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Chapter 1 Origins **XXX**

1.1 Earth, Cells, and Photosynthesis **XXX**
The earth formed 4.6 billion years ago XXX
Photosynthesis evolved by 3.8 billion years ago XXX
Oxygen-producing photosynthesis was widespread by 2.2 billion years ago XXX
Photosynthetic cyanobacteria produced an oxygen-rich atmosphere XXX
Early life on earth evolved in the absence of a protective atmospheric ozone layer XXX

1.2 Eukaryotic Cells XXX
Photosynthetic eukaryotic cells arose from two endosymbiotic events XXX
Several groups of photosynthetic organisms are derived from the endosymbiotic event that gave rise to plastids XXX
Some organisms acquired plastids by secondary and tertiary endosymbiotic events XXX
Fossil evidence indicates that eukaryotic organisms had evolved by 2.7 billion years ago and multicellular organisms by 1.2 billion years ago XXX
Animals and algae diversified in the Early Cambrian Period XXX
Box 1–1 What DNA Can Reveal about Phylogeny and Evolution XXX

1.3 Land Plants XXX
Green plants are monophyletic XXX
Land plants may be descended from plants related to charophycean algae XXX
Microfossils indicate that the first land plants appeared in the Middle Ordovician Period, about 475 million years ago XXX
Plant diversity increased in the Silurian and Devonian Periods XXX
The number of sporangia distinguishes the first land plants from their evolutionary descendants XXX
Tracheophytes have specialized water-conducting cells called xylem XXX
Some of the earliest vascular plants were related to extant lycophytes XXX
Horsetails, ferns, and seed plants are derived from a leafless group of plants of the Early Devonian Period, 400 million years ago XXX
Ferns and horsetails evolved in the Devonian Period XXX
Cellular and chemical complexity increased early in the evolution of land plants XXX
Atmospheric CO_2 and O_2 levels are determined by rates of photosynthesis and carbon burial XXX
The evolution of land plants was at least partly responsible for the decrease in atmospheric CO_2 beginning 450 million years ago XXX
The Mid-Paleozoic decrease in atmospheric CO_2 was a driving force in the evolution of big leaves XXX

1.4 Seed Plants XXX
Seeds contain the genetic products of fertilization protected by tissue derived from the sporophyte XXX
Seed plants evolved in the Devonian and diversified in the Permian, 290 to 250 million years ago XXX
The diploid phase became dominant in the land-plant life cycle in the Devonian Period, 408 to 350 million years ago XXX
Five groups of seed plants live on earth today XXX

1.5 Angiosperms XXX
Angiosperms appear in the fossil record in the Early Cretaceous Period, about 135 million years ago XXX
Angiosperms evolved in the tropics and then spread to higher latitudes XXX
Amborella trichopoda is sister to all living angiosperms XXX
Eudicots are distinguished from other flowering plants by the number of pollen apertures XXX
The earliest angiosperm flowers were small with many parts XXX
Monocots are a monophyletic group nested among the basal angiosperms XXX
The grass family (Poaceae) evolved about 60 million years ago but diversified more recently XXX

Chapter 2 Genomes XXX

2.1 The Nuclear Genome: Chromosomes XXX

2.2 Chromosomal DNA XXX
Specialized, repetitive DNA sequences are found in the centromeres and telomeres XXX
Nuclear genes are transcribed into several types of RNA XXX
Plant chromosomes contain many mobile genetic elements XXX

2.3 Nuclear Gene Regulation XXX
Regulatory sequences and transcription factors control where and when a gene is transcribed XXX
Gene activity can be regulated by chemical changes in the DNA and proteins of chromatin XXX
Chromatin modification can be inherited through cell division XXX
Gene function is also controlled at the RNA level XXX
Small regulatory RNAs control mRNA function XXX
Small RNAs can direct chromatin modification to specific DNA sequences XXX
Box 2-1 Transcription Factors: Combinatorial Control XXX

2.4 Genome Sequences XXX
The Arabidopsis genome was the first plant genome to be fully sequenced XXX
Genome sequences are analyzed to identify individual genes XXX
Sequencing of the Arabidopsis genome revealed a complexity similar to that of animal genomes and a large proportion of plant-specific genes XXX
Comparisons among plant genomes reveal conserved and divergent features XXX
Most angiosperms have undergone genome duplication during their evolution XXX
Genes can acquire new functions by duplication and divergence XXX
The order of genes is conserved between closely related plant species XXX

2.5 Genomes and Biotechnology XXX
Mutated genes can be localized on the genome by co-segregation with known markers XXX
Genes that are mutated by insertion of DNA can be isolated by detecting the inserted sequence XXX
Genes can be screened for mutations at the DNA level independent of phenotype XXX
RNA interference is an alternative method to knock out gene function XXX
Multigenic inheritance is analyzed by mapping quantitative trait loci (QTL) XXX
Genome sequencing allows the development of methods to monitor the activity of many genes simultaneously XXX

2.6 Cytoplasmic Genomes XXX
Plastids and mitochondria evolved from bacteria engulfed by other cells XXX
Organellar genes do not follow Mendel's laws of inheritance XXX
The genomes of plastids and mitochondria have been reduced during evolution XXX
Most polypeptides in organelles are encoded by the nuclear genome and targeted to the organelles XXX
Replication and recombination of plastid DNA is not tightly coupled to cell division XXX
Gene expression has common features in plastids and eubacteria XXX
Plastids contain two distinct RNA polymerases XXX
Post-transcriptional processes are important in regulating plastid gene expression XXX
Organellar transcripts undergo RNA editing XXX
Post-translational processes contribute to maintaining the correct ratio of nuclear- and plastid-encoded components of multisubunit complexes XXX
Developmental regulation of plastid gene expression includes signaling pathways between plastids and the nucleus XXX

Chapter 3 Cells XXX

3.1 The Cell Cycle XXX
Transition from one phase of the cell cycle to the next is regulated by a complex set of mechanisms XXX
The cell cycle in plants is controlled by developmental and environmental inputs XXX
Many differentiating cells undergo endoreduplication: DNA replication without nuclear and cell division XXX
Box 3–1 The Nucleus XXX

3.2 Cell Division XXX
The cytoskeleton moves cellular components during cell division XXX
A preprophase band forms at the site of the future cell wall XXX
Replicated pairs of chromosomes are separated on a spindle of microtubules XXX
Microtubules direct the formation of the phragmoplast, which orchestrates deposition of the new cell wall XXX
Vesicles carry material from the Golgi apparatus to the newly forming cell wall XXX
Meiosis is a specialized type of cell division that gives rise to haploid cells and genetic variation XXX
Box 3–2 The Cytoskeleton XXX

3.3 **Organelles** XXX
Plastids and mitochondria replicate independent of cell division XXX
Plastid and mitochondrial biogenesis involves post-translational import of many proteins XXX
The endomembrane system delivers proteins to the cell surface and to vacuoles XXX
Organelles move around the cell on actin filaments XXX

3.4 **Primary Cell Wall** XXX
The matrix of the cell wall consists of pectins and hemicelluloses XXX
Cellulose is synthesized at the cell surface after the cell plate has formed XXX
Carbohydrate components of the cell wall interact to form a strong and flexible structure XXX
Glycoproteins and enzymes have important functions in the cell wall XXX
Plasmodesmata form channels between cells XXX

3.5 **Cell Expansion and Cell Shape** XXX
The properties of the plasma membrane determine the composition of the cell and mediate its interactions with the environment XXX
Proton transport across the plasma membrane generates electrical and proton gradients that drive other transport processes XXX
Movement of water across the plasma membrane is facilitated by aquaporins XXX
Movement of solutes into the cell vacuole increases turgor and drives cell expansion XXX
The vacuole acts as a storage and sequestration compartment XXX
Coordinated ion transport and water movement drive stomatal opening XXX
The direction of cell expansion is determined by microtubules in the cell cortex XXX
Actin filaments direct new material to the cell surface during cell expansion XXX
In root hair cells and pollen tubes, cell expansion is localized to the cell tips XXX

3.6 **Secondary Cell Wall and Cuticle** XXX
The structure and components of the secondary cell wall vary from one cell type to another XXX
Lignin is a major component of many secondary cell walls XXX
Lignification is a defining characteristic of xylem vessels and tracheids XXX
Wood is formed by secondary growth of vascular tissues XXX
The cuticle forms a hydrophobic barrier on the aerial parts of the plant XXX

Chapter 4 Metabolism XXX

4.1 **Control of Metabolic Pathways** XXX
Compartmentation increases the potential for metabolic diversity XXX
Metabolic processes are coordinated and controlled by regulation of enzyme activities XXX

4.2 **Carbon Assimilation: Photosynthesis** XXX
Net carbon assimilation occurs in the Calvin cycle XXX
Energy for carbon assimilation is generated by light-harvesting processes in the chloroplast thylakoids XXX
Light energy is captured by chlorophyll molecules and transferred to reaction centers XXX
Electron transfer between two reaction centers via an electron transport chain reduces NADP$^+$ and generates a proton gradient across the thylakoid membrane XXX
The proton gradient drives the synthesis of ATP by an ATP synthase complex XXX
Light-harvesting processes are regulated to maximize the dissipation of excess excitation energy XXX
Carbon assimilation and energy supply are coordinated by complex regulation of Calvin cycle enzymes XXX
Sucrose synthesis is tightly controlled by the rate of photosynthesis and the demand for carbon by nonphotosynthetic parts of the plant XXX
Synthesis of starch allows the photosynthetic rate to remain high when sucrose synthesis is restricted XXX
Box 4–1 Light XXX

4.3 **Photorespiration** XXX
Rubisco can use oxygen instead of carbon dioxide as substrate XXX
Photorespiratory metabolism has implications for both the carbon and the nitrogen economy of the leaf XXX
C4 plants eliminate photorespiration by a mechanism that concentrates carbon dioxide XXX

4.4 **Sucrose Transport** XXX
Sucrose moves to nonphotosynthetic parts of the plant via the phloem XXX
Phloem loading may be apoplastic or symplastic XXX
The path of sucrose unloading from the phloem depends on the type of plant organ XXX
The supply of assimilate from the leaf is coordinated with demand elsewhere in the plant XXX

4.5 **Nonphotosynthetic Generation of Energy and Precursors** XXX
Interconversion of sucrose and hexose phosphates allows sensitive regulation of sucrose metabolism XXX

Glycolysis and the oxidative pentose phosphate pathway generate reducing power, ATP, and precursors for biosynthetic pathways XXX
The Krebs cycle and mitochondrial electron transport chains provide the main source of ATP in nonphotosynthesizing cells XXX
Partitioning of sucrose among “metabolic backbone” pathways is extremely flexible and is related to cell function XXX

4.6 Carbon Storage XXX
Sucrose is stored in the vacuole XXX
The starch granule is a semi-crystalline structure synthesized by small families of starch synthases and starch-branching enzymes XXX
The pathway of starch degradation depends on the type of plant organ XXX
Some plants store soluble fructose polymers rather than starch XXX
Storage lipids are synthesized from fatty acids in the endoplasmic reticulum XXX
The fatty acid composition of storage lipids varies among species XXX
Triacylglycerols are converted to sugars by β oxidation and gluconeogenesis XXX
Sugars may act as signals that determine the extent of carbon storage XXX

4.7 Plastid Metabolism XXX
Plastids exchange specific metabolites with the cytosol via metabolite transporters XXX
Fatty acids are synthesized by an enzyme complex in plastids XXX
Membrane lipid synthesis in plastids proceeds via a “prokaryotic” pathway different from the “eukaryotic” pathway elsewhere in the cell XXX
Different pathways of terpenoid synthesis in the plastid and the cytosol give rise to different products XXX
Tetrapyrroles, the precursors of chlorophyll and heme, are synthesized in plastids XXX

4.8 Nitrogen Assimilation XXX
Plants contain several types of nitrate transporter, regulated in response to different signals XXX
Nitrate reductase activity is regulated at many different levels XXX
Assimilation of nitrogen into amino acids is coupled to demand, nitrate availability, and availability of biosynthetic precursors XXX
Amino acid biosynthesis is partly controlled by feedback regulation XXX
Nitrogen is stored as amino acids and specific storage proteins XXX

4.9 Phosphorus, Sulfur, and Iron Assimilation XXX
The availability of phosphorus is a major limitation on plant growth XXX
Sulfur is taken up as sulfate, then reduced to sulfide and assimilated into cysteine XXX
Iron uptake requires specialized mechanisms to increase iron solubility in the soil XXX

4.10 Movement of Water and Minerals XXX
Water moves from the soil to the leaves, where it is lost in transpiration XXX
Water moves from roots to leaves by a hydraulic mechanism XXX
The movement of mineral nutrients in the plant involves both xylem and phloem XXX

Chapter 5 Development XXX
5.1 Overview of Plant Development XXX
Multicellularity evolved independently in plants and animals XXX
Volvox is a simple system in which to study the genetic basis of multicellularity XXX

5.2 Embryo and Seed Development XXX
External cues establish the apical-basal axis in the *Fucus* embryo XXX
The cell wall directs the fate of cells in the *Fucus* embryo XXX
Embryo development in angiosperms occurs in seeds XXX
The fate of embryonic cells is defined by their position XXX
Progressive polarization of auxin transporters mediates formation of the basal pole in embryos XXX
Radial cell pattern in the embryonic root and hypocotyl is defined by the SCARECROW and SHORT ROOT transcription factors XXX
Clues from apical-basal and radial patterning of the embryo are combined to position the root meristem XXX
The shoot meristem is established gradually and independent of the root meristem XXX
The endosperm and embryo develop in parallel XXX
Division of the cells that give rise to endosperm is repressed until fertilization XXX
After embryo and endosperm development, seeds usually become dormant XXX
Box 5–1 Clonal Analysis XXX

5.3 Root Development XXX
Plant roots evolved independently at least twice XXX

Roots have several zones containing cells at successive stages of differentiation XXX

The Arabidopsis root has simple cellular organization XXX

Cell fate depends on the cell's position in the root XXX

Genetic analysis confirms the position-dependent specification of cell type XXX

Lateral root development requires auxin XXX

Box 5–2 Stem Cells in Plants and Animals XXX

5.4 Shoot Development XXX

Cells in the shoot apical meristem are organized in radial zones and in concentric layers XXX

The number of new meristem cells is constantly balanced by the number that form new organs XXX

Organ primordia emerge from the flanks of the meristem in a repetitive pattern XXX

Changes in gene expression precede primordium emergence XXX

Development of compound leaves is associated with expression of meristem genes during early leaf development XXX

Leaves are shaped by organized cell division followed by a period of cell expansion and differentiation XXX

Different regions of the leaf primordium acquire different fates early in development XXX

Specific genes regulate the differences between the two faces of the leaf XXX

Lateral growth requires the boundary between the dorsal and ventral sides of the leaf XXX

The leaf reaches its final shape and size by regulated cell division and cell expansion XXX

Leaf growth is accompanied by development of an increasingly elaborate vascular system, which is controlled by auxin transport XXX

Cell communication and oriented cell divisions control the placement of specialized cell types in the leaf XXX

Leaf senescence is an active process that retrieves nutrients from leaves at the end of their useful lifespan XXX

Branches originate from lateral meristems whose growth is influenced by the apical meristem XXX

Internodes grow by cell division and cell elongation, controlled by gibberellins XXX

A layer of meristem cells generates vascular tissues and causes secondary thickening of the stem XXX

5.5 From Vegetative to Reproductive Development XXX

Reproductive structures in angiosperms are produced by floral and inflorescence meristems XXX

Development of floral meristems is initiated by a conserved regulatory gene XXX

The expression pattern of LEAFY-like genes determines inflorescence architecture XXX

Flowers vary greatly in appearance, but their basic structure is directed by highly conserved genes XXX

In the ABC model of floral organ identity, each type of organ is determined by a specific combination of homeotic genes XXX

Floral organ identity genes are conserved throughout the angiosperms XXX

Asymmetrical growth of floral organs gives rise to bilaterally symmetrical flowers XXX

Additional regulatory genes control later stages of floral organ development XXX

5.6 From Sporophyte to Gametophyte XXX

The male gametophyte is the pollen grain, with a vegetative cell, gametes, and a tough cell wall XXX

Pollen development is aided by the surrounding sporophyte tissues XXX

The female gametophyte develops in the ovule, which contains gametes for the two fertilization events that form the zygote and the endosperm XXX

Development of the female gametophyte is coordinated with development of the sporophyte tissues of the ovule XXX

A pollen grain germinates on the carpel and forms a tube that transports the sperm nuclei toward the ovule XXX

Growth of the pollen tube is oriented by long-range signals in the carpel tissues and short-range signals produced by the ovule XXX

Plants have mechanisms that allow the growth only of pollen tubes carrying specific genes XXX

Self-incompatibility can be gametophytic or sporophytic, depending on the origin of the pollen protein recognized XXX

Angiosperms have double fertilization XXX

Genes from the male and female gametes are not expressed equally after fertilization XXX

Some plants can form seeds without fertilization XXX

Chapter 6 Environmental Signals **XXX**

6.1 Seed Germination XXX

6.2 Light and Photoreceptors XXX

Plant development proceeds along distinct pathways in light and dark XXX

Distinct photoreceptors detect light of different wavelengths XXX

Phytochromes are converted from an inactive to an active form by exposure to red light XXX

Distinct forms of phytochrome have different functions XXX

Phytochrome plays a role in shade avoidance XXX
Cryptochromes are blue-light receptors with specific and overlapping functions XXX
Phototropins are blue-light receptors involved in phototropism, stomatal opening, and chloroplast migration XXX
Some photoreceptors respond to red and blue light XXX
Biochemical and genetic studies provide information on the components of the phytochrome signal-transduction pathway XXX

6.3 Seedling Development XXX
Ethylene is synthesized from methionine in a pathway controlled by a family of genes XXX
Genetic analysis has identified components of the ethylene signal-transduction pathway XXX
The ethylene response is negatively regulated by binding of ethylene to its receptors XXX
Inactivation of CTR1 allows activation of downstream components of the ethylene signaling chain XXX
Ethylene interacts with other signaling pathways XXX
The light responses of seedlings are repressed in the dark XXX
COP1 and the COP9 signalosome function by destabilizing proteins required for photomorphogenesis XXX
Brassinosteroids are required for repression of photomorphogenesis in the dark and other important functions in plant development XXX

6.4 Flowering XXX
Reproductive development in many plants is controlled by photoperiod XXX
Phytochromes and cryptochromes act as light receptors in the photoperiodic control of flowering XXX
Circadian rhythms control the expression of many plant genes and affect the photoperiodic control of flowering XXX
Circadian rhythms in plants result from input of environmental signals, a central oscillator, and output of rhythmic responses XXX
Substances produced in leaves can promote or inhibit flowering XXX
Similar groups of genes are involved in photoperiodic control of flowering in Arabidopsis and in rice XXX
Vernalization is detected in the apex and controls flowering time in many plants XXX
Genetic variation in the control of flowering may be important in the adaptation of plants to different environments XXX
Vernalization response in Arabidopsis involves modification of histones at the *FLC* gene, which is also regulated by the autonomous flowering pathway XXX
Photoperiodic and vernalization pathways of Arabidopsis converge to regulate the transcription of a small set of floral integrator genes XXX

6.5 Root and Shoot Growth XXX
Plant growth is affected by gravitational stimuli XXX
Statoliths are key to graviperception in stems, hypocotyls, and roots XXX
Columella cells of the root cap are the site of graviperception in the growing root XXX
The endodermal cell layer is the site of graviperception in growing stems and hypocotyls XXX
Mutations in auxin signaling or transport cause defects in root gravitropism XXX
The extent of lateral root elongation varies in response to soil nutrient levels XXX

Chapter 7 Environmental Stress XXX
7.1 Light as Stress XXX
Photosystem II is highly sensitive to too much light XXX
High light induces nonphotochemical quenching, a short-term protective mechanism against photooxidation XXX
Vitamin E–type antioxidants also protect photosystem II under light stress XXX
Photodamage to photosystem II is quickly repaired in light stress–tolerant plants XXX
Some plants, such as winter evergreens, have mechanisms for longer-term protection against light stress XXX
Low light leads to changes in leaf architecture, chloroplast structure and orientation, and life cycle XXX
Ultraviolet irradiation damages DNA and proteins XXX
Resistance to UV light involves the production of specialized plant metabolites, as well as morphological changes XXX

7.2 High Temperature XXX
High temperature induces the production of heat shock proteins XXX
Molecular chaperones ensure the correct folding of proteins under all conditions XXX
Families of heat shock proteins play different roles in the heat stress response in different species XXX
Synthesis of heat shock proteins is controlled at the transcriptional level XXX
Some plants have developmental adaptations to heat stress XXX

7.3 Water Deficit XXX
Water deficit occurs as a result of drought, salinity, and low temperature XXX

Plants use abscisic acid as a signal to induce responses to water deficit XXX
Plants also use ABA-independent signaling pathways to respond to drought XXX
Abscisic acid regulates stomatal opening to control water loss XXX
Drought-induced proteins synthesize and transport osmolytes XXX
Ion channels and aquaporins are regulated in response to water stress XXX
Many plant species adopt metabolic specialization under drought stress XXX
Plants that tolerate extreme desiccation have a modified sugar metabolism XXX
Many plant species adapted to arid conditions have specialized morphology XXX
Rapid life cycling during water availability is common in plants of arid regions XXX

7.4 Salt Stress XXX
Salt stress disrupts homeostasis in water potential and ion distribution XXX
Salt stress is signaled by ABA-dependent and ABA-independent pathways XXX
Adaptations to salt stress principally involve internal sequestration of salts XXX
Physiological adaptations to salt stress include modulation of guard cell function XXX
Morphological adaptations to salt stress include salt-secreting trichomes and bladders XXX
Osmotic stress stimulates reproduction in some halophytes XXX

7.5 Cold XXX
Low temperature is similar to water deficit as an environmental stress XXX
Temperate plants acclimated by prior exposure to low temperatures are resistant to freezing damage XXX
Exposure to low temperatures induces cold-regulated (*COR*) genes XXX
Expression of the transcriptional activator CBF1 induces *COR* gene expression and cold tolerance XXX
Low-temperature signaling involves increases in intracellular calcium XXX
ABA-dependent and ABA-independent pathways signal in response to cold XXX
Plant species of warm climates are chill-sensitive XXX
Vernalization and cold acclimation are closely linked processes in wheat and other cereal crops XXX

7.6 Anaerobic Stress XXX
Water-logging is a cause of hypoxic or anoxic stress for plants XXX
Hypoxia is signaled by a Rop-mediated signaling pathway involving transient induction of ROS XXX
Anoxia induces shifts in primary metabolism XXX
Aerenchyma facilitates long-distance oxygen transport in flood-tolerant plants XXX
Water-logging is associated with other developmental adaptations that increase plant survival XXX
Plants synthesize oxygen-binding proteins under hypoxic conditions XXX

7.7 Oxidative Stress XXX
Reactive oxygen species are produced during normal metabolism, but also accumulate under a range of environmental stress conditions XXX
Ascorbate metabolism is central to the elimination of reactive oxygen species XXX
Hydrogen peroxide signals oxidative stress XXX
Ascorbate metabolism is central to responses to oxidative stress XXX

Chapter 8 Interactions with Other Organisms **XXX**
8.1 Microbial Pathogens XXX
Most pathogens can be classified as biotrophs or necrotrophs XXX
Pathogens enter plants via several different routes XXX
Pathogen infections lead to a broad range of disease symptoms XXX
Many pathogens produce effector molecules that influence their interactions with the host plant XXX
Agrobacterium transfers its DNA (T-DNA) into plant cells to modify plant growth and feed the bacterium, and this transfer system is used in biotechnology XXX
Some pathogen effector molecules are recognized by the plant and trigger defense mechanisms XXX
The products of some bacterial *avr* genes act inside the plant cell XXX
The functions of fungal and oomycete effector molecules are poorly understood XXX

8.2 Pests and Parasites XXX
Parasitic nematodes form intimate associations with host plants XXX
Insects cause extensive losses in crop plants, both directly and by facilitating infection by pathogens XXX
Some plants are plant pathogens XXX

8.3 Viruses and Viroids XXX
Viruses and viroids are a diverse and sophisticated set of parasites XXX
Different types of plant viruses have different structures and replication mechanisms XXX

8.4 Defenses XXX

Basal defense mechanisms are triggered by pathogen-associated molecular patterns (PAMPs) XXX

R proteins and many other plant proteins involved in defense carry leucine-rich repeats XXX

R genes encode families of proteins involved in recognition and signal transduction XXX

Most R proteins do not directly recognize pathogen effector molecules XXX

R gene polymorphism restricts disease in natural populations XXX

R genes have been selected in crop breeding from the earliest times XXX

Insensitivity to toxins is important in plant defense against necrotrophs XXX

Plants synthesize antibiotic compounds that confer resistance to some microbes and herbivores XXX

Disease resistance is often associated with the localized death of plant cells XXX

In systemic resistance, plants are “immunized” by biological challenges that lead to cell death XXX

Wounding and insect feeding induce complex plant defense mechanisms XXX

Chewing insects provoke release of volatile compounds that attract other insects XXX

RNA silencing is important in plant resistance to viruses XXX

8.5 Cooperation XXX

Many plant species are pollinated by animals XXX

Symbiotic nitrogen fixation involves specialized interactions of plants and bacteria XXX

Mycorrhizal fungi form intimate symbioses with plant roots XXX

Chapter 9 Domestication and Agriculture **XXX**

9.1 Domestication XXX

The domestication of crop species involved selection by humans XXX

The difference between maize and its wild ancestor, teosinte, can be explained by allelic variation at five different loci XXX

Alterations in the expression of the gene *teosinte branched* played an important role in the domestication of maize XXX

The *teosinte glume architecture* gene regulates glume size and hardness XXX

Cultivated wheat is polyploid XXX

Cauliflower arose through mutation of a meristem-identity gene XXX

Increase in fruit size occurred early in the domestication of tomato XXX

9.2 Scientific Plant Breeding XXX

Scientific approaches to crop-plant improvement have resulted in substantial changes in the genetic structure of many crops XXX

Triticale is a synthetic domesticated crop species XXX

Disease resistance is an important determinant of yield and can be addressed both by plant breeding and by crop management XXX

Mutations in genes affecting fruit color, fruit ripening, and fruit drop have been used in tomato breeding programs XXX

In the “Green Revolution,” the use of dwarfing mutations of wheat and rice resulted in major increases in crop yield XXX

Heterosis also results in major increases in crop yields XXX

Cytoplasmic male sterility facilitates the production of F1 hybrids XXX

9.3 Biotechnology XXX

Agrobacterium-mediated gene transfer is a widely used method for generating transgenic plants XXX

Particle bombardment–mediated gene transfer is an alternative means of generating transgenic plants XXX

Herbicide resistance in transgenic crops facilitates weed control XXX

Transgenic expression of *Bacillus thuringiensis* (Bt) crystal protein in crop plants confers insect resistance and increased yield XXX

Many different crop-plant traits can potentially be improved by transgenesis XXX

“The future is green”: The relationship between plants and people will continue to develop XXX

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