenotype	feathered and white	4m
(ii) F1 genotype	FfWw	4m
F1 phenotype	feathered and white	4m

(iii) F1 genotype   FFWW, FFWw, FfWW, FfWw   4m

    F1 phenotype   feathered and white   4m

(b)   *Definitions*

   (i) Crossing over – movement/ transfer/ exchange/ of gene/ chromosome

      from one place to another   3m+3m

   (ii) Incomplete dominance – one trait fails to dominate another/ an intermediate

      form of the trait results/ explanation using example   3m+3m

   (iii) Continuous variation – characteristics are quantative/ they do not fit into

       distinct groups/ continuous variation between two extreme forms of the

       trait/ explanation using example   3m+3m

   (iv) Multiple alleles – many forms of the same gene/ more than two alleles

      control a trait/ explanation using example   6m

Example alone without explanation for any of the above   3m only