**UACE**

Genetics and Variation

3 hours

**INSTRUCTION TO CANDIDATES:**

*Answer all Questions*

*(Copy the table below on the front page of your answer booklet)*

|  |  |
| --- | --- |
| Number | Marks |
| 1 |  |
| 2 |  |
| 3 |  |
| 4 |  |
| 5 |  |
| 6 |  |
| 7 |  |

1. (a) In humans, the inheritance of skin pigmentation is controlled by two **genes A and B,** such that the presence of both genes in the genotype results in black pigmented skin. Presence of gene A in absence of B results in dark brown pigmented skin and absence of gene A when B is present results in light brown pigmented skin. Absence of both genes results in white skin (albino).
2. What does the above information indicate about the inheritance of skin pigmentation in humans? (02 marks)
3. Determine the phenotypic ratio of a cross between a black man and a dark brown woman that results in offspring of all skin colours with light brown and white skins being fewer but equal proportions and black and dark brown being more but also in equal proportions. **(07 marks)**

(b) In poultry, the allele for **white feather** **(W)** is dominant over the allele for **black feather** **(w)**. The alleles for **pea comb, P**, and **rose comb**, **R**, produce the phenotypes stated. If these alleles are present together they produce a phenotype called **walnut comb** and if their recessive alleles are present in the homozygous condition they produce a phenotype called **single comb**. A cross between a **black rose-comb cock and a white walnut-comb hen** produced the following phenotypes:

3 white walnut-comb, 3 black walnut-comb, 3 white rose-comb, 3 black rose-comb, 1 white pea-comb, 1 black pea-comb, 1 white single comb and 1 black single-comb.

1. What are the parental genotypes? **(02 marks)**
2. Show clearly how they give rise to the phenotypes described above? **(05 marks)**

(c) Suggest the causes of mutations in living organisms **(04 marks)**

1. (a) What is meant by the **term linkage**? **(02 marks)**

(b) In man the gene for red blood corpuscle shape is represented by alleles E (elliptical) and e (normal), while another gene for rhesus blood is represented by alleles R for rhesus positive and r for rhesus negative. The two genes are linked. A person may have alleles E and R on one chromosome and e and r on its homologous partner.

(i) State possible genotypes of the gamete if

- there’s crossing over **(02 marks)**

- there’s no crossing over **(01 marks)**

(c) If a man with genotype **EeRr** marries a woman with genotype **eerr**, what is the chance that this couple will produce a child with the genotype **Eerr** if linkage is complete? (Show your working) **(04 marks)**

(d) In Drosophila, the gene for wing length and shape of the abdomen are sex linked. The genes for long wing and broad abdomen are dominant over those for vestigial wings and narrow abdomen.

(a) Work out the phenotypes resulting from a cross between a vestigial winged and a broad abdomen male and a homozygous long winged and narrow abdomen female fly in the

(i) F1 generation **(06 marks)**

(ii) F2 generation **(05 marks)**

1. In the fruit fly, Drosophila melanogaster, the genes for broad abdomen and long wing are dominant over the genes for narrow abdomen and vestigial wing. Pure-breeding strains of the double dominant variety were crossed with a double recessive variety and a test cross was carried out on the F 1 generation.
2. Using suitable symbols, work out the expected phenotypic ratio of the test cross of the F1 generation, if the genes for abdomen width and length of wings are linked.

**(05 marks)**

1. It was however observed that when the test cross of the F 1 generation was carried out, the following results were obtained:

Broad abdomen, long wings 380

Narrow abdomen, vestigial wings 396

Broad abdomen, vestigial wings 14

Narrow abdomen, long wings 10

1. Explain the above results **(04 marks)**
2. Calculate for the expected number of each phenotype **(02 marks)**
3. Using appropriate genetic crosses show how the above results are obtained. **(06 marks)**
4. Calculate the distance in units between the genes for abdomen width and length of wing **(03 marks)**
5. (a) Giving examples, distinguish between the following:
6. Polygenic and pleiotropic traits **(03 marks)**
7. Quantitative and qualitative inheritance **(07 marks)**
8. Epistasis and Mendelian dominance **(04 marks)**
9. Explain how the environment may cause variation among organisms? **(06 marks)**
10. In 1911, Thomas Morgan collected the gene crossover frequencies shown in Table 1 while studying ***Drosophila* *melanogaster***. The loci for four different genes that code for wing shape are located on the same chromosome. Bar-shaped wings are indicated by the *B* allele, carnation wings by the *C* allele, fused veins on wings by the *FV* allele, and scalloped wings by the *S* allele.

**Table 1**

|  |  |
| --- | --- |
| **Gene combinations** | **Recombination frequency** |
| FV/B | 2.5% |
| FV/C | 3.0% |
| B/C | 5.5% |
| B/S | 5.5% |
| FV/S | 8.0% |
| C/S | 11.0% |

1. (i) Use the crossover frequencies to construct a gene map. **(05 marks)**
2. Identify which genes are farthest apart. Determine their distance. Illustrate your answer by way of a diagram. **(02 marks)**
3. (i) Explain why mutation but not sexual reproduction is considered the main contributor to genetic variation. **(05 marks)**
4. Suggest ways in which euploidy condition may arise in a population. **(05 marks)**
5. Describe the different forms of gene mutations that may arise in organisms

**(08 marks)**

1. (a) In mice, coat colour is controlled by two different genes. B gene brings about black coat colour while presence of b gene will bring about an albino mice. The B gene produces its effect whether or not the second gene (A) is present. However gene A can only produce its effect in the presence of gene B causing production of mice with agouti coat colour.

A pure breeding black mouse was crossed with a pure breeding albino mouse producing agouti mice in the F1 generation. Carry out crosses to show the:

1. F1 generation offspring **(04 marks)**
2. F2 phenotypic ratio of the offspring **(05 marks)**

(b) The presence of black plumage in Andalusian fowl is the result of the possession of an allele for the production of the black pigment melanin. The splashed white stock lack this allele.

The production of blue Andalusian fowls is done by crossing pure-breeding black and splashed white parental stocks.

1. Suggest the type of gene interaction that exists in the above inheritance. **(01 mark)**
2. Carryout genetic crosses to show the F2 offspring phenotypes. **(05 marks)**
3. A homozygous purple-flowered short-stemmed plant was crossed with a homozygous red-flowered long-stemmed plant and the F1 phenotypes had purple flowers and short stems. When the F1 generation was test crossed with a double homozygous recessive plant the following progeny were produced.

52 purple flower, short stem

47 purple flower, long stem

49 red flower, short stem

45 red flower, long stem

Explain these results fully. **(05 marks)**

7. In Drosophila the genes for wing length and for eye colour are sex-linked. Normal wing and red eye are dominant to miniature wing and white eye.

(a) In a cross between a miniature wing, red-eyed male and a homozygous normal wing, white-eyed female, explain fully the appearance of

(i) the F1, and

(ii) the F2 generations. **(08 marks)**

(b) Crossing a female from the F1, generation above with a miniature wing, white-eyed male gave the following results:

normal wing, white-eyed males and females 35

normal wing, red-eyed males and females 17

miniature wing, white-eyed males and females 18

miniature wing, red-eyed males and females 36

Account for the appearance and numbers of the phenotypes shown above. **(07 marks)**

1. Using the process of meiosis, explain Mendel’s principle of independent assortment.

**(05 marks)**

**“DON’T PRAY FOR SUCCESS, AND PREPARE FOR FAILURE** ~ Florence Shinn