1. Once upon a time, in the fascinating world of BB101, our students found themselves on an extraordinary adventure. Equipped with curiosity and a miniature microscope, they decided to shrink down to microscopic proportions to explore the realm of cells.

   (a) In the pursuit of distinguishing between plant and animal cells, a student aims to identify specific organelles under the microscope. Which combination of organelles should the student focus on to effectively discriminate between plant and animal cells?

      i. cell wall and nucleus
      ii. plasma membrane and ribosomes
      iii. plastid and cell wall
      iv. peroxisome and golgi apparatus

   Answer: (iii)

   (b) But the adventure didn't stop there. Eager to understand the cellular machinery, our student embarked on deciphering the order of organelles involved in protein synthesis and transportation. What is the revealed answer?

      i. Ribosome → Endoplasmic reticulum → Golgi apparatus → Cell membrane
      ii. Endoplasmic reticulum → Ribosome → Mitochondria → Golgi apparatus
      iii. Nucleus → Golgi apparatus → Endoplasmic reticulum → Ribosome
      iv. Golgi apparatus → Ribosome → Mitochondria → Endoplasmic reticulum

   Answer: (i)

   (c) As our microscopic explorer prepared to leave the cell, they encountered the Plasma membrane and noticed that it was

      i. completely permeable
      ii. permeable to water
      iii. selectively permeable
      iv. impermeable

   Answer: (iii)

(d) Students conducting a comparative analysis of eukaryotic and prokaryotic cells have discovered a shared organelle present in both types. Identify the common organelle from the options below:

i. Peroxisome
ii. Nucleus
iii. Ribosome
iv. Plastid

Answer: (iii)

2. Consider three gene pairs **Aa**, **Bb**, and **Cc**, each affecting a different character. In each case, the uppercase letter signifies the dominant allele and the lowercase letter signifies the recessive allele. These gene pairs assort independently of each other.

(a) Calculate the probability of obtaining an **AaBB** zygote from a cross of individuals that are **aaBB** and **AAbb**

i. $\frac{1}{16}$
ii. 0
iii. $\frac{3}{4}$
iv. $\frac{1}{2}$

Answer: (ii)

(b) If two heterozygous **AaBb** individuals are crossed, what is the probability that a given offspring will be phenotypically **A, B** — that is, will exhibit all three dominant traits?

i. $\frac{1}{2}$
ii. $\frac{9}{16}$
iii. $\frac{27}{64}$
iv. $\frac{9}{32}$

Answer: (ii)

(c) Calculate the probability of obtaining an **aabb** zygote from a cross of individuals that are **AaBb** and **Aabb**.

i. $\frac{1}{16}$
ii. $\frac{1}{8}$
iii. $\frac{3}{4}$
iv. $\frac{1}{4}$

Answer: (ii)

(d) Calculate the probability of obtaining an **AABB** zygote from similar cross of individuals **AaBb** and **Aabb**.

i. 0

ii. $\frac{1}{4}$

iii. $\frac{3}{16}$

iv. $\frac{1}{2}$

Answer: (i)

3. Now, let's dive into the colorful world of jimsonweed. Here, purple flowers are dominant to white.

(a) Self-fertilization of a particular purple-flowered jimsonweed produces 28 purple-flowered and 10 white-flowered progeny. What proportion of the purple-flowered progeny will breed true in F2 generations?

i. $\frac{1}{4}$

ii. $\frac{2}{3}$

iii. $\frac{1}{3}$

iv. $\frac{3}{4}$

Answer: (iii)

(b) In a parallel scenario, given a population size of 200 plants within the F2 progeny, what is the anticipated quantity of plants exhibiting the trait of purple flower coloration?

i. 180

ii. 150

iii. 95

iv. 200

Answer: (ii)

(c) In the above scenario, what is the anticipated quantity of plants exhibiting the trait of white flower coloration?

i. 80

ii. 50

iii. 20

iv. 10

Answer: (ii)

(d) What are the total number of genotypic and phenotypic classes respectively, in the F2 progeny?

i. 1 and 2
ii. 4 and 5
iii. 3 and 2
iv. 4 and 2

Answer: (iii)

4. Now, let's shift our focus to the broader population, exploring the diverse possibilities that arise from the number of alleles present.

(a) Assume that the number of alleles in a population is `n`. When the different possibilities were asked in a previous BB101 endsem, the students gave the following responses. Which of these are correct?

i. n different homozygous genotypes are possible
ii. $\frac{n(n-1)}{2}$ different heterozygous genotypes are possible
iii. $\frac{n(n-1)}{2}$ different heterozygous genotypes are possible
iv. $n(n+1)$ different genotypes are possible

Answer: (i), (ii), (iii)

(b) If a woman of blood group B marries a man of blood group AB. What is the probability that their children will be of group AB?

i. $\frac{1}{2}$
ii. $\frac{3}{4}$
iii. $\frac{1}{4}$
iv. $\frac{1}{3}$

Answer: (ii)

(c) In a similar scenario, what is the probability that their two children will both be of group B?

i. $\frac{1}{16}$
ii. $\frac{1}{4}$
iii. $\frac{3}{16}$
iv. $\frac{5}{16}$

Answer: (iv)

(d) How many heterozygous genotypes will be there in the F1 progeny?

i. 4

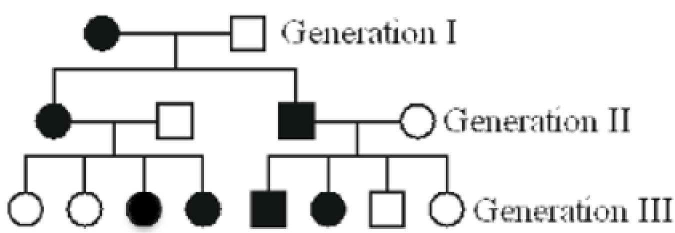
ii. 3

iii. 2

iv. 1

Answer: (ii), (iv)

5. A pedigree is shown below for a disease that is autosomal dominant.



(a) The genetic makeup of the first generation can be:

i. **AA, Aa**

ii. **Aa, aa**

iii. **Aa, AA**

iv. **Aa, Aa**

Answer: (ii)

(b) What will be the probability of affected offspring in generation II?

i. $\frac{1}{2}$

ii. $\frac{3}{4}$

iii. $\frac{1}{4}$

iv. $\frac{1}{3}$

Answer: (i)

(c) What are the genotypes of the children in Generation II?

i. **Aa, Aa, AA, aa**

ii. **AA, AA, aa, Aa**

iii. **Aa, Aa, aa, aa**

iv. **Aa, aa, aa, AA**

Answer: (iii)

(d) What will be the probability of a homozygous dominant offsprings in generation III?

i. $\frac{1}{2}$

ii. $\frac{1}{4}$

iii. 0

iv. 1

Answer: (iii)