Devraj Rathore 2023190

Time: 1 hour | GMB Quiz 2 | 10 marks each question | ~~All questions are mandatory~~ Any 5

Q1: In pigeons, a dominant allele C causes a checkered pattern in the feathers; its recessive allele c produces a plain pattern. Feather coloration is controlled by an independently assorting gene; the dominant allele B produces red feathers, and the recessive allele b produces brown feathers. Birds from a true-breeding checkered (CC BB), red variety are crossed with birds from a true-breeding plain, brown variety (cc bb).
(a) Predict the phenotype of their progeny.
(b) If these progeny are intercrossed, what phenotypes will appear in the F2, and in what proportions?

Q2: In humans, the ABO blood group system is controlled by a single gene with three alleles: I^A, I^B, and i. A woman with blood type AB marries a man with blood type B whose mother had blood type O.
(a) What are the possible blood types and their ratios of the children?
(b) Explain the type of dominance displayed in each possible offspring's blood type.

Q3: In mice, coat color is determined by two independently assorting genes. The first gene, located on chromosome 5, controls pigment production, with the dominant allele A resulting in the production of black pigment and the recessive allele A resulting in no pigment (albino). The second gene, located on chromosome 8, controls pigment deposition, with the dominant allele B allowing the pigment (if produced) to be deposited in the fur, resulting in black fur, and the recessive allele b resulting in a failure to deposit pigment, leading to brown fur. A homozygous black mouse (AABB) is crossed with an albino mouse (aabb), and their offspring are intercrossed to produce an F2 generation.
(a) Identify the type of epistasis and explain how epistasis is involved in determining the coat color of the F2 generation.
(b) Calculate the expected phenotypic ratios for coat color in the F2 generation (black, brown, and albino).

Q4: In a rare genetic disorder affecting muscle development, a single dominant allele M causes muscle weakness. However, not all individuals with the M allele show symptoms, and the severity of the weakness varies among those who do. What genetic phenomenon can explain this variation, and how might they affect the expression of the disorder?

Q5: In the study of bacterial genetics, understanding how bacteria exchange genetic material is crucial for grasping their adaptability and evolution. Write about the types of gene transfer in bacteria and differentiate between them with the help of a diagram.

Q6: In a population of mice, fur color is controlled by a gene with two alleles: B (black) and b (brown), where B is dominant and b is recessive. Another gene controls tail length, with two alleles: L (long tail) and l (short tail), where L is dominant and l is recessive. 50% of the mice are heterozygous for fur color (Bb), 30% are homozygous dominant (BB), and 20% are homozygous recessive (bb). 60% of the mice are heterozygous for tail length (Ll), 25% are homozygous dominant (LL), and 15% are homozygous recessive (ll).
What is the probability that a randomly selected mouse:
(a) Has black fur and a long tail?
(b) Is either homozygous dominant or heterozygous for both fur color and tail length?
(c) Suppose that a disease breaks out in the population, and it is discovered that only mice with brown fur and short tails (genotype bb and ll) are immune to the disease. What is the probability that a randomly selected mouse is immune to the disease?

INDRAPRASTHA INSTITUTE OF INFORMATION TECHNOLOGY DELHI
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INTERNAL ASSESSMENT SHEET

Total Page: 08

Semester : ☑ Monsoon 2024 ☐ Winter 20__ ☐ Summer 20__

Name : Devoj Rathore
Roll No. : 2023190
Course Code : BIO 211
Course Title : GMB - Q2
Date : 30 September 24
No. of Additional Sheet :
Student Sig : Dev
Invigilator Sig :

1. C → Checkered
c → Plain

Both are independently assorting
B → Red
b → brown

a) The phenotype of the progeny will be Checkered Red in all cases. (F1)
Cc Bb

b) If this progeny is intercrossed the F2 generation will have the following phenotypes in these ratios.

9	: 3	: 3	: 1
Checkered Red	Plain Red	Checkered Brow	Plain Brown

2. Woman → $I^A I^B$ Man → $I^B i$
Father (I^B_) Mother (ii)

a) Punnett square

	I^A	I^B
I^B	$I^A I^B$	$I^B I^B$
i	$I^A i$	$I^B i$

Possible blood types
. AB, A, B
$I^A I^B$, $I^A i$, $I^B I^B$ and $I^B i$

b) In $I^A I^B$, I^A and I^B show Co-dominance traits of both show in phenotype

In $I^B I^B$ → Complete dominance (no recessive present)

In $I^A i$ and $I^B i$ → complete dominance, I^A and I^B respectively dominate the recessive i completely.

3. C 5 → Pigment

A → black
a → Albino

C 8 → Deposition

B → Deposition (Black)
b → No deposition (Brown)
(If produced at C5)

a) This is an example of Recessive epistasis, If C5 is recessive (aa), the phenotype is Albino (_ _ aa) regardless of C8.

C5 → epistatic   C8 → hypostatic

F1 gen → All AaBb

F2 gen →

~~1/2~~ : ~~3~~ : ~~1~~

b) 9 (B_ A_) : 3 (bb A_) : ~~1~~ 4 (_ _ aa)

~~Black~~ Black
Pigment produced,
Deposited

Brown
Pigment produced
Not Deposited

Albino
Pigment not
produced

4. · The genetic phenomenon of expressivity, explains this variation.

- Expressivity is the extent to which a gene manifests itself when it is present in the gene of an organism.
- Expressivity is independent of penetrance which is the amount / ratio of the population that carries the gene.
- Expressivity is different in different organisms and can lead to (in this example) symptoms showing / not showing and ~~varw~~ varying severity across organisms.

6. Fur Color — Tail Length

$B \rightarrow$ Black — $L \rightarrow$ Long

$b \rightarrow$ Brown — $l \rightarrow$ Short

5/10	Bb	6/10	Ll
3/10	BB	1/4	LL
2/10	bb	3/20	ll

a) Black fur, Long tail

P(Black fur) × P(Long tail)

$$= \frac{8}{10} \times \left(\frac{6}{10} + \frac{1}{4}\right)$$

$$= \frac{16}{20} \times \left(\frac{12}{20} + \frac{5}{20}\right) = \frac{16}{20} \times \frac{17}{20}$$

$$= \frac{16 \times 17}{400} = \frac{68}{100} = \boxed{68\%}$$

b) P (Homozygous dom) + P (Hetero for both)

$$= P(BBLL) + P(BbLl)$$

$$= \left(\frac{3}{10} \cdot \frac{1}{4}\right) + P\left(\frac{5}{10} \cdot \frac{6}{10}\right)$$

$$= \frac{3}{40} + \frac{30}{100}$$

$$= \frac{3}{40} + \frac{12}{40} = \frac{15}{40} = \frac{3}{8}$$

c) P (Immune) = P (bb ll)

$$= P(bb) \times P(ll)$$

$$= \frac{2}{10} \times \frac{3}{20} = \frac{6}{200} = \boxed{\frac{3}{100} = 3\%}$$

b) P (Either homozygous dominant)

$$= P(BB) + P(LL)$$

$$= \frac{3}{10} + \frac{1}{4} = \frac{6}{20} + \frac{5}{20} = \boxed{\frac{11}{20}}$$

P (Hetero for Both)

$$= P(BbLl) = P(Bb) \times P(Ll) = \frac{5}{10} \cdot \frac{6}{10} = \frac{30}{100} = \boxed{\frac{3}{10}}$$

6) P (Homozygous dom) + P(Hetero for both)

$$= P(BBLL) + P(BbLl)$$

(Confirmed by TA)

(Some ambiguity)

$$= \left(\frac{3}{10} \cdot \frac{1}{4}\right) + \left(\frac{5}{10} \cdot \frac{6}{10}\right)$$

$$= \frac{3}{40} + \frac{3}{10}$$

$$= \frac{3}{40} + \frac{12}{40} = \frac{15}{40} = \boxed{\frac{3}{8}}$$