

8. Blood cells, skin cells, cells of the digestive tract, and liver cells tend to divide rapidly. All cells that tend to be easily damaged or are fragile are more likely to be replaced by cell division. Highly specialized cells, such as those of the brain and kidney, have a limited ability for replacement.

Try This Activity (page 95)

- (a) New roots appear from the cutting.
- (b) Measure changes in the length of the stem and new root; check the drainage hole in the bottom of the pot to see if roots are growing out.

3.4 Practice (page 98)

1. Cloning is the process of making of identical offspring from a single cell or tissue.
2. Twins are called nature's clones because they come from the same fertilized egg cell. The cells during the earliest stages of development separate from a rapidly dividing mass and each new cell mass develops into a new human. Each cell mass carries the same DNA, and thus twins are identical.
3. No, they divide at different rates. Specialized cells have a lower capacity for dividing.
4. An enucleated cell is a cell with no nucleus.

3.4 Practice (page 99)

1. Recombinant DNA is a technique where genes are extracted from the nucleus of one organism and spliced into the chromosomes of a new organism. The donated genes affect the traits of the new organism.
2. Seeds banks preserve seeds and cell cultures for future use in breeding new crop varieties.
3. Biotechnology allows species that would never naturally exchange genetic material to be combined by recombinant DNA techniques.

Section 3.4 Questions (page 100)

1. The nucleus from one cell is removed and then inserted into the cytoplasm of another cell.
2. It was long believed that adult cells couldn't be used to clone animals. This was proven wrong with Dolly.
3. Females would be able to produce females by cloning. The offspring would be a genetic duplicate of the mother.
4. The cloned animal is younger than the original. Any trait that occurred as a result of environmental influence, such as a chipped tooth, would not be present in the clone.
6. Many possible answers. One benefit is that the cloned humans could be used to provide organs for transplant. However this would be considered unethical by many people, and it raises numerous issues about the rights of clones.

3.5 Practice (pages 101–102)

1. Cellular communication allows cells to share information about an organism's needs with one another. For example, a callous is formed when cells communicate the need to reproduce in order to protect delicate nerves and blood vessels under the skin from the external environment. Most normal cells adhere to one another, which helps

communication between cells in a given tissue. This communication regulates cell division. All cancer cells can reproduce without directions from adjacent cells, although they do not completely ignore messages from adjacent cells.

2. Cancer cells grown in tissue culture can divide every 24 hours. At this rate the tumor would produce more than one billion cells in a single month, resulting in a 10-kg tumour in six weeks. This rate is unlikely to occur in the body because the blood could not supply nutrients nor remove wastes fast enough. Also, white blood cells, bacteria, or viruses could kill the cells.
3. Cancer cells often divide more quickly and spend less time differentiating or specializing than do normal cells. This means that in cancerous cells the division phase of the life cycle is proportionately longer.

Section 3.5 Questions (pages 102–103)

1. The skin is exposed to many environmental agents that can alter the DNA of cells, and thereby induce cancer. Skin cells are similar to cancer cells in that they divide quickly and undergo little specialization.
2. Yes, the lack of differentiation and larger than normal nucleus are characteristics of cancer cells. However, the conclusion must be supported. A researcher might also investigate whether the cell can divide independently.
3. (a) Place the plant extract on healthy cells in tissue culture. (Later test them on a cancerous growth on an animal). Use the same concentration and amount for each extract. Set up a control with no plant extract. Isolate cells to see if they continue to divide. Monitor the rate of dividing cells. Check to see if the ratio of nucleus to cytoplasm has changed. Check cells for differentiation.
(b) The rate of cell division with the plant extract would be less than with the control. Cells would not divide if isolated from adjacent cells. Cells treated with the plant extract would differentiate.
(c) The effectiveness of plant extracts A and B can be determined by comparing cancerous tissue that has been treated with the extracts to an untreated control sample of cancerous tissue.
4. Some research topics the students could investigate: radiation, chemotherapy, gene therapy, surgery, changing lifestyle, monoclonal antibodies.
7. Plants will become extinct before they can be tested for their usefulness as medicines.
8. Radiation poisoning slows cell metabolism and the rate of cell division. Hair cells are active cells that produce proteins (hair). The stomach lining must also be frequently reproduced by cell division. The slowing of cell division will affect these cells.
9. When cancers are localized, exposing the cancerous area to radiation can break apart the nuclear material of the cancerous cells without affecting the surrounding, healthy cells.
10. Many possible answers. Why do some cells divide faster than other cells? Why do cells stop dividing? What causes cells to begin dividing? What environmental factors alter cell division?

3.6 Practice (page 107)

1. Meiosis is the formation of gametes.
2. Haploid refers to the number of chromosomes in a gamete. Diploid refers to twice the number of chromosomes in a gamete. All cells of the body, except sex cells, are diploid.
3. A tetrad is a pair of homologous chromosomes, each with two chromatids.
4. Homologous chromosomes are similar in shape, size, and gene arrangement.
5. Yes, homologous chromosomes have the same number of genes. Homologous chromosomes contain genetic information regarding the same traits. The difference between two homologous chromosomes is that one chromosome comes from the father, one chromosome comes from the mother.
6. No, each parent could have different genes.

Try This Activity (page 107)

- (b) No. The chromosomes will not all be visible.
- (c) In prophase I and II, the centriole splits, its parts move to opposite poles, and spindle fibres are formed. In prophase I, the replicated chromosomes condense, homologous chromosomes come together in synapsis and crossing-over occurs. In prophase II, synapsis and crossing-over does not occur. In metaphase I and II, chromosomes line up at the equatorial plate. In anaphase I, homologous chromosomes separate and move to opposite poles of the cell. In anaphase II, sister chromatids of each chromosome separate and move to opposite poles of the cell.
- (d) Cells undergoing meiosis I contain the diploid number of chromosomes, while cells undergoing meiosis II contain the haploid number of chromosomes.

Activity 3.7.1 Analysis (pages 111–112)

- (a) Step 3 models DNA replication.
- (b) The pieces of red and blue clay represent homologous chromosomes; the green balls represent centromeres.
- (c) The diploid number of chromosomes of the cell in step 4 is 4.
- (d) The model in step 4 represents the metaphase stage of mitosis.
- (e) In step 5, the single pieces of clay represent chromatids after separation.
- (f) The model in step 5 represents the anaphase stage of mitosis.
- (g) In step 6, each daughter cell contains 4 chromosomes.
- (h) The daughter cells are the same as the parent cell.
- (i) Chromosomes are considered to be homologous because they are the same shape and size.
- (j) The diploid chromosome number is 4.
- (k) In step 8, synapsis must occur before the homologous chromosomes can cross over.
- (l) Crossing over occurs during metaphase.
- (m) During crossing over, a section of DNA is exchanged between the chromatids in a homologous pair.
- (n) In metaphase I, the diploid number of (homologous) chromosomes line up ($2n$); in metaphase II the haploid number of chromosomes line up (n).
- (o) The haploid chromosome number is 2.

- (p) In mitosis, 2 identical daughter cells with $2n$ chromosomes are produced; in meiosis 4 gametes, each with n chromosomes, are produced. In meiosis, the resulting gametes are not identical.

Sections 3.6–3.7 Questions (page 112)

- The first meiotic division involves the separation of homologous chromosomes; the second meiotic division involves the separation of chromatids.
- There may be new combinations of genetic material on the chromosomes because of cross-over
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| Description | Mitosis | Meiosis |
|---------------------------|-----------------------|---------------------------|
| number of resulting cells | 2 | 4 |
| chromosome number | $2n$ | n |
| number of phases | 1 | 2 |
| type of cell formed | somatic/body/daughter | gamete/reproductive cells |

4.

Table 1

| | Human | Cat | Shrimp | Bean |
|---|---------------|---------------|----------------|---------------|
| Before meiosis | | | | |
| chromosome number (haploid or diploid?) | 46 diploid | 36 diploid | 254 diploid | 22 diploid |
| number of pairs of homologous chromosomes | 23 | 19 | 127 | 11 |
| After meiosis I | | | | |
| chromosome number (haploid or diploid?) | 23 haploid | 19 haploid | 127 haploid | 11 haploid |
| After meiosis II | | | | |
| chromosome number (haploid or diploid?) | 23 haploid | 19 haploid | 127 haploid | 11 haploid |
| number of pairs of homologous chromosomes | 0 | 0 | 0 | 0 |

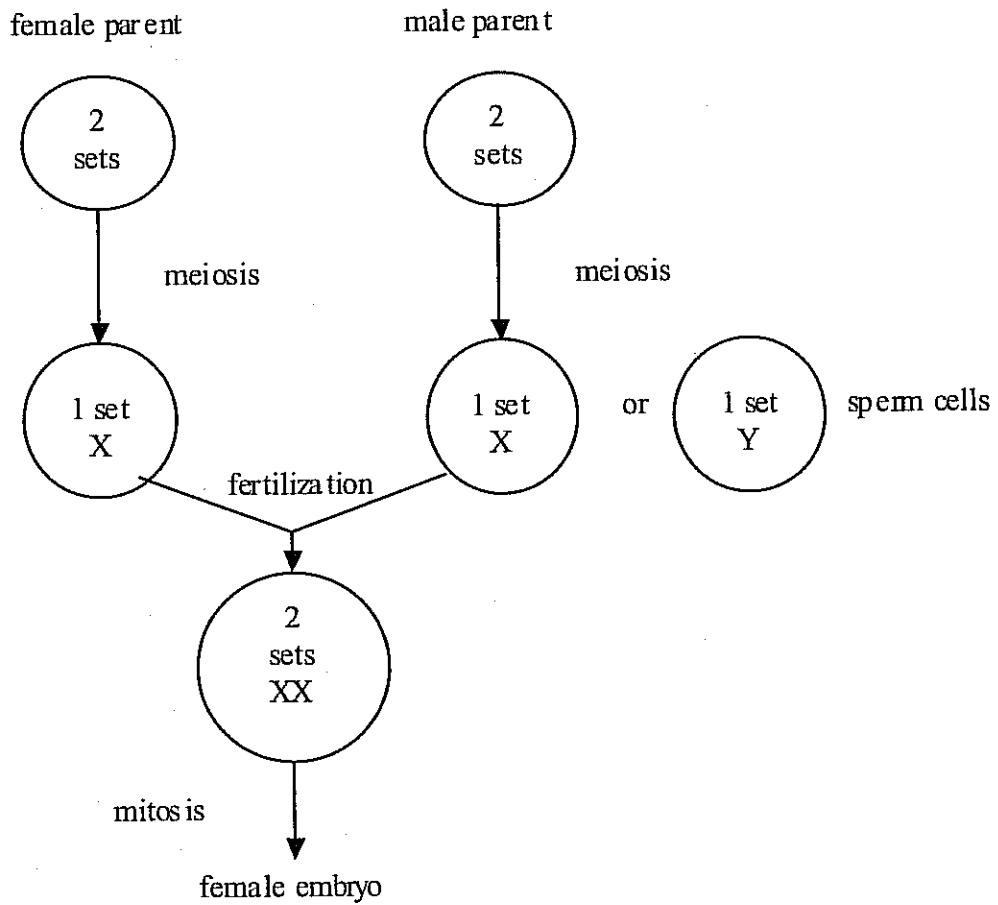
3.8 Practice (pages 114–115)

- (a) A daughter muscle cell would contain 22 chromosomes.
(b) An egg cell would contain 11 chromosomes.
(c) A fertilized egg cell would contain 22 chromosomes.
- Gametogenesis in Humans

| | Spermatogenesis (male) | Oogenesis (female) |
|---|------------------------|--------------------|
| number of cells | 4 | 1 |
| polar bodies | 0 | 3 |
| number of divisions | 2 | 2 |
| number of homologous chromosomes prior to meiosis | 23 | 23 |

- One cell receives most of the cytoplasm. Nutrients and organelles in the cytoplasm are needed to sustain multiple cell divisions if fertilization occurs.

4.



5. In many plants, such as pine trees and roses, sporophytes (spore-producing bodies) form from the zygote, and gametophytes (gamete-producing bodies) form following meiosis. Spores are haploid cells that can germinate and give rise to gametophytes. Alternation between the sporophyte and the gametophyte is shown in the generalized plant life cycle below.

