Enzyme Control of DNA Replication (page 107)

1. DNA replication prepares a chromosome for cell division by producing two chromatids which are (or should be) identical copies of the genetic information for the chromosome.

2. (a) Step 1: Enzymes unwind DNA molecule to expose the two original strands.
   (b) Step 2: DNA polymerase enzyme uses the two original strands as template to make complementary strands.
   (c) Step 3: The two resulting double-helix molecules coil up to form two chromatids.

3. (a) **Helicase**: Unwinds the 'parental' strands.
   (b) **DNA polymerase I**: Hydrolyzes the RNA primer and replaces it with DNA.
   (c) **DNA polymerase III**: Elongates the leading strand. It synthesizes the new Okazaki fragment until it encounters the primer on the previous fragment.
   (d) **Ligase**: Joins Okazaki fragments into a continuous length of DNA.

4. 16 minutes 40 seconds

Mitosis and the Cell Cycle (page 145)

1. (a) Anaphase
   (b) Prophase
   (c) Early anaphase
   (d) Late anaphase
   (e) Late telophase or beginning of interphase

2. The **DNA must be replicated** to form a second chromatid. The **chromosomes must condense** to avoid tangling.

3. A. **Interphase**: The stage between cell divisions (mitoses). Just before mitosis, the DNA is replicated to form an extra copy of each chromosome (still part of the same chromosome as an extra chromatid).
   B. **Late prophase**: Chromosomes condense (coil and fold up) becoming visible as double chromatids. Centrioles move to opposite ends of the cell.
   C. **Metaphase**: Spindle fibers finish forming between the centrioles. Chromosomes attach to the spindle fibers at the cell equator.
   D. **Late anaphase**: Chromatids from each chromosome are pulled apart and move in opposite directions, towards the centrioles
   E. **Telophase**: Chromosomes begin to unwind again. Two new nuclei form. The cell plate forms across the midline where the new cell wall will form.
   F. **Cytokinesis**: Cell cytoplasm divides to create two distinct daughter cells from the original cell. It is in this form for most of its existence, and carries out its designated role (normal function).

Meiosis (page 149)

1. In the first division of meiosis, homologous pairs of chromosomes pair to form bivalents. Segments of chromosome may be exchanged in crossing over and the homologues then separate (are pulled apart). This division reduces the number of chromosomes in the intermediate cells, so that only one chromosome from each homologous pair is present.

2. In the second division of meiosis, chromatids separate (are pulled apart), but the number of chromosomes stays the same. This is more or less a 'mitotic' division.

3. Non-disjunction in the parental cell during meiosis I results in both the daughter cells being faulty which will be transferred to the daughter cells produced in meiosis II. Nondisjunction in a parental cell during meiosis II results in only half the total number of daughter cells being faulty.

4. **A** shows metaphase of meiosis I: the homologous pairs of chromosomes are lined up on the cell equator. **B** shows metaphase of meiosis II: the individual chromatids are about to separate.

AP Biology 1

Mendel's Laws of Inheritance (page 160)

1. Particulate inheritance: Inherited characteristics are transmitted by discrete entities (genes) which themselves remain unchanged from generation to generation.

2. **Note**: During meiosis, the two alleles for a gene will separate into different gametes, and subsequently into different offspring. Normally both alleles cannot end up in the same offspring. Occasionally, faulty meiosis can occur, resulting in aneuploidy or polyploidy.
   (a) Aa (b) A, A, a, a (c) 2 kinds: A and a

3. **Note**: During meiosis, all combinations of alleles are distributed to gametes with equal probability. The pair of alleles for each gene are sorted independently of those for all other genes. Genes that are linked on the same chromosome tend to be inherited together.
   (a) AB and ab (b) 4 kinds: AB, Ab, aB, ab

Chi-Squared Exercise in Genetics

(page 376)

1. (a) H_0: "If both parents are heterozygous and there is independent assortment of alleles (no linkage) then we would expect to see a 9:3:3:1 ratio of phenotypes in the offspring ".
   (b) H_A: "If both parents are heterozygous and the genes are linked (i.e. on the same chromosome), then we would expect the ratios of phenotypes in the offspring to deviate from the 9:3:3:1".

2. (a) Completed table:

Category	O	E	O – E	$(O-E)^2$	$\frac{(O-E)^2}{E}$
Purple stem, jagged leaf	12	16.3	–4.3	18.5	1.1
Purple stem, smooth leaf	9	5.4	3.6	13	2.4
Green stem, jagged leaf	8	5.4	2.6	6.8	1.3
Green stem, smooth leaf	0	1.8	–1.8	3.2	1.8
	Σ 29				Σ 6.6

Expected frequencies calculated as follows:
Purple stem, jagged leaf = 9/16 x 29 = 16.3
Purple stem, smooth leaf = 3/16 x 29 = 5.4
Green stem, jagged leaf = 3/16 x 29 = 5.4
Green stem, smooth leaf = 1/16 x 29 = 1.8
Note: Whole numbers could be used in preference to rounding to one decimal place.

(b) $\chi^2 = 6.6$
(c) Degrees of freedom = (4-1=) 3
(d) The critical value of χ^2 at $P = 0.05$ and at d.f.= 3 is 7.82. The calculated χ^2 value is less than the critical value (6.6 < 7.82).
(e) We cannot reject H_0: There was no significant difference between the observed results and the expected phenotype ratio of 9:3:3:1. We must conclude that the genes controlling stem color and leaf shape in tomatoes are on separate chromosomes (unlinked).

3. (a) H_0 and H_A as for question 1.
   (b) Completed table:

Category	O	E	O – E	$(O-E)^2$	$\frac{(O-E)^2}{E}$
Round-yellow seed	441	450	–9	81	0.18
Round-green seed	159	150	9	81	0.54
Wrinkled-yellow seed	143	150	–7	49	0.33
Wrinkled-green seed	57	50	7	49	0.98
	Σ 800				Σ 2.03

Expected frequencies calculated as follows:
Round-yellow seed = 9/16 x 800 = 450
Round-green seed = 3/16 x 800 = 150
Wrinkled-yellow seed = 3/16 x 800 = 150
Wrinkled-green seed = 1/16 x 800 = 50
(c) $\chi^2 = 2.03$
Degrees of freedom = (4-1) 3 . The critical value of χ^2 at $P = 0.05$ and at d.f.= 3 is 7.82. Calculated χ^2 is less than critical value (2.03 < 7.82).
(d) We cannot reject H_0: There was no significant difference between the observed results and the expected phenotype ratio of 9:3:3:1. We must conclude that the genes controlling seed shape and color are on separate chromosomes (unlinked).

4. In both cases, we cannot reject H_0, but in the first case, the χ^2 value is much higher. In the case of the tomatoes, the genes for stem color and leaf shape **are** on separate chromosomes, but given the relatively large χ^2 value, repeating the experiment using more plants, or replicate setups, would serve as a check.