Chapter 8: The Cellular Basis of Reproduction and Inheritance

Opening Essay

Explain why cancer cells are dangerous, how cancer is treated, and why cells divide in organisms.

Cell Division and Reproduction

8.1 Explain why cell division is essential for prokaryotic and eukaryotic life.
8.1 Compare the parent-offspring relationship in asexual and sexual reproduction.
8.2 Explain how prokaryotes reproduce by binary fission.

The Eukaryotic Cell Cycle and Mitosis

8.3 Compare the structure of prokaryotic and eukaryotic chromosomes.
8.3 Describe the formation, structure, and fate of sister chromatids.
8.4 Describe the stages of the cell cycle. Identify when DNA is replicated, chromosomes are sorted, and two new cells are formed.
8.5 List the phases of mitosis and describe the events characteristic of each phase. Recognize the phases of mitosis from diagrams and micrographs.
8.6 Compare cytokinesis in animal and plant cells.
8.9 Explain how cancerous cells are different from healthy cells. Distinguish between benign and malignant tumors.

Meiosis and Crossing Over

8.11 Describe the number and organization of human chromosomes in a typical somatic cell. Distinguish between autosomes and sex chromosomes.
8.12 Distinguish between somatic cells and gametes and between diploid cells and haploid cells.
8.13 Explain why sexual reproduction requires meiosis.
8.13 List the phases of meiosis I and meiosis II and describe the events characteristic of each phase. Recognize the phases of meiosis from diagrams and micrographs.
8.14 Describe the similarities and differences between mitosis and meiosis. Explain how the result of meiosis differs from the result of mitosis.
8.15–8.17 Explain how independent orientation of chromosomes at metaphase I, random fertilization, and crossing over contribute to genetic variation in sexually reproducing organisms.

Alterations of Chromosome Number and Structure

8.18 Define nondisjunction, explain how it can occur, and describe what can result.
8.19 Explain how and why karyotyping is performed.
8.20 Describe the causes and symptoms of Down syndrome.
8.21 Describe the consequences of abnormal numbers of sex chromosomes.
8.22 Explain how new species form from errors in cell division.
8.23 Describe the main types of chromosomal changes. Explain why cancer is not usually inherited.
CHAPTER 9: Patterns of Inheritance

Mendel’s Laws

9.2 Explain why Mendel’s decision to work with peas was a good choice. Define and distinguish between true-breeding organisms, hybrids, the P generation, the F1 generation, and the F2 generation.

9.3 Define and distinguish between the following pairs of terms: homozygous and heterozygous; dominant allele and recessive allele; genotype and phenotype. Also, define a monohybrid cross and a Punnett square.

9.3 Explain how Mendel’s law of segregation describes the inheritance of a single characteristic.

9.4 Describe the genetic relationships between homologous chromosomes.

9.5 Explain how Mendel’s law of independent assortment applies to a dihybrid cross. Illustrate this law with examples from Labrador retrievers and Mendel’s work with peas.

9.6 Explain how a testcross is performed to determine the genotype of an organism.

9.7 Explain how and when the rule of multiplication and the rule of addition can be used to determine the probability of an event. Explain why Mendel was wise to use large sample sizes in his studies.

9.8 Explain how family pedigrees can help determine the inheritance of many human traits.

9.9 Explain how recessive and dominant disorders are inherited. Provide examples of each.

9.10 Compare the health risks, advantages, and disadvantages of the following forms of fetal testing: amniocentesis, chorionic villus sampling, and ultrasound imaging. Describe the ethical dilemmas created by advances in biotechnology discussed in this chapter.

Variations on Mendel’s Laws

9.11–9.15 Describe the inheritance patterns of incomplete dominance, multiple alleles, codominance, pleiotropy, and polygenic inheritance. Provide an example of each.

9.13 Explain how the sickle-cell allele can be adaptive.

9.14–9.15 Explain why human skin coloration is not sufficiently explained by polygenic inheritance.

The Chromosomal Basis of Inheritance

9.16 Define the chromosome theory of inheritance. Explain the chromosomal basis of the laws of segregation and independent assortment.

9.17 Explain how linked genes are inherited differently from nonlinked genes.

9.18 Describe T. H. Morgan’s studies of crossing over in fruit flies. Explain how crossing over produces new combinations of alleles.

Sex Chromosomes and Sex-Linked Genes

9.20 Explain how sex is genetically determined in humans and the significance of the SRY gene. Compare the sex determination system in humans to those in fruit flies, grasshoppers, birds, ants, and bees.

9.21–9.22 Describe patterns of sex-linked inheritance, noting examples in fruit flies and humans.

9.22 Explain why sex-linked disorders are expressed more frequently in men than in women.
CHAPTER 10: Molecular Biology of the Gene

The Structure of the Genetic Material

10.1 Describe the experiments of Griffith, Hershey, and Chase, which supported the idea that DNA was life’s genetic material.

10.2–10.3 Compare the structures of DNA and RNA.

10.3 Explain how Chargaff’s rules relate to the structure of DNA.

DNA Replication

10.4 Explain how the structure of DNA facilitates its replication.

10.5 Describe the process of DNA replication.

The Flow of Genetic Information from DNA to RNA to Protein

10.6 Describe the locations, reactants, and products of transcription and translation.

10.7–10.8 Explain how the “languages” of DNA and RNA are used to produce polypeptides.

10.9 Explain how mRNA is produced using DNA in prokaryotic cells.

10.10 Explain how eukaryotic RNA is processed before leaving the nucleus.

10.11 Relate the structure of tRNA to its functions in the process of translation.

10.12 Describe the structure and function of ribosomes. Explain the different ribosomes in eukaryotes and prokaryotes.

10.13 Explain how translation begins.

10.14 Describe the step-by-step process by which amino acids are added to a growing polypeptide chain.

10.15 Diagram the overall process of transcription and translation, noting where each occurs in eukaryotic and prokaryotic cells.

10.16 Describe the major types of mutations, causes of mutations, and potential consequences.

The Genetics of Viruses and Bacteria

10.17 Compare the lytic and lysogenic reproductive cycles of a phage.

10.21 Describe the structure of viroids and prions and explain how they cause disease.

10.22 Define and compare the processes of transformation, transduction, and conjugation.

10.23 Describe the roles of bacterial F factors. Define a plasmid and explain why R plasmids pose serious human health problems.

CHAPTER 11: How Genes Are Controlled

Control of Gene Expression

11.1 Describe and compare the regulatory mechanisms of the lac operon, trp operon, and operons using activators.

11.2 Explain how selective gene expression yields a variety of cell types in multicellular eukaryotes.

11.3 Explain how eukaryotic gene expression is controlled. Compare the eukaryotic gene expression mechanisms to those of prokaryotes.

11.7 Explain how gene expression can be controlled in eukaryotic cells.

11.8 Describe the roles of homeotic genes in development
Key Terms

- ABO blood groups
- alleles
- carriers
- character
- chromosome theory
- of inheritance
- codominant
- complete dominance
- cross
- dihybrid cross
- dominant allele
- F₁ generation
- F₂ generation
- genetics
- genotype
- heredity
- heterozygous
- homozygous
- hybrids
- incomplete dominance
- law of independent assortment
- law of segregation
- linkage map
- linked genes
- locus (plural, loci)
- monohybrid cross
- pedigree
- P generation
- phenotype
- pleiotropy
- polygenic inheritance
- Punnett square
- recessive allele
- recombination frequency
- sex chromosomes
- sex-linked gene
- sickle-cell disease
- testcross
- trait
- true-breeding

- anaphase
- anchorage dependence
- asexual reproduction
- autosomes
- benign tumor
- binary fission
- cancer
- cell cycle
- cell cycle control system
- cell division
- cell plate
- centromere
- centrosome
- chiasma (plural, chiasmata)
- chromatin
- chromosome
- cleavage furrow
- crossing over
- cytokinesis
- deletion
- density-dependent inhibition
- diploid
- Down syndrome
- duplication
- fertilization
- gametes
- genetic recombination
- growth factor
- haploid
- homologous chromosomes
- interphase
- inversion
- karyotype
- life cycle
- locus (plural, loci)
- malignant tumor
- meiosis
- metaphase
- metastasis
- mitosis mitotic phase (M phase)
- mitotic spindle
- nondisjunction
- prometaphase
- prophase
- sex chromosomes
- sexual reproduction
- sister chromatids
- somatic cell
- synapsis
- telophase
- translocation
- trisomy 21
- tumor
- zygote
adenine (A)  
AIDS  
anticodon  
A site  
bacteriophages  
capsid  
codons  
conjugation  
cytoplasmic (C)  
deoxyribonucleic acid  
DNA  
DNA ligase  
DNA polymerases  
double helix  
emerging viruses  
exons  
F factor  
frameshift mutations  
genetic code  
guanine (G)  
HIV  
introns  
lysogenic cycle  
lytic cycle  
messenger RNA (mRNA)  
missense mutation  
molecular biology  
mutagenesis  
multiplicity  
motors  
mRNA  
mRNA splicing  
R plasmids  
semiconservative model  
silent mutation  
start codon  
stop codon  
sugar-phosphate backbone  
terminator  
thymine (T)  
transcription  
transduction  
transfer RNA (tRNA)  
transformation  
translation  
triplet code  
uracil (U)  
virions  
virus  
ribosomes  
RNA polymerase  
RNA splicing  
R plasmids  
semiconservative model  
silent mutation  
start codon  
stop codon  
sugar-phosphate backbone  
terminator  
thymine (T)  
transcription  
transduction  
transfer RNA (tRNA)  
transformation  
translation  
triplet code  
uracil (U)  
virions  
virus  
activator  
adult stem cell  
alternative RNA splicing  
carcinogen  
clone  
differentiation  
enhancers  
epigenetic inheritance  
gene expression  
gene regulation  
homeotic gene  
nucleosome  
oncogene  
operator  
operon  
promoter  
proto-oncogene  
regeneration  
regulatory gene  
repressor  
RNA interference (RNAi)  
signal transduction pathway  
transcription factors  
tumor-suppressor gene