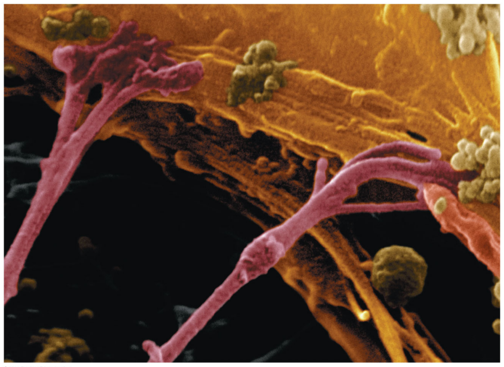


CHAPTER 6: A TOUR OF THE CELL

AP BIOLOGY 2011

1

IMPORTANCE OF CELLS

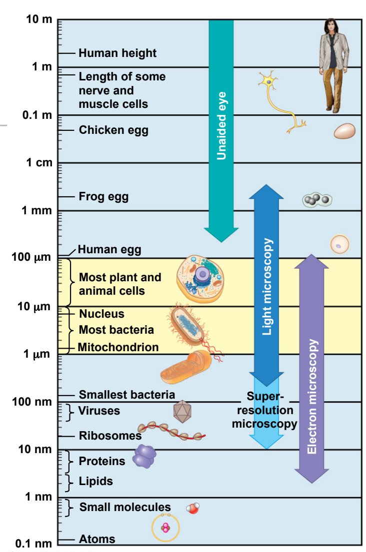
- ALL ORGANISMS ARE MADE OF CELLS
- CELLS ARE THE SMALLEST LIVING UNIT
- STRUCTURE IS CORRELATED TO FUNCTION
- ALL CELLS ARE RELATED BY THEIR DESCENT FROM EARLIER CELLS

2

MICROSCOPY

- LIGHT MICROSCOPE
  - PASS VISIBLE LIGHT THROUGH A SPECIMEN
  - MAGNIFY CELL STRUCTURES WITH LENSES

FIG. 6.2



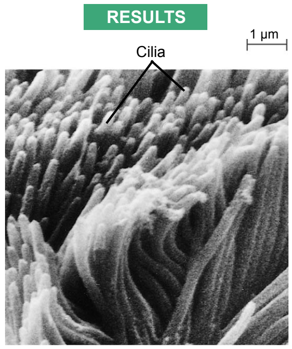
3

ELECTRON MICROSCOPE

- FOCUS A BEAM OF ELECTRONS THOUGH A SPECIMEN (TEM) OR ONTO ITS SURFACE (SEM)

TECHNIQUE | **RESULTS**

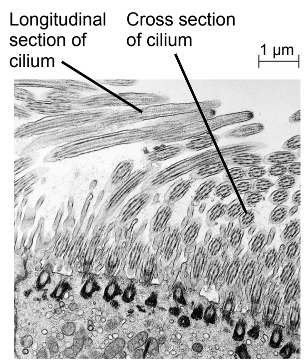
(a) Scanning electron microscopy (SEM). Micrographs taken with a scanning electron microscope show a 3D image of the surface of a specimen. This SEM shows the surface of a cell from a rabbit trachea (windpipe) covered with motile organelles called cilia. Beating of the cilia helps move inhaled debris upward toward the throat.



4

ELECTRON MICROSCOPE

(b) Transmission electron microscopy (TEM). A transmission electron microscope profiles a thin section of a specimen. Here we see a section through a tracheal cell, revealing its ultrastructure. In preparing the TEM, some cilia were cut along their lengths, creating longitudinal sections, while other cilia were cut straight across, creating cross sections.



5

CELL FRACTIONATION

- TAKES CELLS APART AND SEPARATES THE MAJOR ORGANELLES FROM ONE ANOTHER
- CENTRIFUGES USED TO FRACTIONATE CELLS INTO THEIR COMPONENTS PARTS
- ENABLES SCIENTISTS TO DETERMINE THE FUNCTIONS OF ORGANELLES (BIOCHEMISTRY AND CYTOLOGY HELP CORRELATE CELL FUNCTION WITH STRUCTURE)

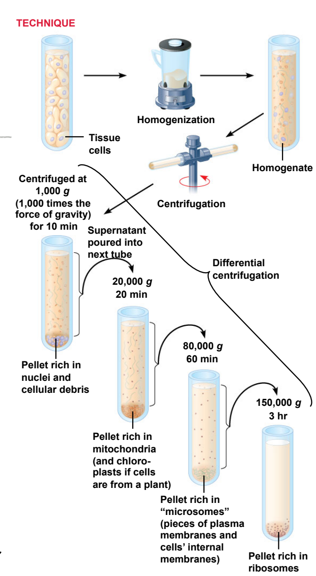


FIG. 6.4

6

CELL TYPES

- PROKARYOTIC (DOMAINS BACTERIA AND ARCHAEA)
- EUKARYOTIC (DOMAIN EUKARYA)
- BOTH ARE:
  - BOUNDED BY A PLASMA MEMBRANE
  - CONTAIN CYTOSOL
  - CONTAIN CHROMOSOMES
  - HAVE RIBOSOMES

7

PROKARYOTIC CELLS

- DO NOT CONTAIN A NUCLEUS
- HAVE DNA LOCATED IN A REGION CALLED A NUCLEOID
- NO MEMBRANE-BOUND ORGANELLES

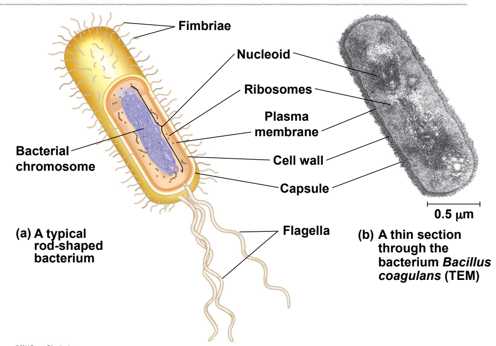
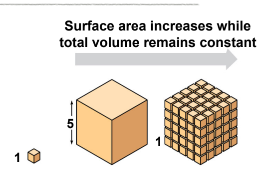


FIG. 6.5

8

EUKARYOTIC CELLS

- CONTAIN A TRUE NUCLEUS BOUNDED BY A MEMBRANOUS NUCLEAR ENVELOPE
- MEMBRANE-BOUND ORGANELLES
- GENERALLY BIGGER THAN PROKARYOTIC CELLS
  - CELL METABOLISM LIMITS CELL SIZE



Total surface area [sum of the surface areas (height × width) of all box sides × number of boxes]	6	150	750
Total volume [height × width × length × number of boxes]	1	125	125
Surface-to-volume (S-to-V) ratio [surface area ÷ volume]	6	1.2	6

FIG. 6.7

9

PLASMA MEMBRANE

- FUNCTIONS AS A SELECTIVE BARRIER THAT ALLOWS SUFFICIENT PASSAGE OF OXYGEN, NUTRIENTS, AND WASTE
- STRUCTURED AS A DOUBLE LAYER OF PHOSPHOLIPIDS

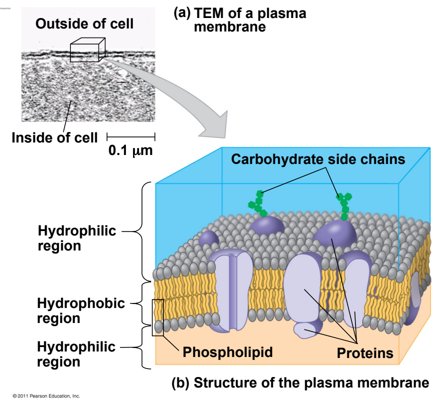
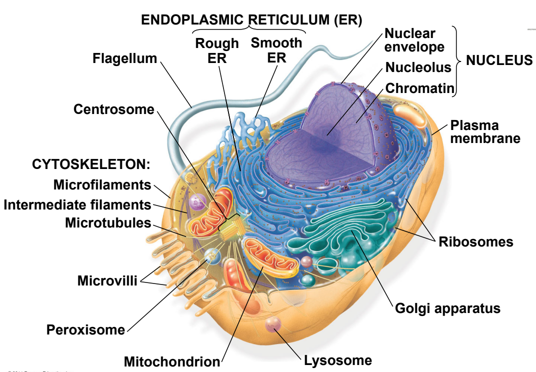


FIG. 6.6

10

ANIMAL CELL



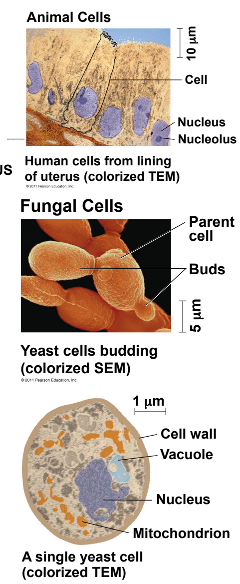
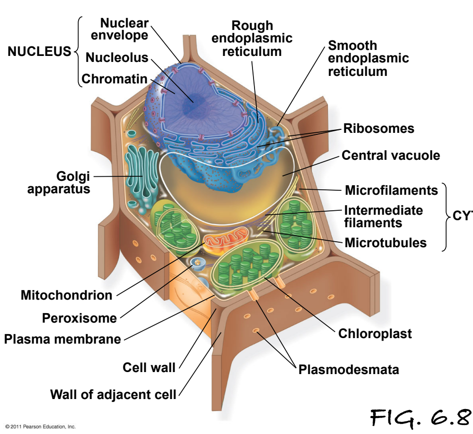
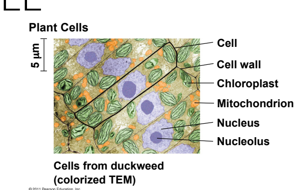


FIG. 6.8

11

PLANT CELL





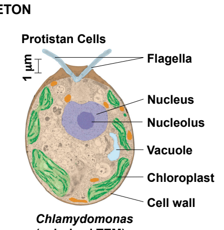


FIG. 6.8

12

NUCLEUS

- ☐ CELL'S GENETIC INSTRUCTIONS ARE HOUSED IN THE NUCLEUS
- ☐ NUCLEAR ENVELOPE - ENCLOSES THE NUCLEUS, SEPARATES ITS CONTENTS FROM THE CYTOPLASM

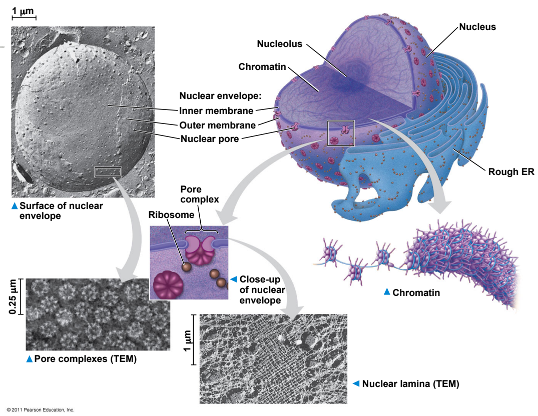


FIG. 6.9

13

RIBOSOMES

- ☐ MADE UP OF RIBOSOMAL RNA AND PROTEIN
- ☐ CARRY OUT PROTEIN SYNTHESIS IN TWO LOCATIONS (CYTOSOL = FREE RIBOSOMES; ER = BOUND RIBOSOMES)
- ☐ PROKARYOTES = 70S RIBOSOMES
- ☐ EUKARYOTES = 80S RIBOSOMES

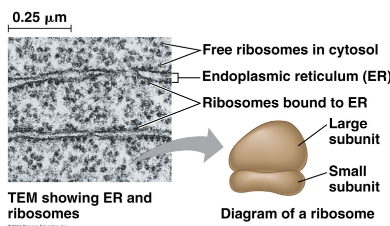


FIG. 6.10

14

ENDOMEMBRANE SYSTEM

- ☐ REGULATES PROTEIN TRAFFIC AND PERFORMS METABOLIC FUNCTIONS IN THE CELL
  - ☐ COMPONENTS:
    - ☐ NUCLEAR ENVELOPE
    - ☐ ENDOPLASMIC RETICULUM
    - ☐ GOLGI APPARATUS
    - ☐ LYSOSOMES
    - ☐ VACUOLES
    - ☐ PLASMA MEMBRANE

15

ENDOPLASMIC RETICULUM

- ENDOPLASMIC RETICULUM
  - ACCOUNTS FOR MORE THAN HALF OF THE TOTAL MEMBRANE IN EUKARYOTIC CELLS
  - CONTINUOUS WITH THE NUCLEAR ENVELOPE
  - SMOOTH ER - LACKS RIBOSOMES
  - ROUGH ER - CONTAINS RIBOSOMES

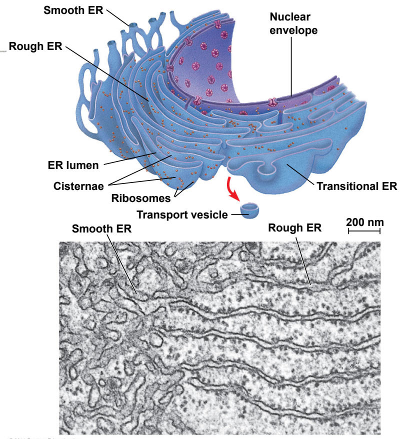


FIG. 6.11

SMOOTH ER VS. ROUGH ER

- SMOOTH ER
  - SYNTHESIZES LIPIDS
  - METABOLIZES CARBOHYDRATES
  - STORES CALCIUM
  - DETOXIFIES POISON
- ROUGH ER
  - HAS BOUND RIBOSOMES WHICH SECRETE GLYCOPROTEINS
  - PRODUCES PROTEINS AND MEMBRANES WHICH ARE DISTRIBUTED BY TRANSPORT VESICLES

GOLGI APPARATUS

- RECEIVES MANY OF THE TRANSPORT VESICLES PRODUCED IN THE ROUGH ER
- CONSISTS OF FLATTENED MEMBRANOUS SACS CALLED CISTERNAE
- MODIFIES THE PRODUCTS OF THE ROUGH ER
- MANUFACTURES CERTAIN MACROMOLECULES
- SORTS AND PACKAGES MATERIALS INTO TRANSPORT VESICLES

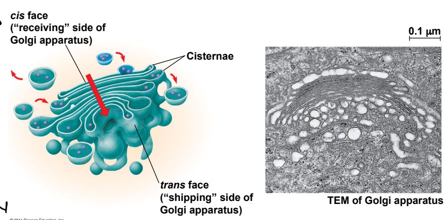
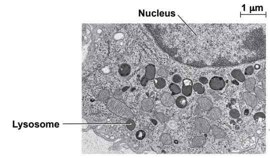
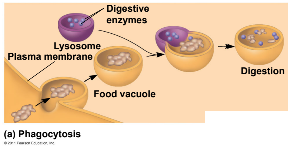


FIG. 6.12

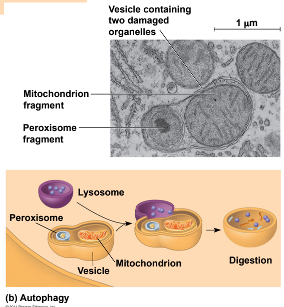
LYSOSOME



- MEMBRANOUS SAC OF HYDROLYTIC ENZYMES
- CAN DIGEST ALL KINDS OF MACROMOLECULES
- CARRY OUT INTRACELLULAR DIGESTION THROUGH PHAGOCYTOSIS



(a) Phagocytosis



(b) Autophagy

FIG. 6.13

VACUOLES

- PLANT OR FUNGAL CELLS MAY HAVE ONE OR SEVERAL VACUOLES
- FOOD VACUOLES - FORMED BY PHAGOCYTOSIS
- CONTRACTILE VACUOLES - PUMP EXCESS WATER OUT OF PROTIST CELLS
- CENTRAL VACUOLES - FOUND IN PLANT CELLS AND HOLD RESERVES OF IMPORTANT ORGANIC COMPOUNDS AND WATER

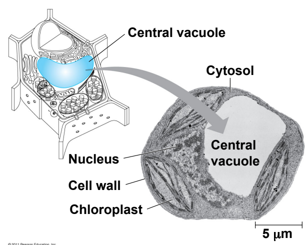


FIG. 6.14

ENDOMEMBRANE SYSTEM REVIEW

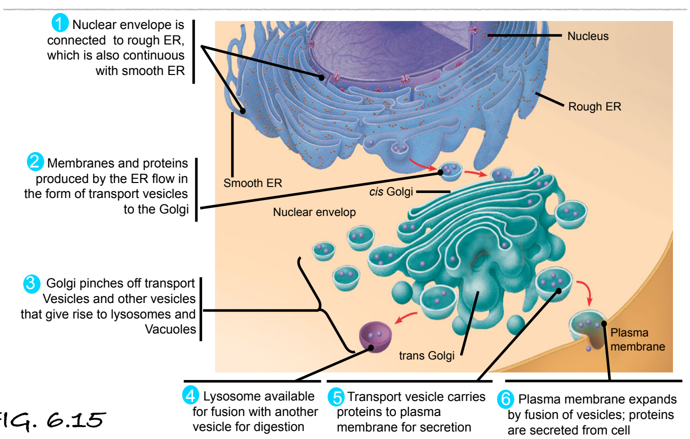


FIG. 6.15

MITOCHONDRIA AND CHLOROPLASTS

- CHANGE ENERGY FROM ONE FORM TO ANOTHER
- MITOCHONDRIA - SITES OF CELLULAR RESPIRATION
  - FOUND IN NEARLY ALL EUKARYOTIC CELLS
- CHLOROPLASTS - THE SITE OF PHOTOSYNTHESIS
  - FOUND ONLY IN PLANT CELLS

EVOLUTION OF MITOCHONDRIA AND CHLOROPLASTS

- HAVE SIMILARITIES WITH BACTERIA
  - HAVE A DOUBLE MEMBRANE
  - CONTAIN FREE RIBOSOMES AND CIRCULAR DNA
  - GROW AND REPRODUCE INDEPENDENTLY IN CELLS
- ENDOSYMBIONT THEORY
  - EARLY ANCESTOR OF EUKARYOTIC CELLS ENGULFED PROKARYOTIC CELL
  - HOST AND ENDOSYMBIONT MERGED INTO A SINGLE ORGANISM

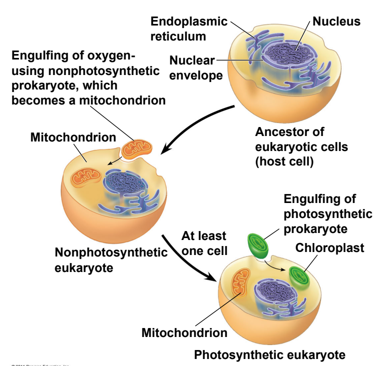
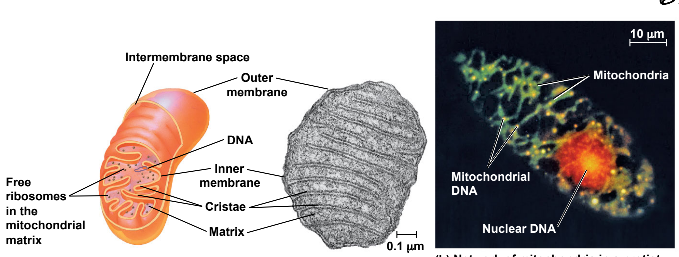


FIG. 6.16

MITOCHONDRIA

- ENCLOSED BY TWO MEMBRANES
- SMOOTH OUTER MEMBRANE
- INNER MEMBRANE FOLDED INTO CRISTAE

FIG. 6.17

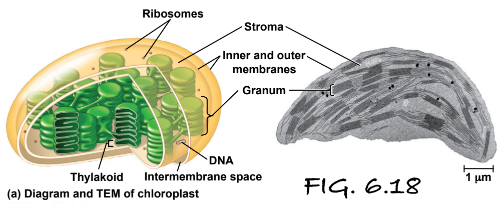


(a) Diagram and TEM of mitochondrion

(b) Network of mitochondria in a protist cell (LM)

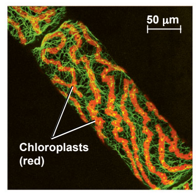
CHLOROPLAST

- ☐ CAPTURE LIGHT AND ENERGY
- ☐ SPECIALIZED MEMBER OF A FAMILY OF CLOSELY RELATED PLANT ORGANELLES CALLED PLASTIDS
- ☐ CONTAINS CHLOROPHYLL
- ☐ FOUND IN LEAVES AND OTHER GREEN ORGANS OF PLANTS AND IN ALGAE
- ☐ STRUCTURE INCLUDES THYLAKOIDS (MEMBRANOUS SACS) AND STROMA (INTERNAL FLUID)



(a) Diagram and TEM of chloroplast

FIG. 6.18



(b) Chloroplasts in an algal cell

25

PEROXISOMES

- ☐ PRODUCE HYDROGEN PEROXIDE AND CONVERT IT TO WATER

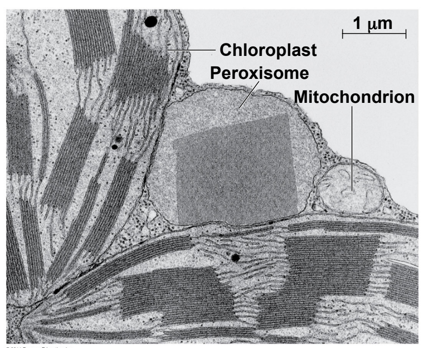
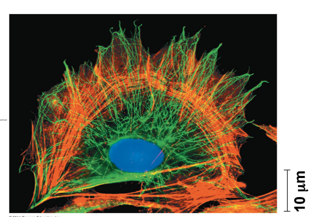


FIG. 6.19

26

CYTOSKELETON

- ☐ NETWORK OF FIBERS THAT ORGANIZES STRUCTURES AND ACTIVITIES OF THE CELL
- ☐ EXTENDS THROUGHOUT THE CYTOPLASM
- ☐ GIVES MECHANICAL SUPPORT TO THE CELL
- ☐ INVOLVED IN CELL MOTILITY (USING MOTOR PROTEINS)



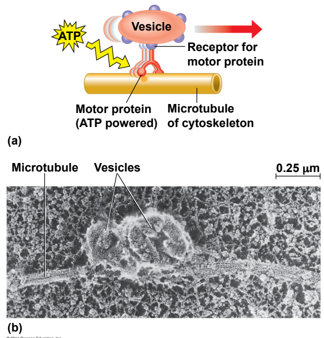


FIG. 6.21

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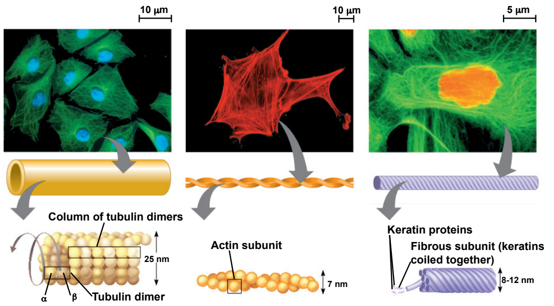
Table 6.1 The Structure and Function of the Cytoskeleton

Property	Microtubules (Tubulin Polymers)	Microfilaments (Actin Filaments)	Intermediate Filaments
Structure	Hollow tubes; wall consists of 13 columns of tubulin molecules	Two intertwined strands of actin, each a polymer of actin subunits	Fibrous proteins supercoiled into thicker cables
Diameter	25 nm with 15-nm lumen	7 nm	8–12 nm
Protein subunits	Tubulin, a dimer consisting of α-tubulin and β-tubulin	Actin	One of several different proteins (such as keratins), depending on cell type
Main functions	Maintenance of cell shape (compression-resisting "girders") Cell motility (as in cilia or flagella) Chromosome movements in cell division Organelle movements	Maintenance of cell shape (tension-bearing elements) Changes in cell shape Muscle contraction Cytoplasmic streaming Cell motility (as in pseudopodia) Cell division (cleavage furrow formation)	Maintenance of cell shape (tension-bearing elements) Anchorage of nucleus and certain other organelles Formation of nuclear lamina



28

MICROTUBULES

- ☐ SHAPE THE CELL
- ☐ GUIDE MOVEMENT OF ORGANELLES
- ☐ HELP SEPARATE THE CHROMOSOME COPIES IN DIVIDING CELLS
- ☐ CAN GROW OUT OF CENTROSOMES

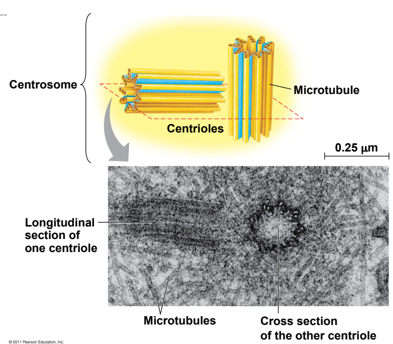


FIG. 6.22

29

CILIA AND FLAGELLA

- ☐ CONTAIN SPECIALIZED ARRANGEMENTS OF MICROTUBULES
- ☐ LOCOMOTOR APPENDAGES OF SOME CELLS
- ☐ SHARE SOME COMMON STRUCTURES

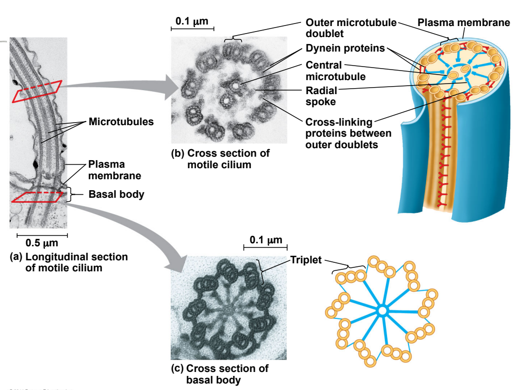
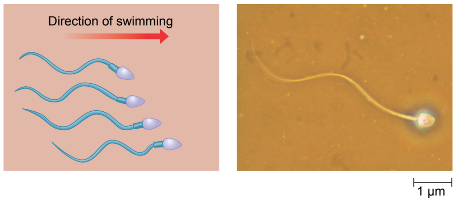


FIG. 6.24

30

CILIA AND FLAGELLA

(a) Motion of flagella. A flagellum usually undulates, its snakelike motion driving a cell in the same direction as the axis of the flagellum. Propulsion of a human sperm cell is an example of flagellatelocomotion (LM).



(b) Motion of cilia. Cilia have a back-and-forth motion that moves the cell in a direction perpendicular to the axis of the cilium. A dense nap of cilia, beating at a rate of about 40 to 60 strokes a second, covers this *Colpidium,* a freshwater protozoan (SEM).

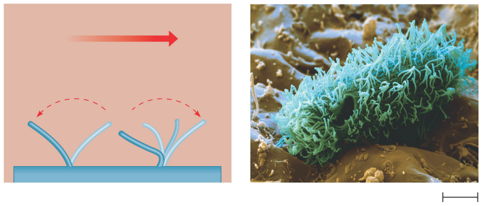


Figure 6.23 B

31

MOVEMENT

- DYNEIN - PROTEIN RESPONSIBLE FOR BENDING MOVEMENT OF CILIA AND FLAGELLA

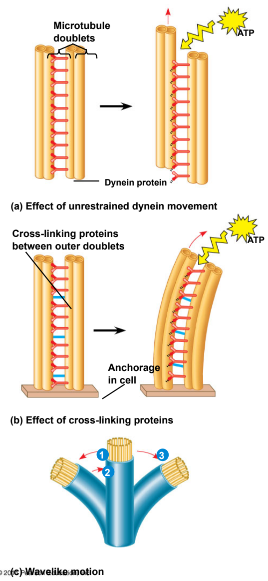


FIG. 6.25

32

MICROFILAMENTS

- BUILT FROM MOLECULES OF THE PROTEIN ACTIN
- FOUND IN MICROVILLI
- WHEN FUNCTIONING IN CELLULAR MOTILITY IT MUST ALSO CONTAIN THE PROTEIN MYOSIN

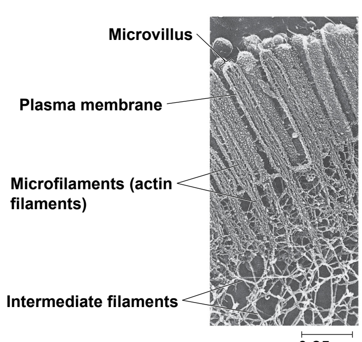


FIG. 6.36

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MOVEMENT

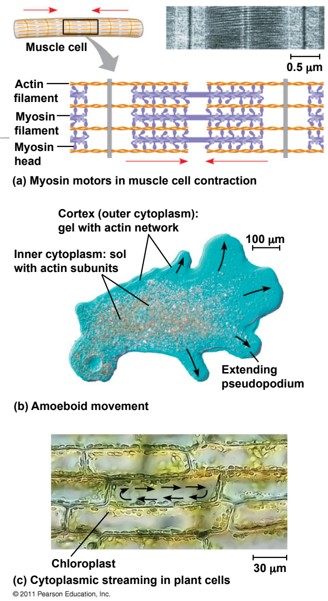

FIG. 6.27

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INTERMEDIATE FILAMENTS

- SUPPORT CELL SHAPE
- FIX ORGANELLES IN PLACE

35

CELL WALL

- EXTRACELLULAR STRUCTURE FOUND IN PLANTS
- MADE OF CELLULOSE FIBERS EMBEDDED IN OTHER POLYSACCHARIDES AND PROTEINS
- HAVE MULTIPLE LAYERS

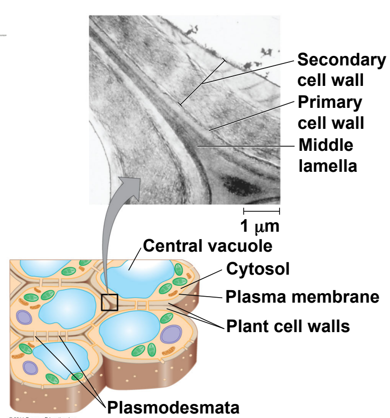

FIG. 6.28

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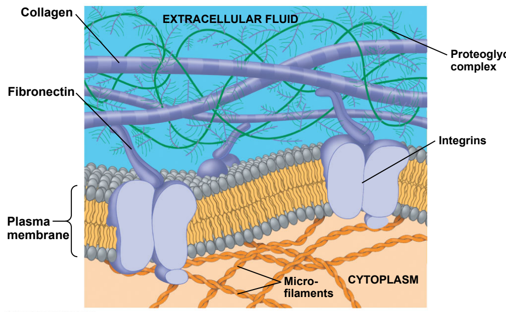
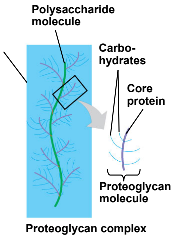
EXTRACELLULAR MATRIX

- ANIMAL CELLS LACK CELL WALLS SO ECM IS MADE UP OF GLYCOPROTEINS AND OTHER MACROMOLECULES
- FUNCTIONS OF THE ECM: SUPPORT, ADHESION, MOVEMENT, AND REGULATION

FIG. 6.30





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CELLULAR JUNCTIONS: PLASMODESMATA

- FOUND IN PLANTS
- CHANNELS THAT PERFORATE PLANT CELL WALLS

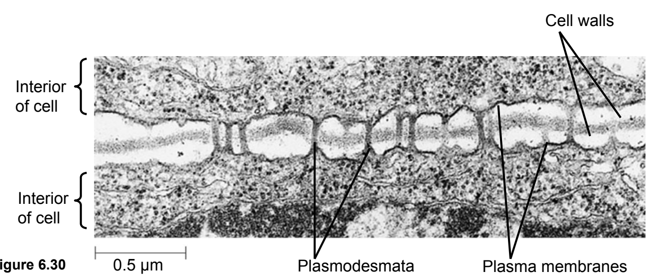

Figure 6.30

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INTERCELLULAR JUNCTIONS IN ANIMAL CELLS

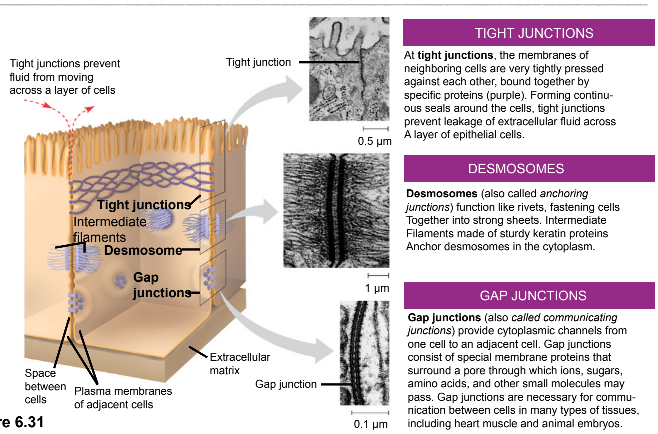

Figure 6.31

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