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| *Human Perspectives ATAR Units 1 & 2* |

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Answers

Chapter 10 Cells divide for growth, repair, replacement and reproduction

Questions 10.1

Recall knowledge

**1** List the reasons that cells need to divide.

Answer*:* New cells are needed for growth and replacement of cells that have died or been damaged.

**2** Place the stages of the cell cycle in order: metaphase, G1, G2, telophase, anaphase, S, prophase.

Answer*:* G1 → S → G2 → prophase → metaphase → anaphase → telophase

**3** Name the stage where each of the following occurs:

**a** The chromosomes line up on the equator.

Answer*:* Metaphase

**b** The DNA replicates.

Answer*:* Synthesis phase or interphase may be accepted

**c** Chromatin condenses and becomes visible.

Answer*:* Prophase

**d** The nuclear membrane forms.

Answer*:* Telophase

**e** Chromosomes move to opposite sides of the cell.

Answer*:* Anaphase

**f** The nuclear membrane disappears.

Answer*:* Prophase

**4** List the types of stem cells.

Answer*:* Totipotent, Pluripotent, Multipotent

Apply knowledge

**5** Explain why liver cells live for approximately 450 days, while cells lining the stomach live for only 2.9 days.

Answer*:* The cells lining the stomach are exposed to hydrochloric acid and gastric juices that damage the cells and therefore need to be replaced more rapidly. Liver cells are not exposed to as much damage, and therefore have a longer life span.

**6** Explain why interphase was not listed in Question 2.

Answer*:* Interphase contains the G1, S and G2 phases – it is the period of time between nuclear divisions.

**7** Contrast mitosis and cytokinesis.

Answer*:* Mitosis is the division of the nucleus whereas cytokinesis is the division of the cytoplasm between the two nuclei.

**8** Explain why it is important that embryonic cells from the first few cell divisions are totipotent.

Answer*:* Totipotent cells have the potential to create any type of cell needed for embryonic development. This includes the embryo itself and the membranes necessary to surround, support and nourish the developing embryo. If the cells produced were anything other than totipotent, there would not be successful embryonic development.

Questions 10.2

Recall knowledge

**1** Where does meiosis occur?

Answer*:* Meiosis occurs in the gonads; ovaries for females and testes for males.

**2** Match the stage of meiosis with the process.

Answer:

|  |  |
| --- | --- |
| **Stage** | **Process** |
| Interphase | DNA replicates |
| Meiosis I | Homologous pairs separate |
| Meiosis II | Sister chromatids separate |

**3** For each of the diagrams below, name the phase of meiosis and state how you decided this.

Answer*:* **a** Anaphase II – the sister chromosomes are being pulled to opposite poles of the cell

**b** Metaphase I – the chromosomes are lined up on the equator of the cell in their homologous pairs or tetrad

**4** How many chromosomes are in a cell at the

**a** start of meiosis?

Answer*:* 46 or 23 pairs or diploid

**b** end of meiosis I?

Answer*:* 23 chromosomes or haploid

**c** end of meiosis II?

Answer*:* 23 chromatids

**5** Define ‘diploid’.

Answer*:* When a cell has 2 of each type of chromosome, the chromosomes exist in pairs, and can be represented as 2*n*.

Apply knowledge

**6** The Tasmanian devil has a diploid number of 14. State its haploid number.

Answer: 7

**7** Draw a Venn diagram to compare and contrast mitosis and meiosis.

Answer:

Interphase, DNA replication, Cytokinesis occurs, Spindle fibres used

 **8** Explain why meiosis has two stages, whereas mitosis has only one.

Answer*:* Meiosis can also be known as reduction division, where the chromosome number needs to reduce by half. As such, two stages of meiosis need to occur, without replication of DNA between, to reduce the chromosome number. Mitosis results in two genetically identical diploid daughter cells, whereas meiosis results in four genetically different haploid daughter cells.

Questions 10.3

Recall knowledge

**1** List three processes that lead to variation between daughter cells.

Answer: Crossing over, non-disjunction, random (or independent) assortment

**2** Define ‘chiasma’.

Answer*:* The point at which crossing over occurs between non-sister chromatids.

**3** Explain how non-disjunction can lead to Down syndrome.

Answer*:* Non-disjunction results when one or more of the homologous chromosomes (in meiosis I) or one or more chromatids (meiosis II) fail to separate properly. This results in one of the daughter cells receiving one more or one less chromosome. In the case of Down syndrome, one of the daughter cells has 2 copies of chromosome 21. When this cell is fertilised, the resulting embryo has 3 copies of chromosome 21. Down syndrome can also be called trisomy 21 (indicating 3 of chromosome 21 present in the individual).

**4** Draw a series of diagrams to show how nondisjunction in the first meiotic division can lead to trisomy.

Answer*:* Refer to Figure 10.12b on page 259 of the student book.

**5** Describe random (or independent) assortment with reference to chromosomes.

Answer*:* During the first meiotic division, the homologous chromosomes separate at random, meaning that when they move to the opposite poles, they have no influence over how the other homologous chromosomes separate. All 23 pairs of chromosomes behave this way, so there are 223 possible combinations of chromosomes that each daughter cell can receive.

Apply knowledge

**6** Explain the difference between crossing over and recombination.

Answer*:* Crossing over occurs in Prophase I and involves swapping genetic material between non-sister chromatids. This will reorder the alleles found along the chromosome. Recombination is the changing of the order of alleles along a chromosome, it is a direct result of crossing over.

**7** If a cell has 15 pairs of chromosomes, how many different combinations of chromosomes are there in the gametes?

Answer*:* 215 which equals 32 768.

Questions 10.4

Recall knowledge

**1** Define ‘cancer’.

Answer*:* Cancer can be defined as uncontrolled cell division that can produce a tumour.

**2** List five different types of cancer.

Answer*:* Examples include: Breast, bowel, brain, pancreatic, skin, cervical, throat, stomach. Other options may be accepted.

**3** List three carcinogens.

Answer*:* Examples include: Ultraviolet (UV) radiation, X-rays, ionising radiation, viruses, alcohol, tobacco, asbestos. Other examples may be accepted.

**4** Describe how cervical cancer can be detected in its early stage.

Answer*:* The cervical screening test detects abnormal cells or changes in the cervical cells that may develop into cancer. Cells are taken from the cervix and examined under a microscope, to look for any unusual cells.

**5** Name the diagnostic tests for prostate cancer.

Answer*:* Digital rectal examination (DRE), prostate-specific antigen (PSA) blood test, and biopsy.

Apply knowledge

**6** Explain how cancer cells are different from normal cells.

Answer*:* Cancer cells have uncontrolled rates of cell division and do not specialise/differentiate into the normal tissue cells that surround them. This makes them more easily identified.

**7** Explain why tumours can be identified when a sample is viewed under a microscope.

Answer*:* The tumour cells do not look like the surrounding normal tissue cells as they have not differentiated.

**8** Compare and contrast benign tumours and malignant tumours.

Answer*:* A benign tumour does not spread or invade normal tissues and does not spread around the body. Benign tumours form a mass that can press onto surrounding tissues. Malignant tumours are able to spread into other parts of the body, they can enter the blood stream or lymph and grow secondary tumours away from the original tumour.

**9** Explain how education has been able to reduce the incidence of some cancers.

Answer*:* Education has made the public aware of ways to limit their exposure to known carcinogens including UV radiation (Slip, Slop, Slap campaign), tobacco (plain packaging with large warning signs) and alcohol (labelling on bottles or cans).

**10** Suggest why some people who receive the faecal occult blood test kit still do not do the test.

Answer*:* The faecal occult test involves taking a small sample of faeces from two separate bowel movements using a test kit. These samples are then sent off for testing. People may choose not to test if they feel the testing is unhygienic, or they have no history of bowel cancer in their family (are low risk), or they are fearful of the test results. Receiving a positive test result may result in further testing and invasive techniques including a colonoscopy.

Chapter 10 Activities

Activity 10.2 Observing mitosis

Results

**1** Draw a cell that is in each of the four phases.

Answer*:* See Figure 10.5 on page 252 of the student book for illustrations of the four phases.

**2** You cannot see the spindle in any of the cells. Suggest why it cannot be seen.

Answer*:* The spindle is made up of very narrow fibres that are too small to be seen with a school microscope.

**3** Estimate the number of chromosomes in the cells you are observing. How does your estimate compare with that of others in your class?

Answer*:* Answers will depend on the species observed. Onions have a chromosome number of 8.

**4** If you observed onion cells, what major difference did you see between those cells and the animal cells we have discussed in this chapter?

Answer*:* The main difference is that plant cells have a cell wall and the animal cells do not. Cytokinesis is also different in plant and animal cells. In animal cells a deepening furrow forms between the two daughter cells and eventually divides the cytoplasm into two. In plant cells a cell plate forms – a disc of cellulose between two dividing cells. The cell plate gradually increases in diameter until it divides the cytoplasm into two.

Activity 10.3 Modelling meiosis

Studying your results

**1** What is meant by a ‘model’ in science?

Answer*:* A model is a simplified representation of a complex idea, object or process. For example, Figure 2.2 on page 27 of the student book is a model of a cell. It shows most of the structures that make up a cell, but no real cell would have all those structures in the same proportions.

**2** With respect to the colours of the chromosomes, how many different types of gametes did your model produce? How many colour combinations are possible?

Answer*:* There will be two different types of gametes. The combination of colours will depend on how students arranged the chromosomes before separation. Four combinations of colours are possible, but each pair of students will have only two combinations.

**3** Suppose the chromosome number of your cell was 10. How many combinations of chromosomes would now be possible?

Answer*:* 25 which equals 32 possible combinations of chromosomes.

**4** Humans have a chromosome number of 46. What can you say about the number of possible chromosome combinations in human eggs and sperm?

Answer*:* There are more than 8 million possible combinations; that is, 223.

**5** Why is it that children of the same parents do not inherit identical chromosomes (except for identical twins)?

Answer*:* Each time meiosis occurs to produce an egg or a sperm, a new combination of chromosomes is possible, as well as the chance of recombination of genes through crossing over. That, together with the chance occurrence of which sperm fertilises which egg, means that there is very little chance of siblings being identical. There are more than 8 million possible combinations of chromosomes in the egg, and more than 8 million in the sperm. The number of possible combinations in the zygote is 8 million × 8 million.

**6** How did your movie demonstrate independent assortment of chromosomes?

Answer*:* Students responses will vary.

Activity 10.4 Investigating the incidence of cancer in Australia

Many people are treated successfully for cancer each year, but cancer is still a major cause of death in Australia. Use references to find out:

• which cancers are most common in Australia

• whether there is any relationship between the type of cancer and where people live in Australia

• the age groups at which particular cancers are more common in Australia

• whether there are any upward or downward trends in the incidence of particular cancers in Australia.

Answer*:* A suggested table is included here. Students responses to research may vary.

|  |  |  |
| --- | --- | --- |
| **Cancer type** | **Frequency** | **Age groups most at risk** |
| Prostate | 5th most common cancer in men  | Over 65 |
| Melanoma | Third most common cancer |  |
| Bowel | 2nd most common cancer in both men and women  | Over the age of 50 |
| Lung | 5th most common cancer and the leading cause of cancer death |  |
| Breast | Most common cancer in women | Over the age of 50 unless there is a family history |

There seems to be a relationship with the state or territory you live in the incidence of cancers, for example the Northern Territory shows a higher mortality to incidence ratio, but does have a smaller population with respect other states in Australia.

Some cancers show an overall decrease in new cases and mortality associated with them, others have an increase.

Chapter 10 review questions

Recall

**1** Describe the function of the DNA in a cell.

Answer*:* DNA determines the types of protein that the cell can make.

**2 a** What is the cell cycle?

Answer*:* The cell cycle refers to the sequence of events that takes place in a cell during the interphase period and cell division.

**b** Describe what happens in the four phases of the cell cycle.

Answer:

* G1 phase: The cell grows (producing new proteins).
* S phase: DNA molecules replicate.
* G2 phase: There is a short period of additional growth.
* M phase: The events of mitosis occur and the cell divides.

**3** Name three places where mitosis would be occurring in the body of a healthy adult human.

Answer*:* Any three of:

* Lining of the alimentary canal
* Cheek epidermis
* Skin
* Cervix
* Tongue

**4** Define ‘carcinogen’ and list five examples.

Answer*:* Carcinogens are environmental factors that are known to cause malignant tumours. Examples include:

* X-rays
* UV radiation
* Certain viruses
* Radiation
* Substances such as asbestos, organic solvents, soot, tar, tobacco tar and alcohol

**5** Describe the most common tests for:

**a** bowel cancer

Answer*:* A test for blood in the faeces, known as a faecal occult blood test

**b** breast cancer

Answer*:* Mammogram, which is an X-ray of the breast

**c** prostate cancer

Answer*:* The most common test is a digital rectal examination. Blood tests for prostate specific antigen are also common.

**d** cervical cancer.

Answer*:* A cervical screening to test for abnormal cells from the cervix.

Explain

**6** Explain the difference between a chromatid and a chromosome.

Answer*:* A chromosome is a tightly coiled thread of DNA. When the chromosomes become visible during cell division, they are already duplicated. Each duplicate is called a chromatid because they share a centromere. The pair of chromatids with their centromere is a chromosome. When the centromeres divide during cell division each chromatid becomes a chromosome with its own centromere.

**7** Explain why cell reproduction is necessary in the places listed in Question 3.

Answer*:* There is a lot of wear-and-tear in these areas, so cell reproduction is necessary for replacement of cells that are damaged and worn away.

**8** Explain how mitosis ensures that each daughter cell has exactly the same genetic information as the parent cell.

Answer*:* Chromosomes replicate and at mitosis one of each copy separates into each daughter cell.

**9** Explain how each of the following lead to variation in daughter cells:

**a** independent assortment

Answer*:* When cells divide, the homologous chromosomes are randomly distributed throughout the cell and separate and segregate independently of each other. Effectively you are shuffling the chromosomes into different orders before separation. The location of one chromosome has no impact on the location of any other chromosome.

**b** non-disjunction

Answer*:* Non-disjunction results from the failure of one or more chromosome pairs to separate. This will result in the daughter cells having one too many, or one too few chromosomes. This can occur in anaphase I and/or anaphase II.

**c** crossing over.

Answer*:* Crossing over occurs during prophase I and involves the swapping of genetic material between two non-sister chromatids. This adjusts the alleles present on each chromatid, resulting in variation seen in the daughter cells.

**10** Explain the difference between a benign and a malignant tumour.

Answer*:* A malignant tumour is one that undergoes metastasis, giving rise to secondary tumours. Benign tumours do not spread to other parts of the body.

Apply

**11 a** Use a series of diagrams, or a written description, to show the events that take place during meiosis.

Answer*:* Refer to Figure 10.10 on page 256 of the student book.

**b** Explain why meiosis is essential in sexually reproducing organisms.

Answer*:* Meiosis ensures that each sex cell has only the haploid number of chromosomes so that, at fertilisation, the resulting cell has a full complement of chromosomes, the diploid number.

**c** Explain the difference between haploid and diploid cells.

Answer*:* Haploid cells have half the usual number of chromosomes. In humans the haploid number is 23. Haploid cells form the gametes. Diploid cells have two of each type of chromosome or homologous pairs. The diploid number in humans is 46.

**12** The genes for hair colour and eye colour are located close to each other on the same chromosome. Explain why these traits are usually inherited together.

Answer*:* Crossing over occurs at gene locations that are further apart. Genes that are closer together tend to be inherited together, they are sometimes referred to as linked genes.

**13** Skeletal muscle cells and most nerve cells remain in the G0 phase of the cell cycle. Is it likely that these cells would be dividing? Explain your answer.

Answer*:* The cells would not be dividing because in the G0 phase of the cell cycle cell division does not occur.

**14** Explain the main differences between the processes of mitosis and meiosis. Relate the differences to the type of cells produced by each process.

Answer*:* In mitosis, the homologous chromosomes duplicate, but do not pair off or cross over, so the genetic make-up of the chromosomes remains the same. Cells then divide once, producing two diploid cells each with a complete set of daughter chromosomes. Mitosis produces new cells for growth and repair.

**15** How many chromosomes are present in a cell in a human ovary during each of the following stages of meiosis?

**a** Prophase of the first meiotic division

Answer: 46

**b** At the end of telophase of the first division

Answer: 23

**c** Prophase of the second meiotic division

Answer: 23

**d** At the end of telophase of the second division

Answer: 23

**16** Variation only occurs when organisms reproduce sexually. When a single-celled organism such as an amoeba reproduces asexually, the two new amoebae are identical to the parent. Explain why asexual reproduction does not produce variation.

Answer*:* Asexual reproduction occurs by mitosis. In mitosis the daughter cells have DNA that is identical to the parent cell, so there can be no variation. Only one parent and one set of DNA are cloned. Therefore, there can be no variation. Students may mention that some variation may occur through mutation.

**17** Use a table to summarise the advantages and disadvantages of the different diagnostic tools for prostate cancer.

Answer:

|  |  |  |
| --- | --- | --- |
| **Prostate cancer test** | **Advantages** | **Disadvantages** |
| Digital rectal examination | Easily administered | Depends on the skill of the medical examinerIt is not possible to feel all the prostate |
| Blood test for PSA | Detects an increase in the prostate specific antigen (PSA) | Not all elevations in PSA arenecessarily due to cancer |
| Biopsy | Determine if cancerous cells are present | Invasive and expensive because it involves surgeryRequires skilled medicalpractitioners |

Extend

**18** What do you think would happen if the spindle fibres did not form in a cell that was undergoing mitosis?

Answer*:* The chromosomes would not separate, so when cytokinesis occurs the daughter cells would have random numbers of chromosomes. It is unlikely that a daughter cell would end up with one complete set of chromosomes.

**19** Explain why medical scientists hope that many diseases that have so far been untreatable may be able to be treated using stem cells.

Answer*:* Stem cells, if conditions are appropriate, can differentiate into different types of specialised cells. Scientists hope that stem cells will provide replacement cells for diseased or damaged tissues.

**20** The frequency of non-disjunction of chromosome 21 (Down syndrome) increases with the age of the mother. Find out how age is thought to contribute to non-disjunction.

Answer*:* Individual research, so answers will vary. However, most responses should mention that as women age, meiotic mechanisms erode, leading to an increased incidence of trisomy.

**21 a** List as many reasons as you can for the fact that Australia has the highest incidence of skin cancer in the world.

Answer:

* Most of Australia has high levels of ultraviolet (UV) radiation.
* Australians are particularly fond of outdoor pursuits where they are exposed to UV.
* Australians are very keen on sport and most sports are played outdoors.
* A high proportion of Australians have light skin with little melanin.
* Many Australians live close to the coast and enjoy swimming and other water-based activities.

**b** How can you change your habits to reduce the risk of skin cancer?

Answer*:* Answers will depend on the individual but may include:

* staying out of the sun during times of highest UV radiation
* wearing a hat or other protective clothing
* using sunscreen
* wearing sunglasses.

**c** Describe any recommended changes in beach wear that are aimed at reducing exposure to UV radiation.

Answer:

* Rash vests
* Legionnaire’s hats or broad-brimmed hats
* T-shirts
* Close fitting, wraparound sunglasses
* Clothing made of material with high ultraviolet protection factor (UPF)

**22** List reasons why our exposure to carcinogens is greater today than it has been in the past.

Answer:

* X-rays and medical scans have increased exposure to radiation.
* Synthetic materials are used more often and may sometimes contain carcinogenic substances.
* Modern lifestyle increases exposure to carcinogenic agents.
* People are living longer, so the time available for exposure is increased.
* Higher population densities increase the spread of carcinogenic viruses.