16. Inheritance

16.1 Passage of Information from Parents to Offspring

Paper 4

Question Paper

1 Many different genes are involved in the production of pigments in mammals. One example is the *TYR* gene.

(a) In humans the *TYR* gene is located on chromosome 11.

Fig. 6.1 shows the homologous pair for chromosome 11.

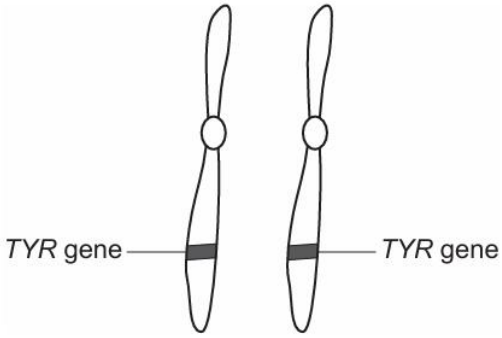


Fig. 6.1

(i) Homologous chromosomes have the same genes located at the same loci.

State one **other** feature shared by homologous chromosomes.

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..... [1]

2 *Lunularia cruciata* is a primitive plant. Its body consists of a flattened sheet of photosynthetic tissue called a thallus.

Fig. 5.1 shows *L. cruciata* with two different types of reproductive structure, labelled **A** and **B**, on its surface.

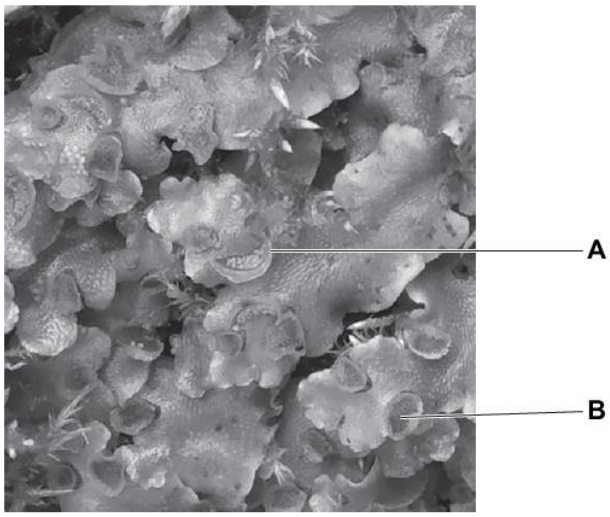


Fig. 5.1

(a) Structures **A** and **B** and the thallus of *L. cruciata* are haploid.

Explain what is meant by haploid.

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(b) Structure **A** contains pale discs of tissue, **C**, that can germinate into new *L. cruciata*. The new plants that develop from **C** are genetically identical to the parent plant in Fig. 5.1.

Structure **B** contains male sperm that are chemically attracted to swim to female eggs on a neighbouring parent plant. When the egg and sperm fuse, they form structure **D**. Structure **D** develops to produce spores that grow into new plants that are genetically different from the two parent plants.

Identify which of the structures **A**, **B**, **C** and **D** are:

associated with sexual reproduction .....

produced by mitosis .....

the site of meiosis .....

Each letter may be used once, more than once, or not at all. [3]

(c) Fig. 5.2 shows a horse, *Equus caballus*. Horses are diploid animals that reproduce sexually. Male and female horses produce gametes, which fuse to form genetically different offspring.



Fig. 5.2

Explain the need for a reduction division during meiosis in the production of gametes in animals such as horses.

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3 **(a)** In sexual reproduction, meiosis occurs to produce haploid gametes from a diploid cell.

Explain the meaning of the terms haploid **and** diploid.

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(b) Describe the behaviour of **chromosomes** during the main stages of meiosis I in animal cells.

prophase I .....

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metaphase I .....

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anaphase I .....

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telophase I .....

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[4]

(c) The production of haploid gametes by meiosis also involves division of the cytoplasm.

State the term used to describe this division of the cytoplasm.

..... [1]

4 Fig. 8.1 shows a cell from the testis of a locust at the late prophase I stage of meiosis.



Fig. 8.1

Explain how the behaviour of the chromosomes in prophase I of meiosis results in the appearance shown in Fig. 8.1.

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5 Yeasts are unicellular organisms from the kingdom Fungi. *Saccharomyces cerevisiae* is one species of yeast that can carry out either asexual reproduction by mitosis or sexual reproduction by meiosis.

Budding in *S. cerevisiae* is a process where a small daughter cell forms as a bud on the parent cell. The bud contains a copy of the parent cell nucleus and it eventually separates from the parent cell to form a new cell.

S. cerevisiae can exist in two forms: haploid cells or diploid cells.

- Haploid cells can be one of two different mating types: **a** and α.
- Haploid cells can only mate with other haploid cells of the opposite mating type.

Fig. 2.1 shows the life cycle of *S. cerevisiae* with its asexual and sexual reproductive stages.

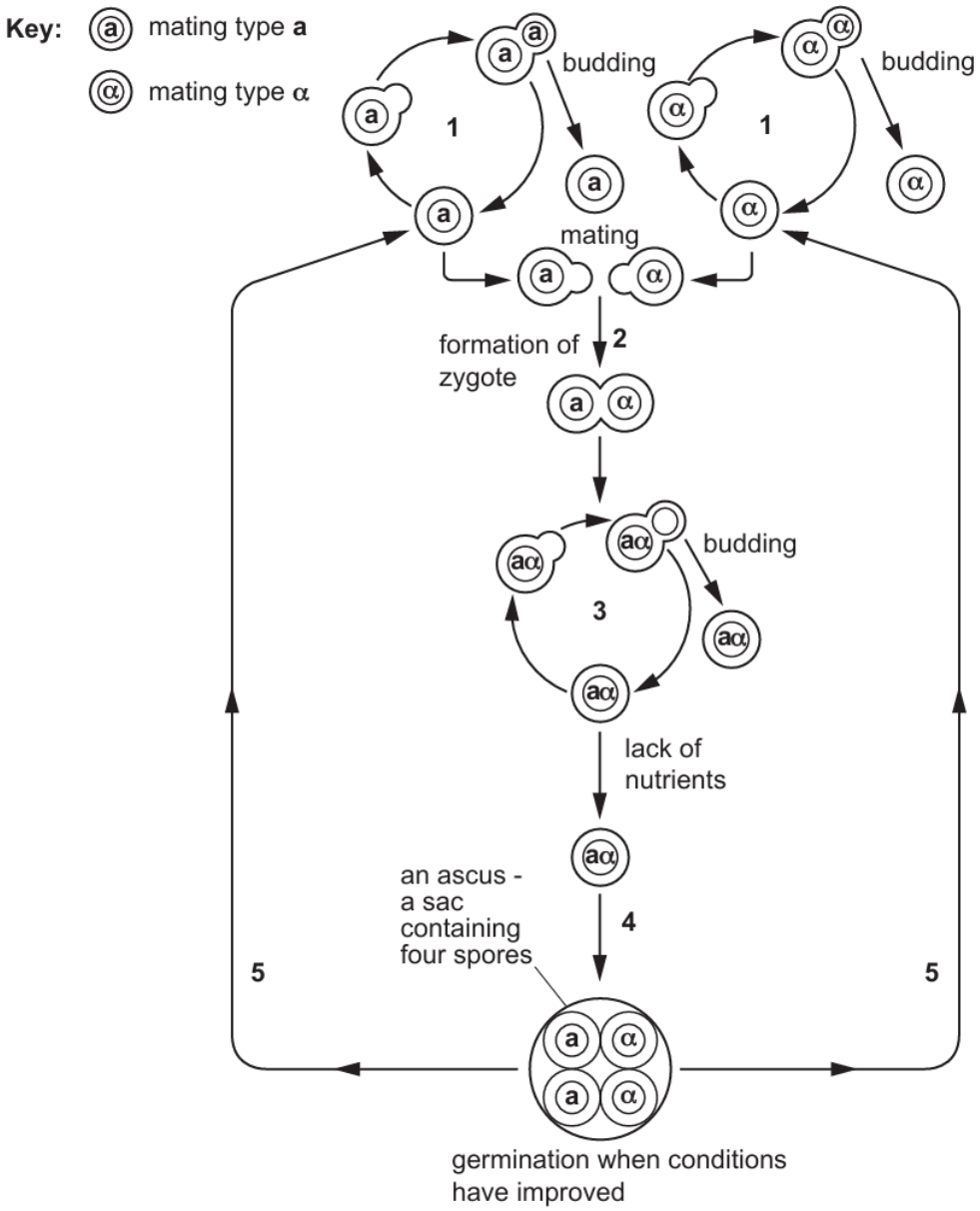


Fig. 2.1

(a) With reference to Fig. 2.1, state the numbers of the stages **1**–**5** that:

involve mitosis .....

involve meiosis .....

produces new genetic variation .....

shows only haploid cells .....

shows only diploid cells .....

[5]

(b) When there is a lack of nutrients, cells made in stage **3** will carry out stage **4** to make spores, which germinate only when conditions improve.

Suggest **and** explain how the type of reproduction that makes spores during stage **4** is advantageous for *S. cerevisiae* in a changing environment.

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6 The tiger barb, *Puntigrus tetrazona*, is a South American fish that is popular worldwide as an aquarium fish. Fig. 6.1 shows the appearance (phenotype) of a normal (wild-type) tiger barb.



Fig. 6.1

- Tiger barbs that show a wild-type phenotype are gold with black stripes.
- Tiger barbs that show an albino phenotype are gold with white stripes.
- In 2012, a fish breeder discovered a tiger barb with a new, transparent, phenotype. This fish had a transparent body and black stripes.

The fish breeder crossed the tiger barb showing the new transparent phenotype with a tiger barb showing the albino phenotype.

All the F1 offspring were wild-type. These F1 offspring were crossed with each other.

Table 6.1 shows the phenotypes obtained in the F2 generation and the number of fish showing each phenotype.

Table 6.1

F2 phenotype	number of fish
wild-type (gold with black stripes)	173
albino (gold with white stripes)	57
transparent with black stripes	58
transparent with white stripes	19

(b) The F1 tiger barbs all looked the same but the F2 offspring showed variation. The F2 offspring showed four different phenotypes.

Describe the processes that occurred during meiosis in the F1 fish that allowed this variation to occur.

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7 **(a)** Meiosis has an important role in sexual reproduction. Meiosis occurs during gametogenesis in humans and during the formation of pollen grains and embryo sacs in plants.

(i) Complete Table 4.1 to compare meiosis with mitosis.

For both columns, put a tick (✓) in the box if the statement is correct and put a cross (✗) in the box if the statement is incorrect.

Each box must contain either a tick or a cross.

Table 4.1

statement	meiosis	mitosis
chromosome number is maintained		
homologous chromosomes pair up		
sister chromatids separate		
occurs in prokaryotes		

[2]

(ii) Compare the role of meiosis in gametogenesis to produce sperm cells in humans with the role of meiosis in gametogenesis in producing pollen grains in flowering plants.

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8 Within a population, the variation for one characteristic is usually the result of genetic and environmental causes.

(a) Meiosis is one source of genetic variation.

(i) Describe the events that take place during prophase I of meiosis in an animal cell.

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(ii) Explain how independent assortment of homologous chromosomes leads to genetic variation during meiosis I.

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9 **(a)** Meiosis is one process that contributes to genetic variation.

(i) State **precisely** the stage of meiosis where single chromosomes line up on the equator.

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(ii) Outline the events taking place during anaphase I of meiosis.

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(iii) Describe how crossing over during meiosis leads to genetic variation.

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