Patterns of inheritance – 2021/20 GCE Biology A Component 02

1. Nov/2021/Paper_H420/02/No.19

The inheritance of some alleles depends on the sex of the individual.

(a) In birds, sex is determined by a combination of **Z** and **W** chromosomes.

Male birds have two **Z** chromosomes and female birds have one **Z** chromosome and one **W** chromosome.

(i) The chromosomes used to determine sex inheritance are given different letters in birds and mammals.

Identify one **other** way in which the sex determination in birds is different from sex determination in mammals.

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..... **[1]**

(ii) A pigeon is a bird. The colour of pigeon feathers is determined by a single gene on the **Z** chromosome.

The feather colour gene has three alleles.
Z^A = red
Z^B = blue
Z^b = brown

Z^A is dominant to Z^B and Z^b
Z^B is dominant to Z^b

The **W** chromosome contains no gene for feather colour.

A pigeon with the genotype $Z^A Z^b$ was crossed with a pigeon with genotype $Z^B W$.

Complete the answer lines below to show this genetic cross.

Parent genotypes: $Z^A Z^b$ × $Z^B W$

Parent phenotypes: ....

Gametes: ....

Offspring genotypes: .....

Offspring phenotypes: .....

.....

[4]

(b) Haemophilia in humans is a sex-linked disorder.

The recessive haemophilia allele is carried on the **X** chromosome.

Females who carry the recessive allele for haemophilia on one of their sex chromosomes do not show any symptoms.

A female who was a carrier of the haemophilia allele and a male who did not have the haemophilia allele had nine children. The expected ratio of phenotypes in the children of this couple would be 2 healthy females : 1 healthy male : 1 male with haemophilia.

(i) A student performed a chi squared calculation on the phenotypes of the actual nine children.

Part of the calculation is shown in **Table 19.1**.

Phenotypes	**Observed number (O)**	**Expected number (E)**	**O–E**	**$(O–E)^2$**	**$\frac{(O–E)^2}{E}$**
Healthy female			0.5	0.25	0.056
Healthy male			0.75	0.56	0.249
Haemophilia male			–1.25	1.56	0.693
				χ^2 =	0.998

Table 19.1

Complete the table by filling in the columns for the observed and expected numbers.

[Answer on Table 19.1] **[2]**

(ii) **Table 19.2** shows part of a statistical table for the chi squared test.

p%	99	95	90	10	5.0	1.0	0.5
v = **1**	.0001	.0039	.0158	2.706	3.841	6.635	7.879
2	.0201	0.103	0.211	4.605	5.991	9.210	10.60
3	0.115	0.352	0.584	6.251	7.815	11.34	12.84
4	0.297	0.711	1.064	7.779	9.488	13.28	14.86
5	0.554	1.145	1.610	9.236	11.07	15.09	16.75
6	0.872	1.635	2.204	10.64	12.59	16.81	18.55
7	1.239	2.167	2.833	12.02	14.07	18.48	20.28
8	1.646	2.733	3.490	13.36	15.51	20.09	21.95
9	2.088	3.325	4.168	14.68	16.92	21.67	23.59

Table 19.2

Identify the critical value for the chi squared test in part **(i)**.

Critical value = ... **[1]**

(iii) The calculated value for χ^2 was below the critical value.

The student concluded that their expected ratio of 2 : 1 : 1 was incorrect and should be rejected.

Evaluate the student's conclusion.

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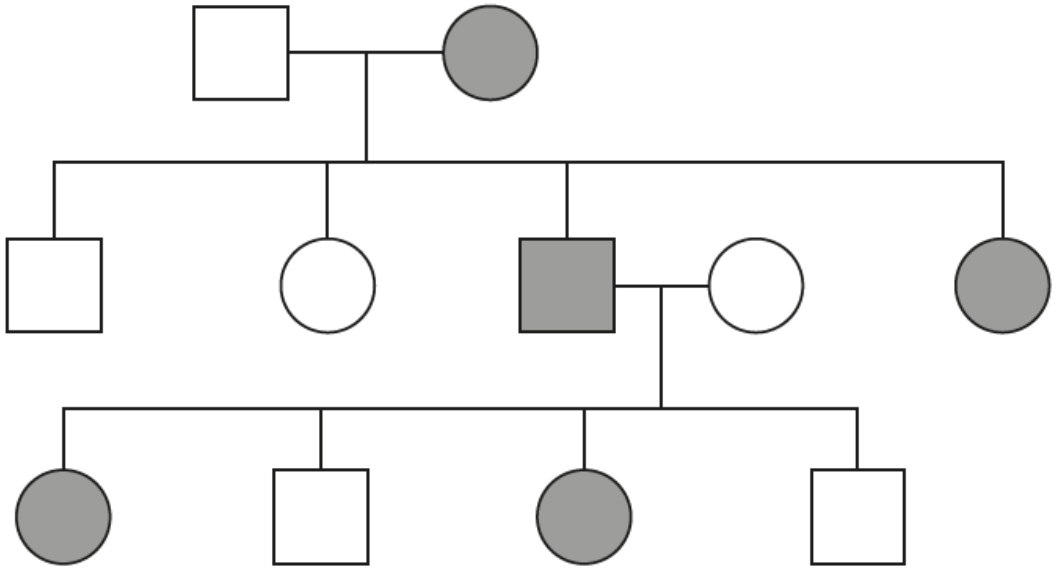
..... **[2]**

(c) Hypophosphatemic rickets is a sex-linked condition.

The diagram shows the occurrence of hypophosphatemic rickets in a single family.



What conclusions can be drawn about the inheritance of hypophosphatemic rickets?

Explain your answer.

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..... **[2]**

2. Nov/2020/Paper_H420/02/No.19

Mitosis and meiosis are important in the life cycles of organisms.

(a) *Hydra* is a small animal that lives in fresh water. When environmental conditions are favourable, *Hydra* reproduces asexually. Large numbers of offspring can be produced in this way.

Asexual reproduction in *Hydra* is shown in Fig. 19.1.

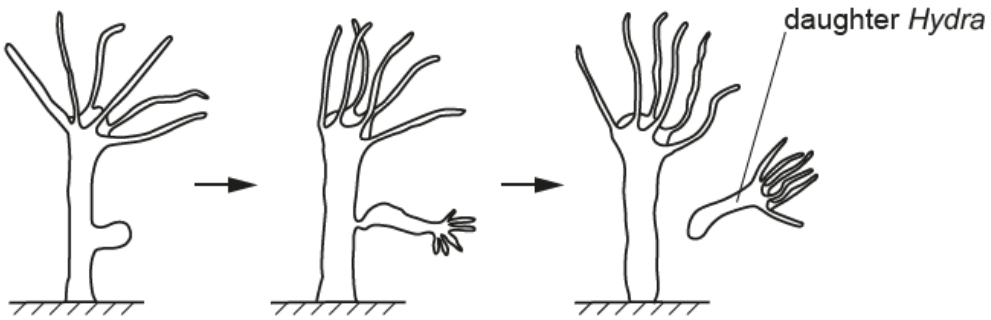

Fig. 19.1

(i) Asexual reproduction involves mitosis.

Name the stages of mitosis in the correct order.

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..... **[2]**

(ii) Suggest why *Hydra* reproduces asexually when conditions are favourable.

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..... **[2]**

(b) When conditions are not favourable, *Hydra* reproduces sexually. This often happens in the winter.

Cells in the body wall produce sperms and eggs by meiosis.

Large numbers of sperms are released into the water. These sperms can fertilise eggs from different individuals. Each egg forms a tough outer coat, and can lie dormant at the bottom of the water until conditions improve.

(i)* Explain how sexual reproduction in *Hydra* leads to genetic variation in the offspring.

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..... **[6]**

(ii) Suggest why sexual reproduction in *Hydra* usually occurs in the winter.

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..... **[1]**

(c) Mosses are small plants that live in damp conditions.

The life cycle of many mosses involves two stages: a gametophyte and a sporophyte.

The gametophyte contains haploid cells and produces sperms and eggs.

The sporophyte contains diploid cells and produces spores which can be spread easily through the air.

The spores germinate and grow into a gametophyte.

Fig. 19.2 shows the life cycle of the moss *Funaria*.

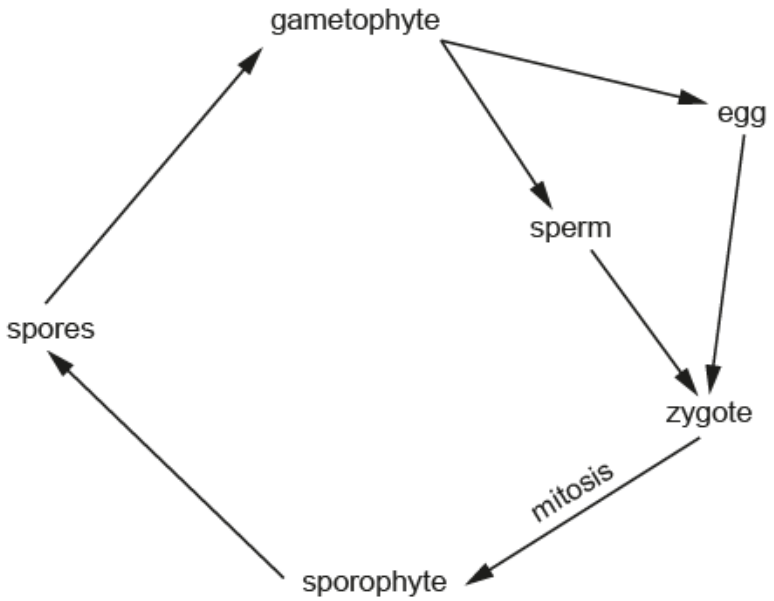

Fig. 19.2

(i) The zygote grows into the sporophyte by mitosis.

The haploid gametophyte of one species of *Funaria* contains 28 chromosomes.

A single DNA molecule contains two strands.

Calculate the number of strands of DNA present in the nucleus of the zygote immediately before mitosis.

number of strands = ... **[1]**

(ii) Mark an **X** on **Fig. 19.2** at the point at which meiosis occurs.

..... Answer on **Fig. 19.2** .....**[1]**

(iii) A diagram of a moss sperm is shown in Fig. 19.3.

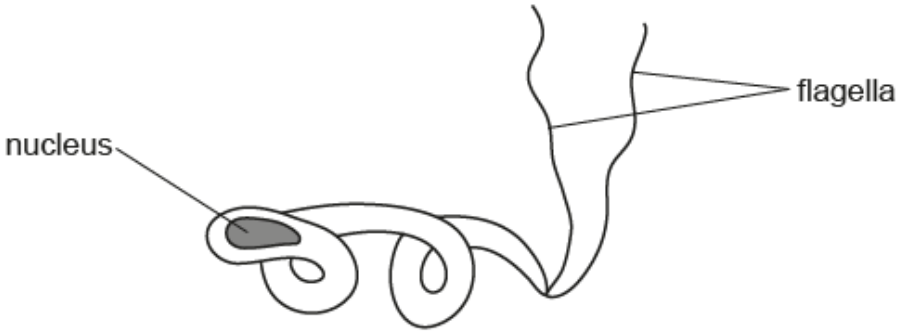

Fig. 19.3

The flagella allow the sperm to move towards an egg.

Suggest and explain another adaptation that is likely to be present in these sperm cells.

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..... **[2]**