1. PRINSIP-PRINSIP BIOLOGI DAN ALUR BERPIKIR ILMIAH
2. SEL SEBAGAI UNIT KEHIDUPAN

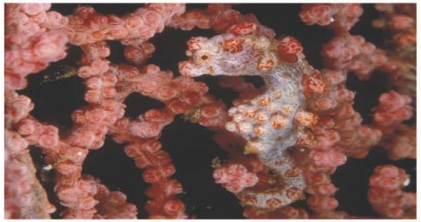
TIM BIOLOGI DASAR - PDB
UNIVERSITAS AIRLANGGA
2023

UNIVERSITAS AIRLANGGA
Excellence with Morality

UPKK

Beberapa sifat kehidupan

(a) Order



(b) Evolutionary adaptation

(c) Response to the environment

(d) Regulation

(e) Energy processing

(g) Reproduction

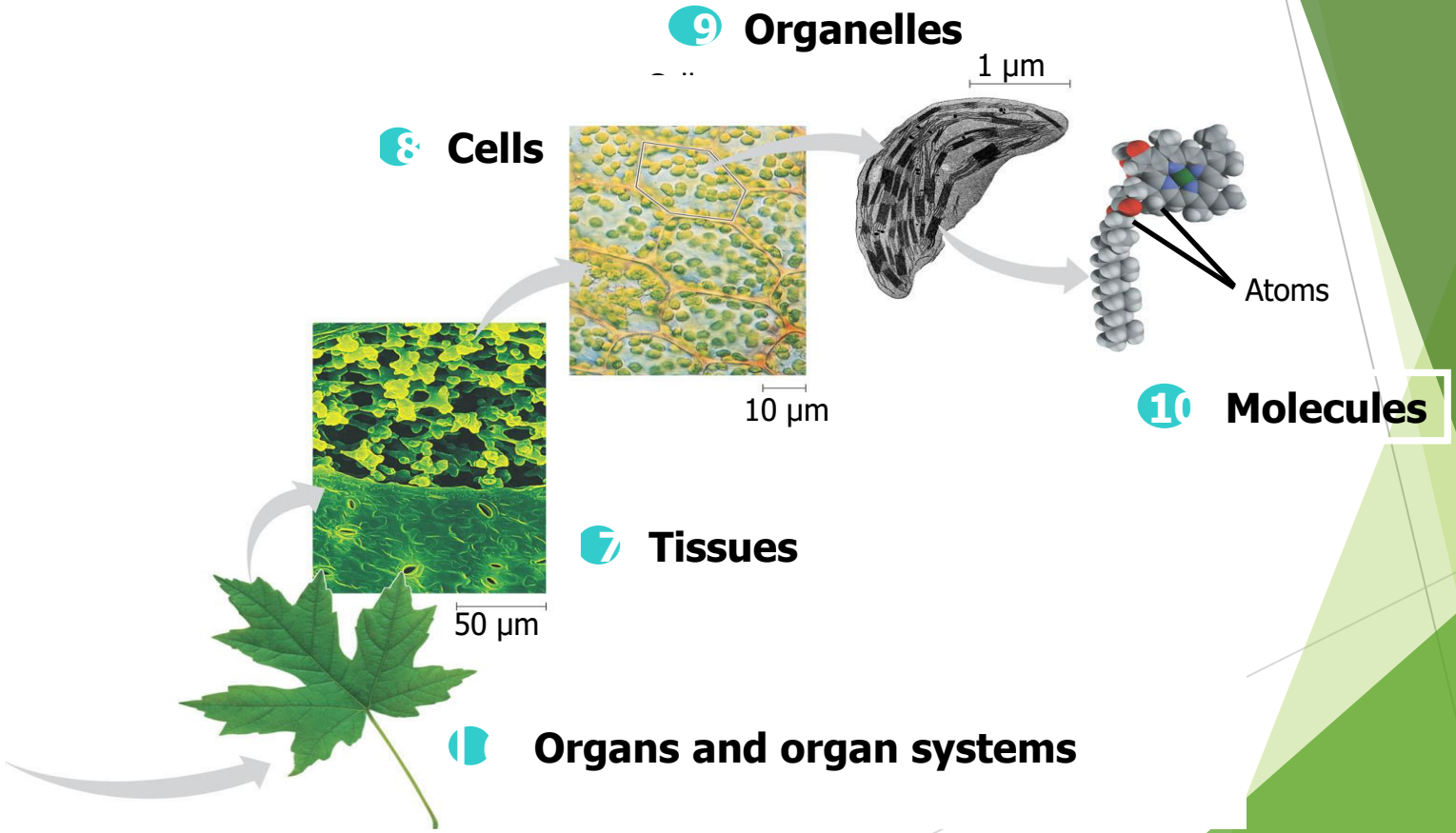
(f) Growth and development

HIRARKI ORGANISASI BIOLOGI

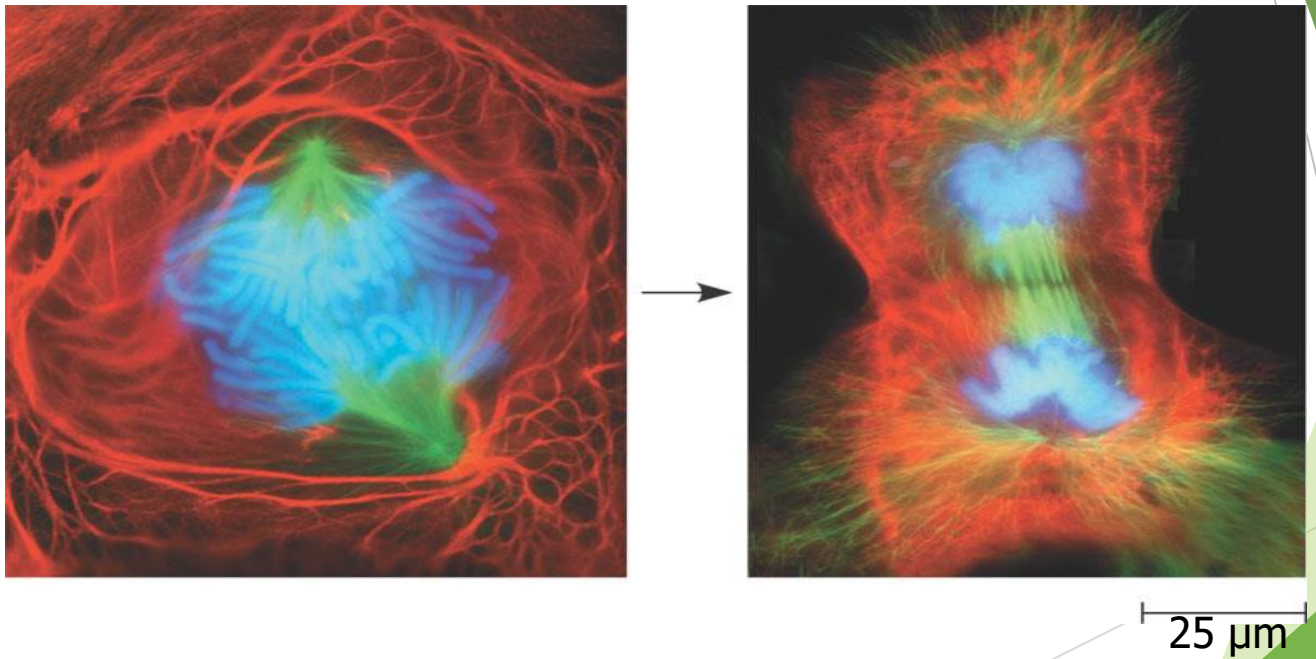
Dari biosfer ke organisme

1 The biosphere

Dari sel ke molekul



Sel adalah tingkat terendah dari organisasi yang dapat melakukan semua kegiatan yang diperlukan untuk hidup

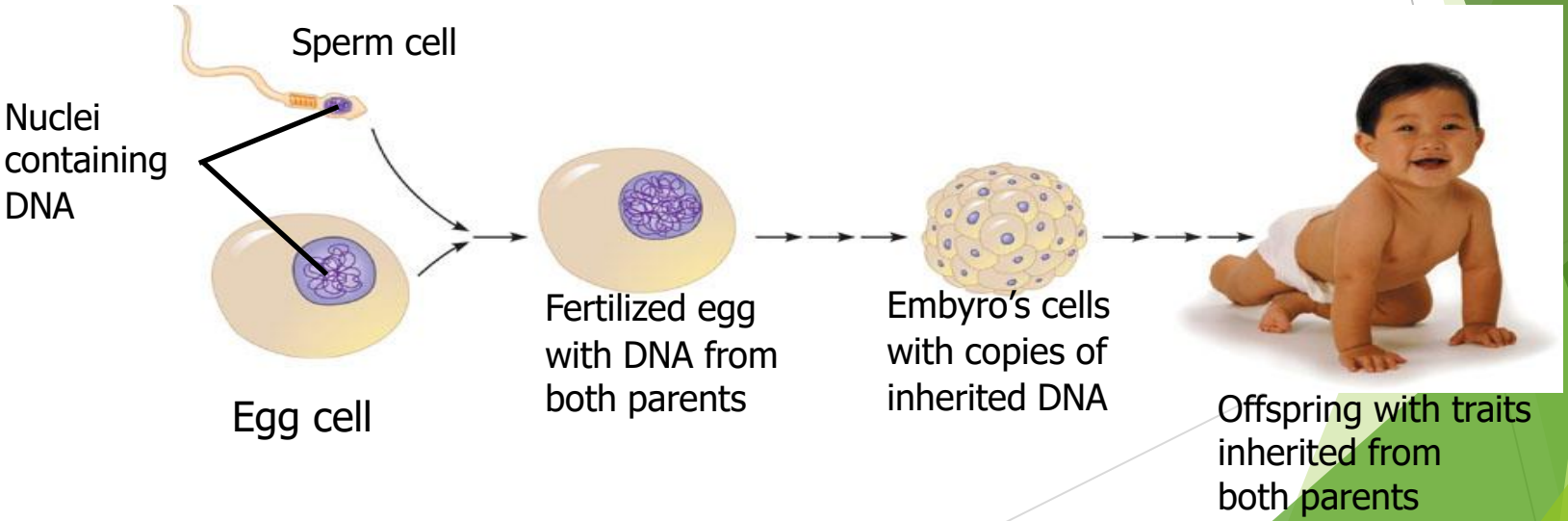


PRINSIP-PRINSIP BIOLOGI

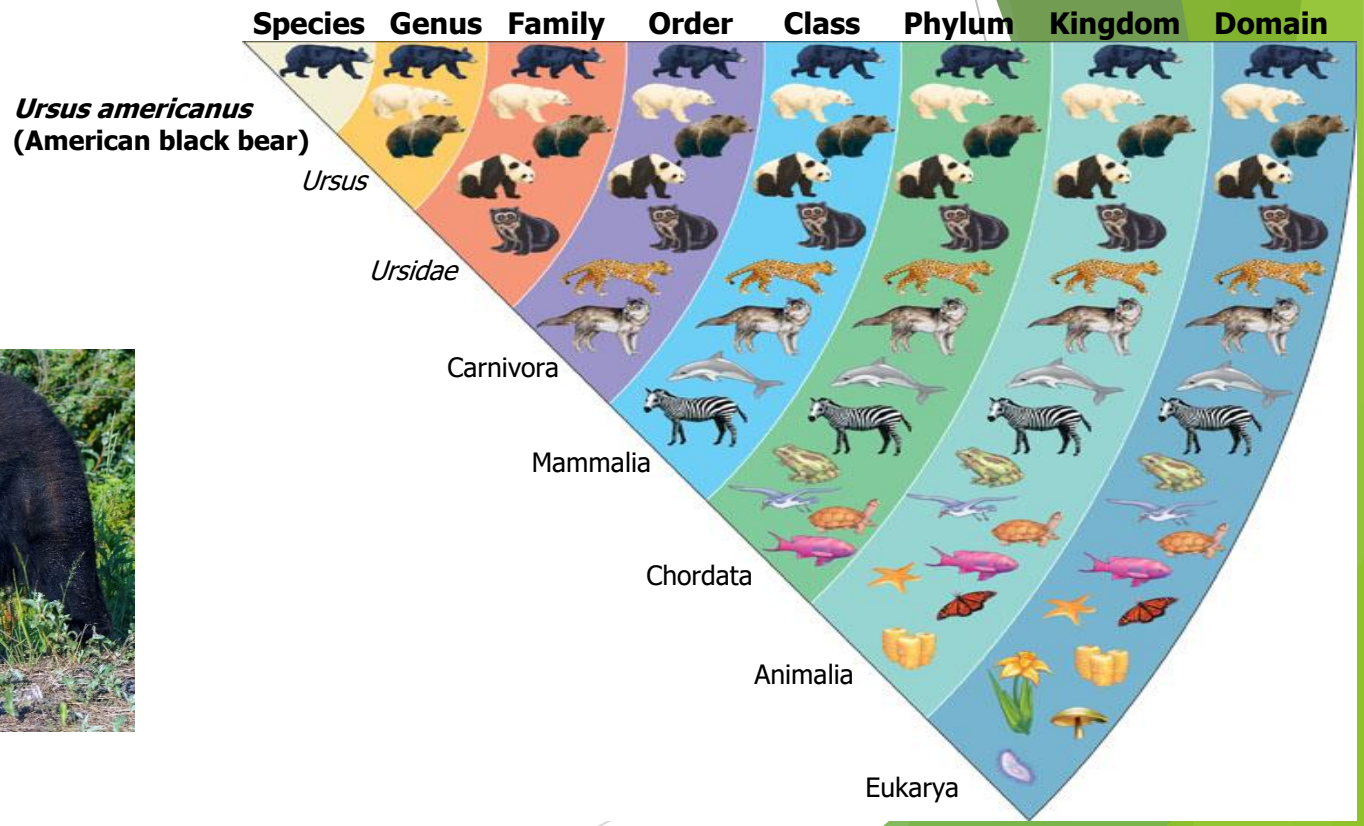
1. UNIVERSALITAS: **umum**, semua organisme tersusun oleh bahan kimia dan sel. Dalam sel terjadi reaksi kimia
2. KONTINUITAS: **keberlanjutan**, sel maupun organisme melalukan proses reproduksi yang akan menjaga kelestariannya
3. DIVERSITAS: **beranekaragam**, dalam kehidupan terdapat keanekaragam-an organisme yang sangat besar. Organisme dikelompokkan dalam takson.
4. HOMEOSTASIS: **keadaan yang relatif konstan di dalam lingkungan internal tubuh,** dipertahankan secara alami oleh mekanisme adaptasi fisiologis.
5. EVOLUSI: perubahan pada suatu populasi organisme yang sifat-sifatnya terwariskan dari satu generasi ke generasi berikutnya.
6. INTERAKSI: berhubungan, organisme berinteraksi dengan lingkungan

Informasi dalam sel diwariskan

- Sel mengandung kromosom yang tersusun dari DNA, substansi gen
- DNA memprogram produksi protein sel dan mengirimkan informasi dari orang tua kepada keturunannya



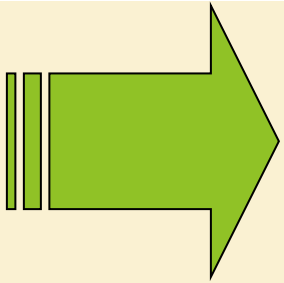
Klasifikasi kehidupan



Ursus americanus

PERKEMBANGAN PENGETAHUAN MANUSIA

- Mesir Kuno
- Mesopotamia
- Babylonia



Berusaha
Mengatasi
Bencana

MITOS

EMPIRI

Pandangan Manusia tentang darah berdasar rekaman Inhotep pada Papirus (4.000 tahun)

Hippocrates : cairan vital di dalam darah manusia terdiri atas :

- **Darah**
- **Palegma**
- **Empedu hitam dan kuning**

EMPIRI → PENALARAN

I. TAHAP EMPIRI →

Hubungan EMPIRI antar gejala alam ↓

Konsep Geosentris

II. TAHAP TEORITIS →

Usaha menarik penalaran rangkaian gejala alam ↓

IPA SISTEMATIK →

Konsep Heliosentris

Metode Ilmiah

- **Pendekatan Rasionalisme**

  merupakan pendekatan yang menyusun pengetahuan secara konsisten dan kumulatif berdasarkan pengetahuan yang telah tersusun sebelumnya

- **Pendekatan Empirisme**

  Merupakan pendekatan untuk memperoleh pengetahuan berdasarkan fakta

“Pengetahuan yang rasional tetapi tidak didukung fakta bukan merupakan pengetahuan yang benar”

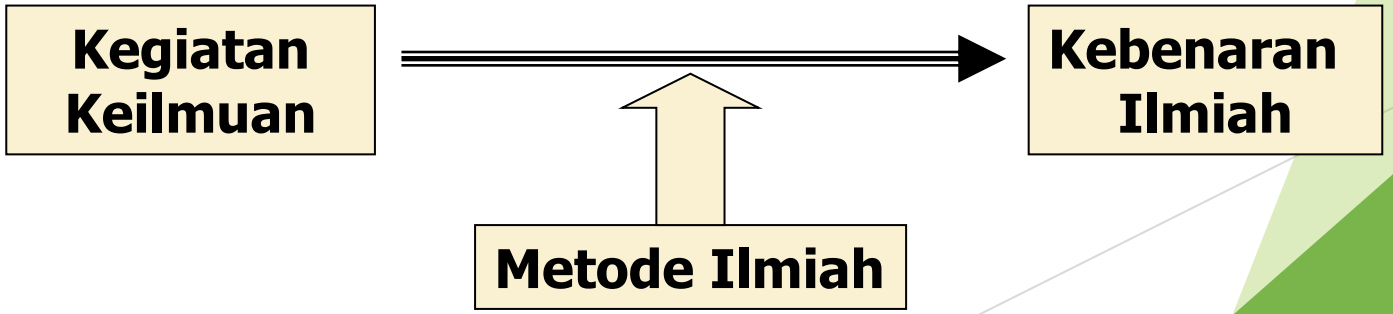
Metode Ilmiah :

Menggabungkan antara **pendekatan rasionalisme dan empirisme** sehingga pengetahuan ilmiah/ilmu mempunyai dua kriteria utama:

- **Adanya konsistensi pengetahuan baru/berikutnya dengan pengetahuan-pengetahuan sebelumnya,** sehingga secara kumulatif mengembangkan pengetahuan yang telah ada
- **Adanya kesesuaian antara pengetahuan yang dikembangkan dengan fakta/fenomena empiris**

Metode ilmiah

- Merupakan langkah-langkah dalam memproses pengetahuan ilmiah melalui penggabungan cara berpikir rasional dan empiris dengan jalan membangun jembatan penghubung dalam bentuk pengajuan hipotesis
- Cara kerja/prosedur untuk dapat memahami suatu objek/fenomena sesuai dengan syarat-syarat yang dituntut ilmu berdasarkan berpikir ilmiah



Metode Ilmiah pada hakekatnya merupakan langkah-langkah yang berporoskan **troika**, yaitu :

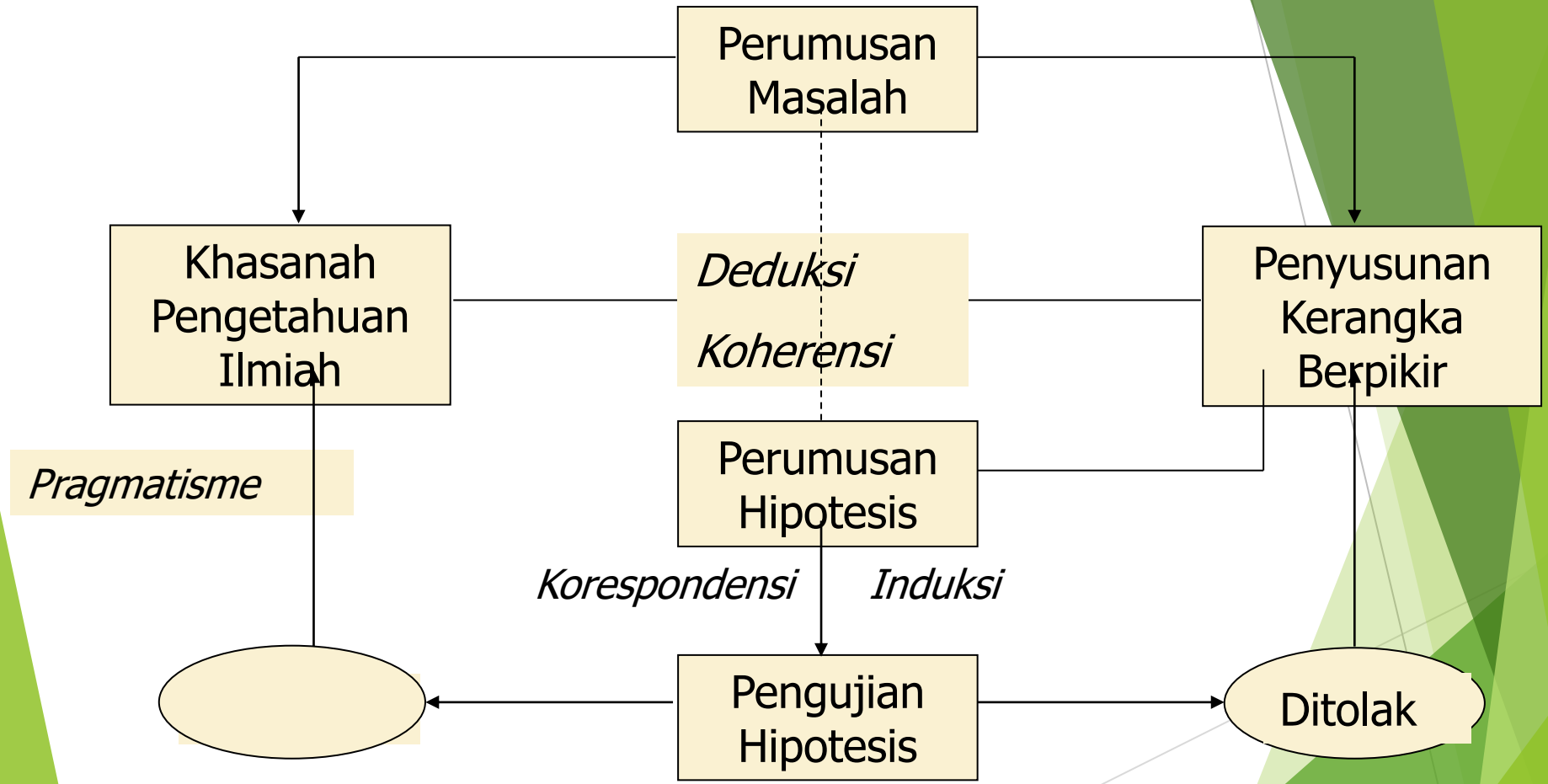
1. Penyusunan kerangka berpikir --- logika deduktif
2. Pengajuan hipotesis --- kesimpulan kerangka berpikir
3. Pengujian [verifikasi] hipotesis

Metode ilmiah dikenal juga dengan proses :

Logiko – Hipotetiko – Verifikatif

atau

Dedukto – Hipotetiko – Verifikatif



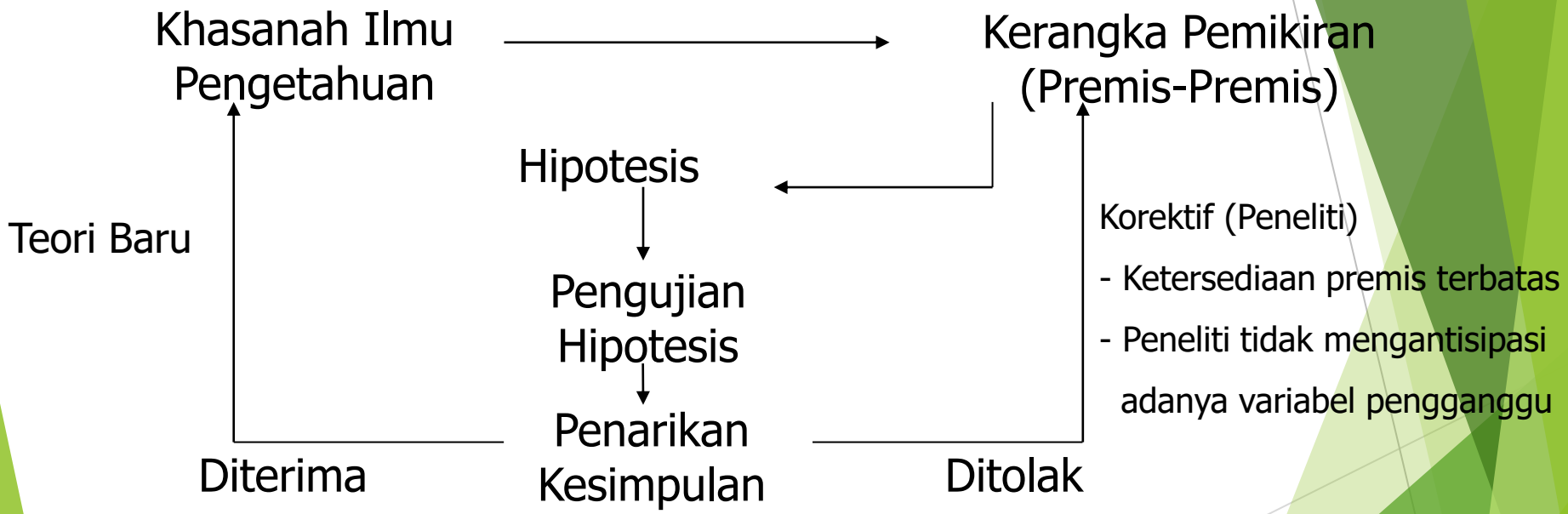
ALUR BERPIKIR ILMIAH

ALUR BERPIKIR ILMIAH

Alur berpikir yang tercakup dalam metode ilmiah dapat dijabarkan dalam beberapa langkah :

- Perumusan Masalah --- merupakan pertanyaan mengenai objek empiris yang jelas batas-batasnya serta dapat diidentifikasikan faktor-faktor yang terkait di dalamnya.
- Penyusunan kerangka berpikir dalam pengajuan hipotesisi --- merupakan argumentasi yang menjelaskan hubungan yang mungkin terdapat antara berbagai faktor yang saling mengkait dan membentuk kontelasi ilmiah
- Perumusan hipotesis --- merupakan jawaban sementara atau dugaan jawaban pertanyaan yang diajukan yang materinya merupakan kesimpulan dari kerangka berpikir yang dikembangkan.
- Pengujian hipotesis --- merupakan pengumpulan fakta-fakta yang relevan dengan hipotesisi yang diajukan untuk memperlihatkan apakah terdapat fakta-fakta yang mendukung hipotesis tersebut atau tidak
- Penarikan kesimpulan --- merupakan penilaian apakah sebuah hipotesis yang diajukan diterima atau ditolak

SIKLUS EMPIRIS METODE ILMIAH : merupakan umpan balik ilmu berupa produk kepada khazanah ilmu pengetahuan



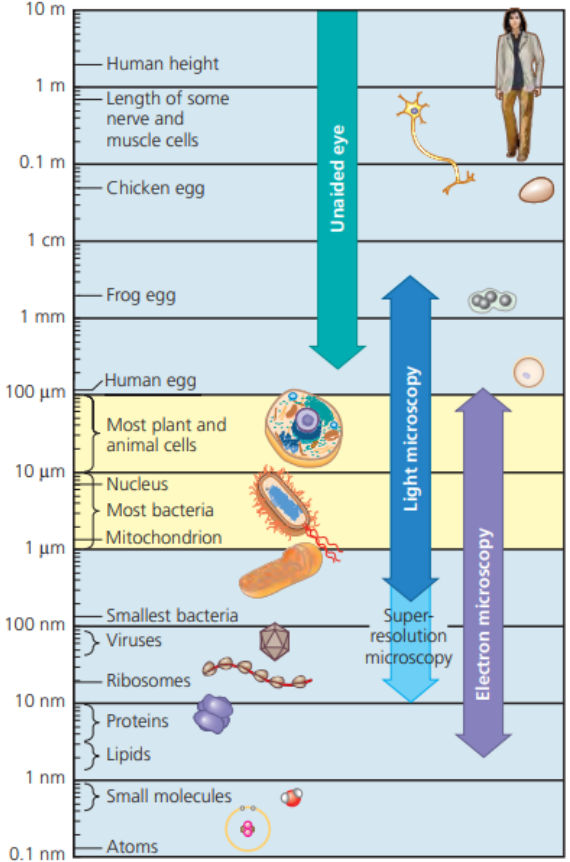
Proses berstruktur

[fungsi setiap unsur terkait] -- Struktur Penelitian Ilmiah -- Struktur Penulisan Ilmiah

SEL SEBAGAI UNIT KEHIDUPAN

Dalam hirarki organisasi biolologik :
SEL ADALAH BAGIAN TERKECIL
DARI MAHLUK HIDUP /INDIVIDU

UKURAN SEL



▲ **Figure 6.2 The size range of cells.** Most cells are between 1 and 100 µm in diameter (yellow region of chart) and are therefore visible only under a microscope. Notice that the scale along the left side is logarithmic to accommodate the range of sizes shown. Starting at the top of the scale with 10 m and going down, each reference measurement marks a tenfold decrease in diameter or length. For a complete table of the metric system, see Appendix C.

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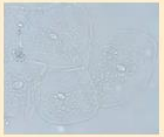
MIKROSKOP

▼ Figure 6.3

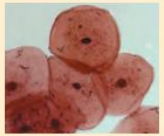
Exploring Microscopy

Light Microscopy (LM)

Brightfield (unstained specimen). Light passes directly through the specimen. Unless the cell is naturally pigmented or artificially stained, the image has little contrast. (The first four light micrographs show human cheek epithelial cells; the scale bar pertains to all four micrographs.)



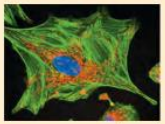
Brightfield (stained specimen). Staining with various dyes enhances contrast. Most staining procedures require that cells be fixed (preserved).



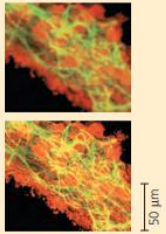
Phase-contrast. Variations in density within the specimen are amplified to enhance contrast in unstained cells, which is especially useful for examining living, unpigmented cells.

Differential-interference-contrast (Nomarski). As in phase-contrast microscopy, optical modifications are used to exaggerate differences in density, making the image appear almost 3-D.

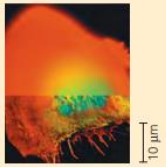
Fluorescence. The locations of specific molecules in the cell can be revealed by labeling the molecules with fluorescent dyes or antibodies; some cells have molecules that fluoresce on their own. Fluorescent substances absorb ultraviolet radiation and emit visible light. In this fluorescently labeled uterine cell, nuclear material is blue, organelles called mitochondria are orange, and the cell's "skeleton" is green.



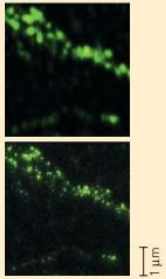
Confocal. The top image is a standard fluorescence micrograph of fluorescently labeled nervous tissue (nerve cells are green, support cells are orange, and regions of overlap are yellow); below it is a confocal image of the same tissue. Using a laser, this "optical sectioning" technique eliminates out-of-focus light from a thick sample, creating a single plane of fluorescence in the image. By capturing sharp images at many different planes, a 3-D reconstruction can be created. The standard image is blurry because out-of-focus light is not excluded.



Deconvolution. The top of this split image is a compilation of standard fluorescence micrographs through the depth of a white blood cell. Below is an image of the same cell reconstructed from many blurry images at different planes, each of which was processed using deconvolution software. This process digitally removes out-of-focus light and reassigns it to its source, creating a much sharper 3-D image.



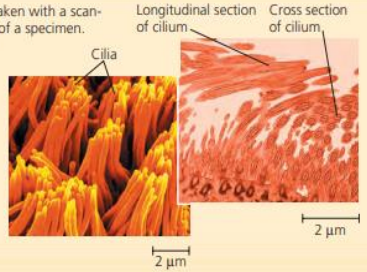
Super-resolution. On the top is a confocal image of part of a nerve cell, using a fluorescent label that binds to a molecule clustered in small sacs in the cell (vesicles) that are 40 nm in diameter. The greenish-yellow spots are blurry because 40 nm is below the 200-nm limit of resolution for standard light microscopy. Below is an image of the same part of the cell, seen using a new "super-resolution" technique. Sophisticated equipment is used to light up individual fluorescent molecules and record their position. Combining information from many molecules in different places "breaks" the limit of resolution, resulting in the sharp greenish-yellow dots seen here. (Each dot is a 40-nm vesicle.)



Electron Microscopy (EM)

Scanning electron microscopy (SEM). Micrographs taken with a scanning electron microscope show a 3-D image of the surface of a specimen. This SEM shows the surface of a cell from a trachea (windpipe) covered with cilia. Beating of the cilia helps move inhaled debris upward toward the throat. The SEM and TEM shown here have been artificially colorized. (Electron micrographs are black and white, but are often artificially colorized to highlight particular structures.)

Abbreviations used in this book:
LM = Light Micrograph
SEM = Scanning Electron Micrograph
TEM = Transmission Electron Micrograph



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 internal structure. In preparing the TEM, some cilia were cut along their lengths, creating longitudinal sections, while other cilia were cut straight across, creating cross sections.

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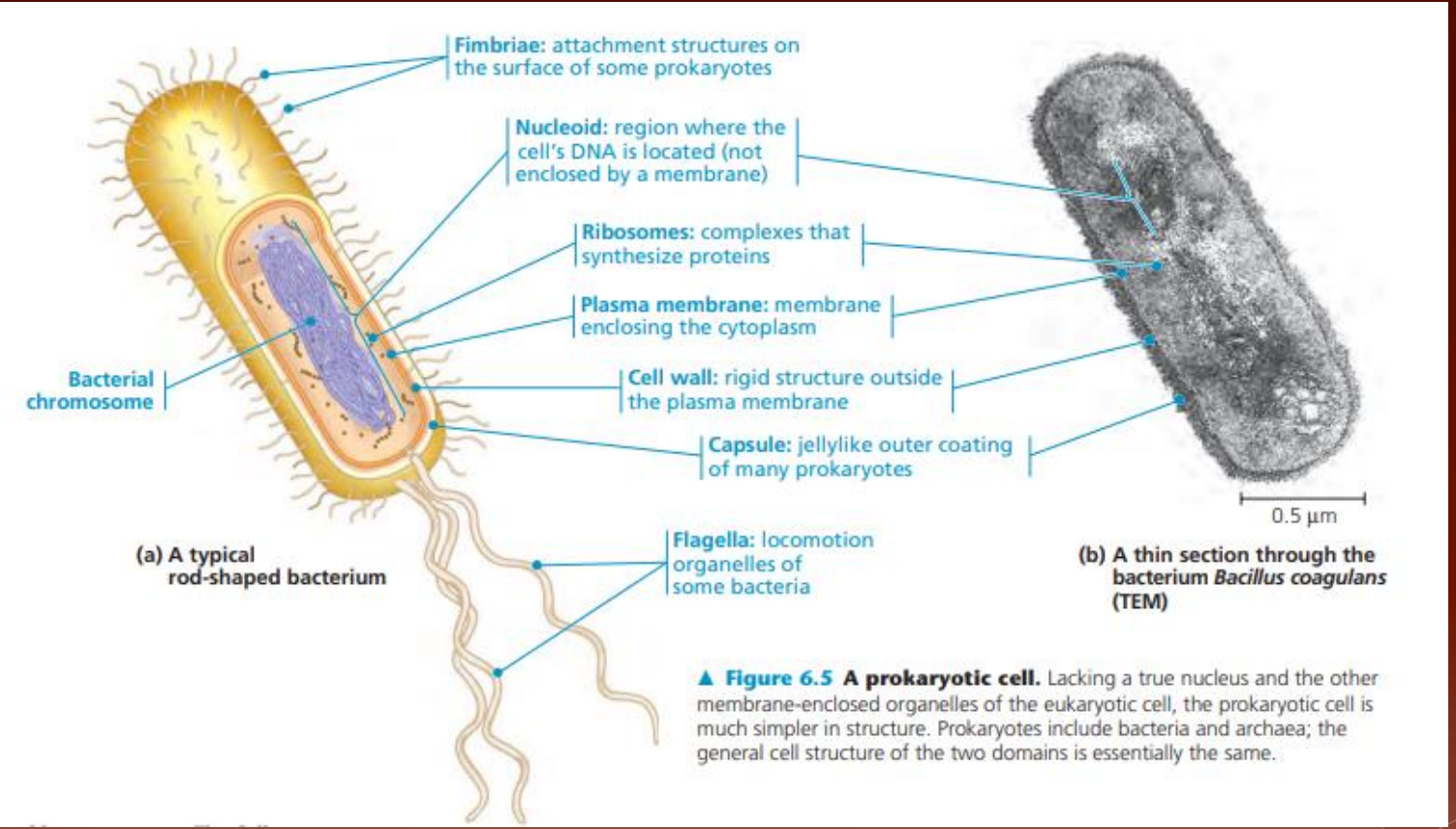
Unit struktural dan fungsional organisme

1. **PROKARIOTIK** (domain Bakteri dan Archaea)
2. **EUKARIOTIK** (Protista, Fungi/jamur, Animalia/hewan, dan Plantae/tanaman)

SEL

	PROKARIOTIK	EUKARIOTIK
Membran nukleus	-	√
DNA/RNA	Nukleoid	Nukleus
Ukuran	0,1-10 μm	10-100 μm
Reproduksi	Vegetatif	Vegetatif, generatif
Struktur sel	Sederhana	Kompleks
Membran sel	Selektif (O_2, nutrien, limbah)	Kompleks (bilayer lipid, komposisinya tergantung pada fungsi spesifik membran)
Sintesis protein	Ribosom	Ribosom



▲ **Figure 6.5 A prokaryotic cell.** Lacking a true nucleus and the other membrane-enclosed organelles of the eukaryotic cell, the prokaryotic cell is much simpler in structure. Prokaryotes include bacteria and archaea; the general cell structure of the two domains is essentially the same.

Struktur Sel Prokariota

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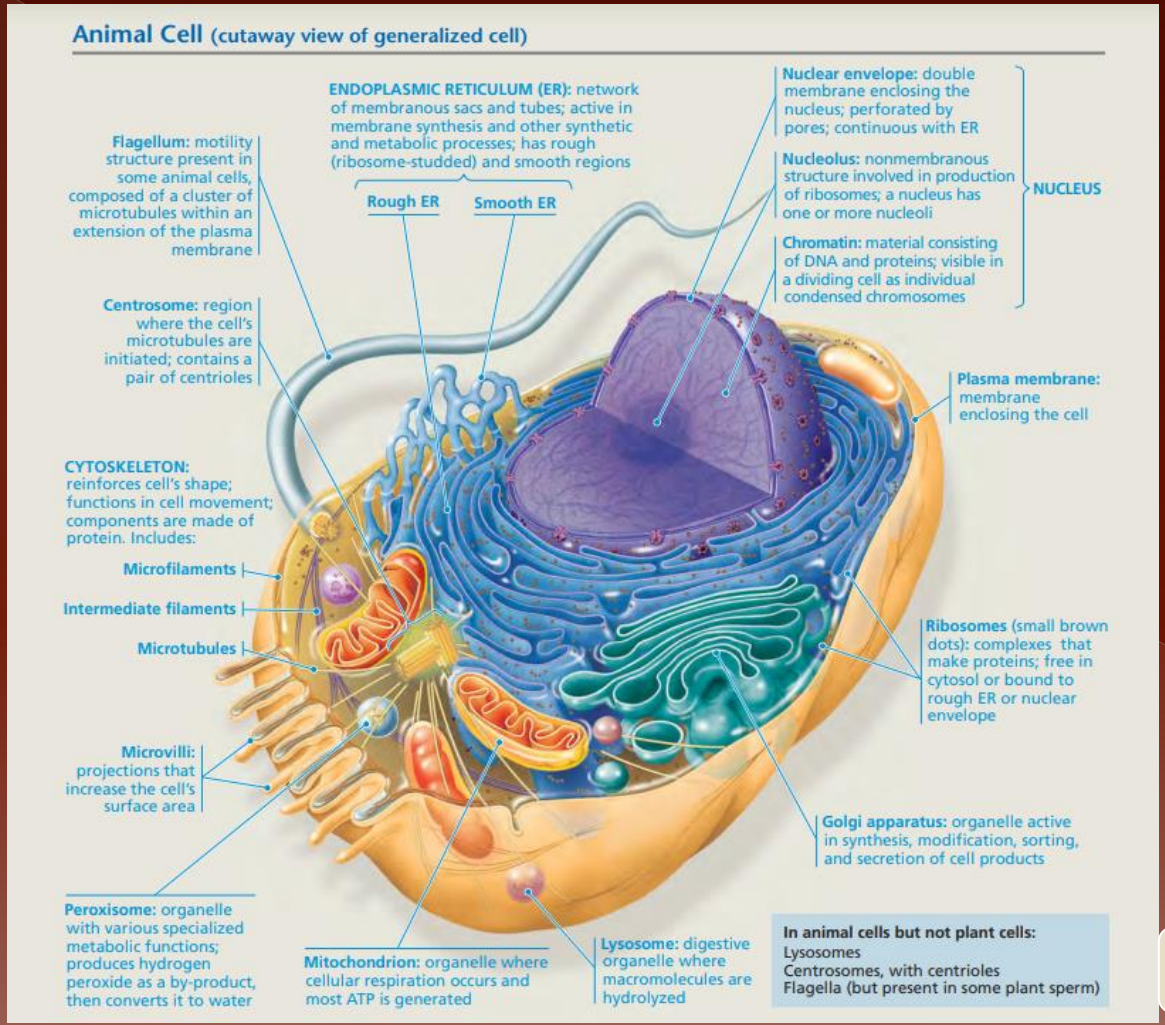
Sel Hewan



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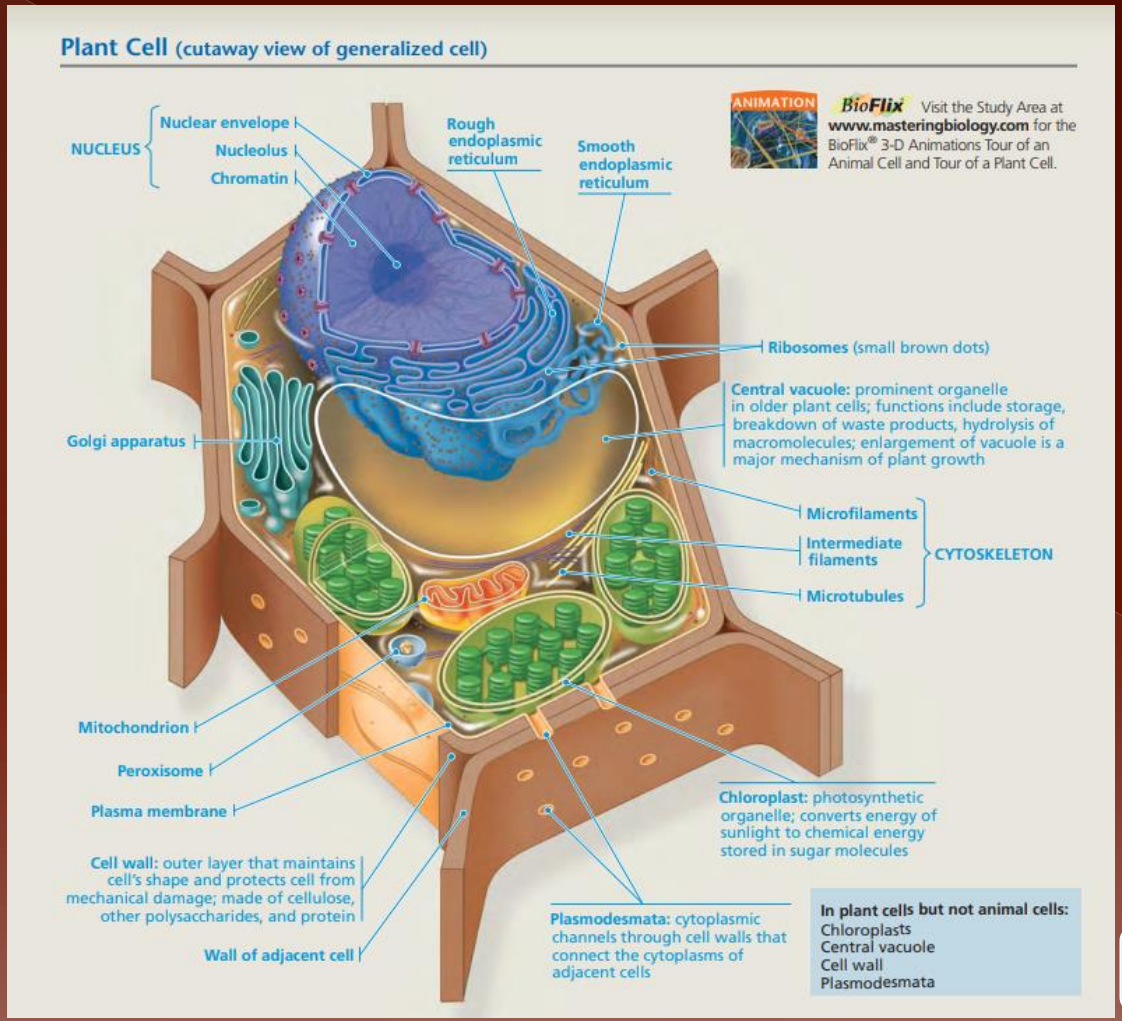
Sel Tumbuhan



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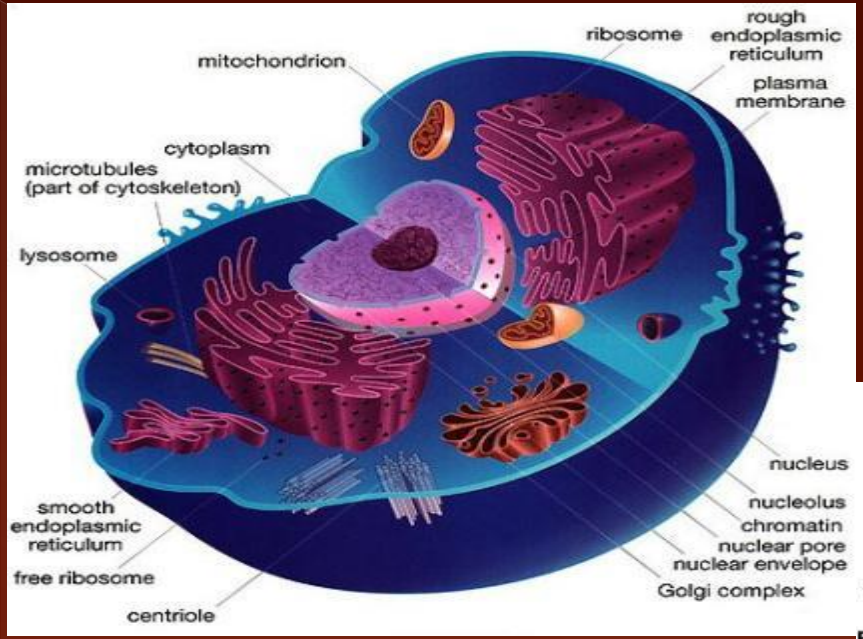
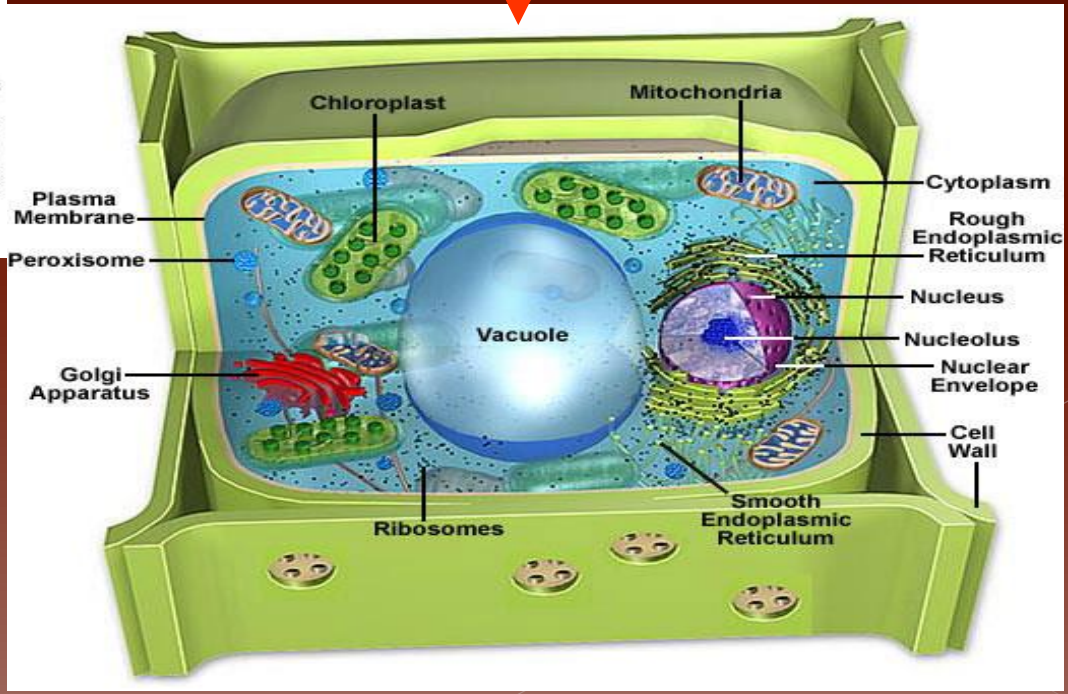


Sel hewan

Sel tumbuhan



ORGANEL SEL

-NUKLEUS (INTI SEL)

-RIBOSOM

-RETIKULUM ENDOPLASMIK

-APARATUS GOLGI

-LISOSOM

-VAKUOLA

-MITOKONDRIA

-KLOROPLAS

-SITOSKELETON

NUKLEUS

-Materi genetik

-Membran bilayer lipid

-Mengatur sintesis protein

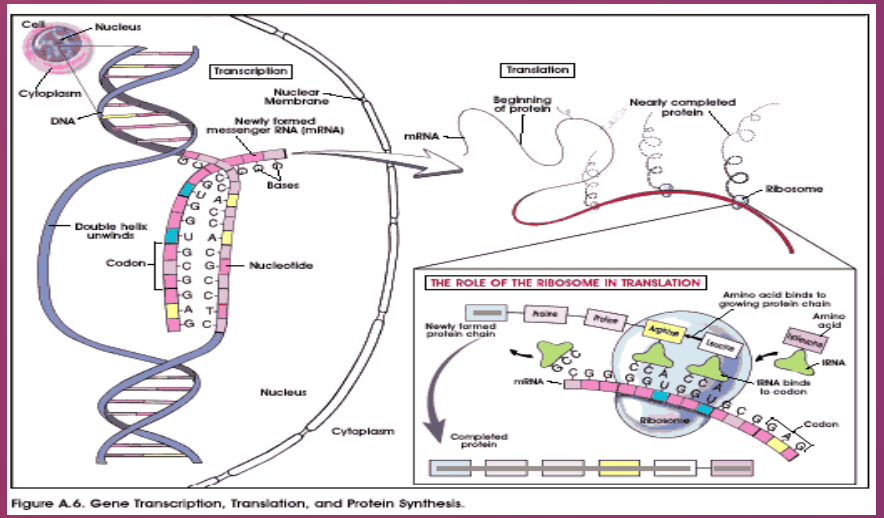


Figure A.6. Gene Transcription, Translation, and Protein Synthesis.

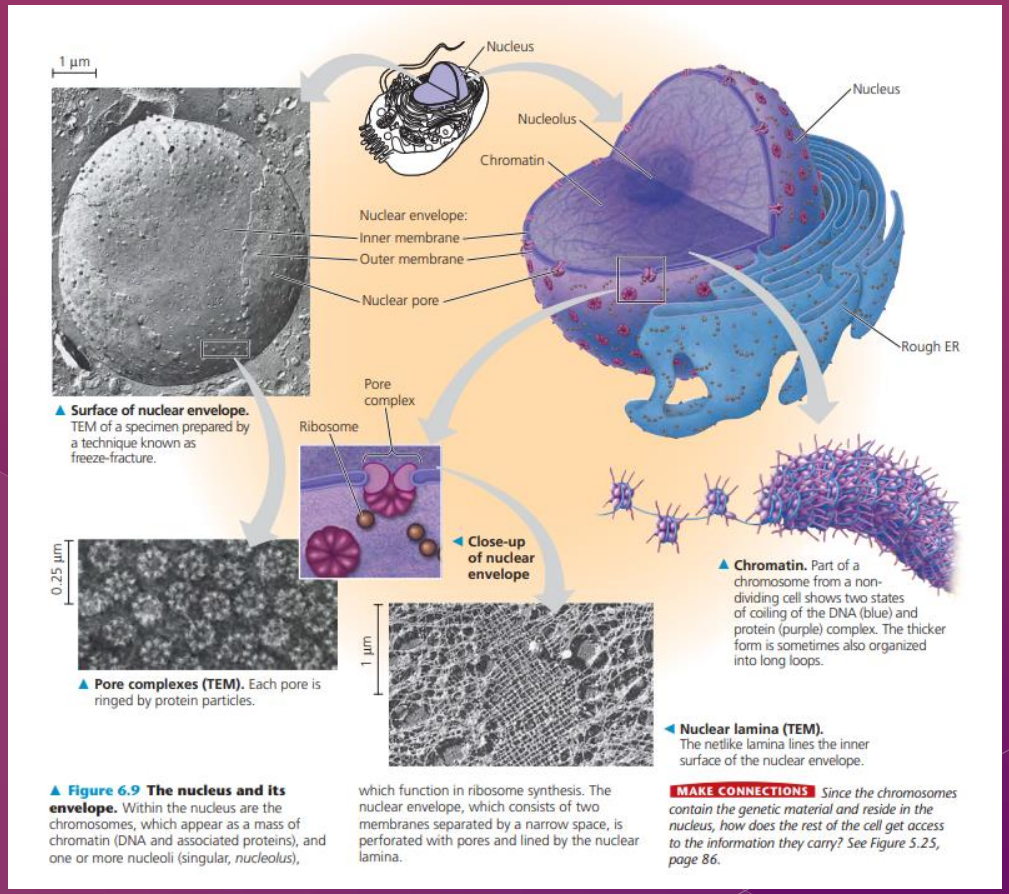


Figure 6.9 The nucleus and its envelope. Within the nucleus are the chromosomes, which appear as a mass of chromatin (DNA and associated proteins), and one or more nucleoli (singular, *nucleolus*), which function in ribosome synthesis. The nuclear envelope, which consists of two membranes separated by a narrow space, is perforated with pores and lined by the nuclear lamina.

MAKE CONNECTIONS *Since the chromosomes contain the genetic material and reside in the nucleus, how does the rest of the cell get access to the information they carry? See Figure 5.25, page 86.*

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RIBOSOM

-Tempat sintesis protein

-Ribosom bebas → sitosol

-Ribosom terikat → bag luar membran RE

ENDOMEMBRAN

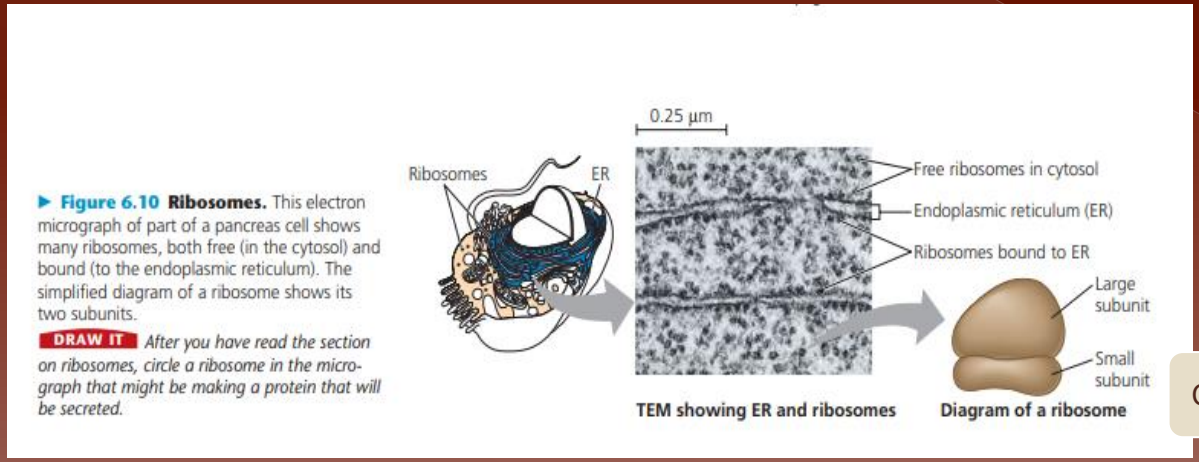
-Nukleus

-Retikulumendoplasmik

-Aparatus golgi

-Lisosom

-Vakuola



▶ **Figure 6.10 Ribosomes.** This electron micrograph of part of a pancreas cell shows many ribosomes, both free (in the cytosol) and bound (to the endoplasmic reticulum). The simplified diagram of a ribosome shows its two subunits.

DRAW IT *After you have read the section on ribosomes, circle a ribosome in the micrograph that might be making a protein that will be secreted.*

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RETIKULUM ENDOPLASMIK

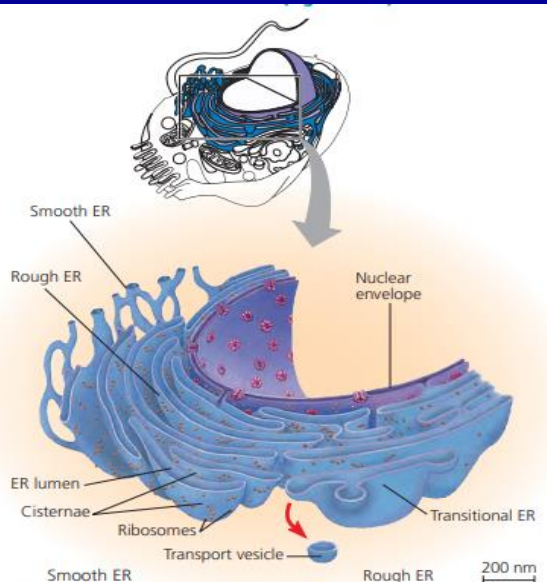
RE halus:

Fungsi dalam proses sintesis lipid (fosfolipid, steroid), metabolisme karbohidrat (glikogen → glukosa), menetralisir racun

RE kasar:

Fungsi sintesis protein : insulin (glikoprotein)

Keluar sel melalui vesikula (vesikula transpot)



▲ **Figure 6.11 Endoplasmic reticulum (ER).** A membranous system of interconnected tubules and flattened sacs called cisternae, the ER is also continuous with the nuclear envelope. (The drawing is a cutaway view.) The membrane of the ER encloses a continuous compartment called the ER lumen (or cisternal space). Rough ER, which is studded on its outer surface with ribosomes, can be distinguished from smooth ER in the electron micrograph (TEM). Transport vesicles bud off from a region of the rough ER called transitional ER and travel to the Golgi apparatus and other destinations.

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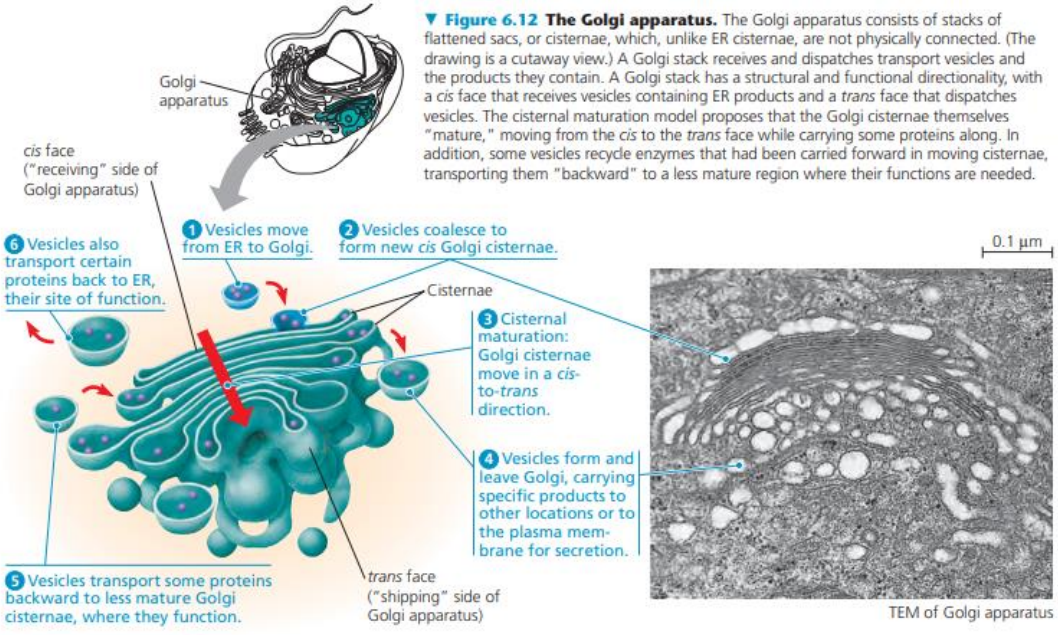
Aparatus Golgi

-Protein dari RE → vesikula → aparatus golgi

-membran sisterne

-cis → dekat RE → penerima

-trans → menghasilkan vesikula → membran



▼ **Figure 6.12 The Golgi apparatus.** The Golgi apparatus consists of stacks of flattened sacs, or cisternae, which, unlike ER cisternae, are not physically connected. (The drawing is a cutaway view.) A Golgi stack receives and dispatches transport vesicles and the products they contain. A Golgi stack has a structural and functional directionality, with a *cis* face that receives vesicles containing ER products and a *trans* face that dispatches vesicles. The cisternal maturation model proposes that the Golgi cisternae themselves "mature," moving from the *cis* to the *trans* face while carrying some proteins along. In addition, some vesicles recycle enzymes that had been carried forward in moving cisternae, transporting them "backward" to a less mature region where their functions are needed.

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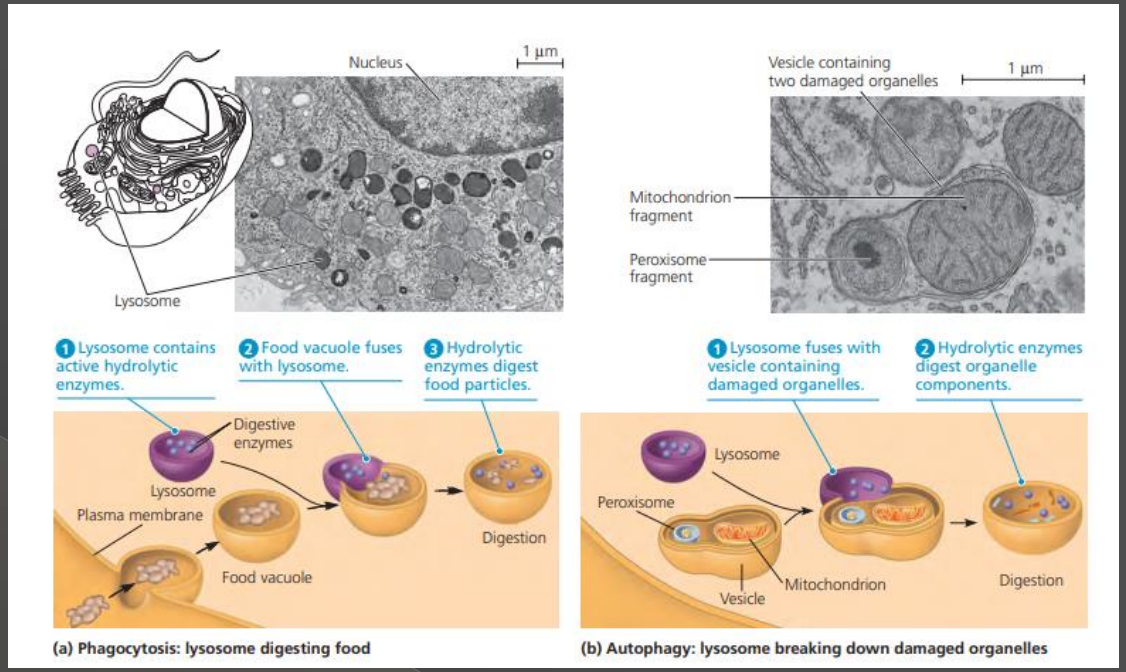
LISOSOM

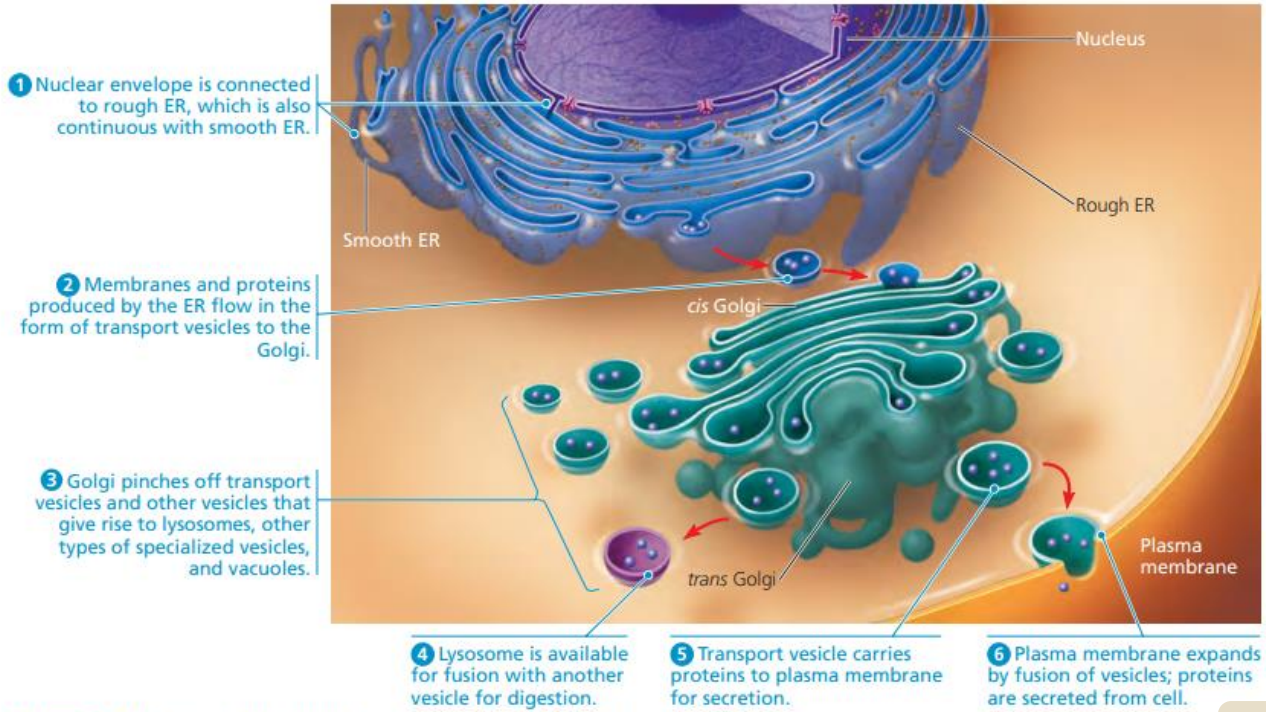


-Kantong membran yang berisi enzim hidrolitik untuk mencerna makromolekul

-Enzim lisosom menghidrolisis : protein, polisakarida, lemak asam nukleat

RE kasar → Enzim hidrolitik → Golgi → **Lisosom**

Hubungan di antara organel-organel dalam sistem endomembran



▲ **Figure 6.15 Review: relationships among organelles of the endomembrane system.**
The red arrows show some of the migration pathways for membranes and the materials they enclose.

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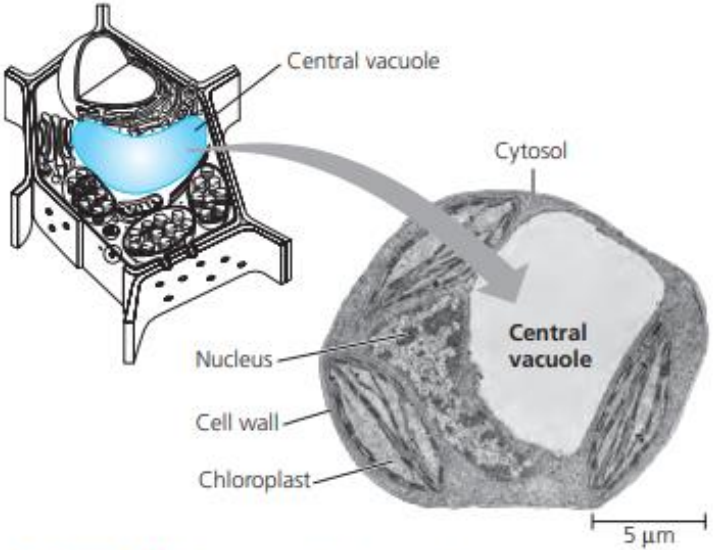
Vakuola

Vakuola makanan : kantong membran tempat untuk menyimpan senyawa organik → protein atau materi lain (seperti vesikel)

Vakuola kontraktil : pompa air ke luar sel (protista air)



▲ **Figure 6.14 The plant cell vacuole.** The central vacuole is usually the largest compartment in a plant cell; the rest of the cytoplasm is often confined to a narrow zone between the vacuolar membrane and the plasma membrane (TEM).

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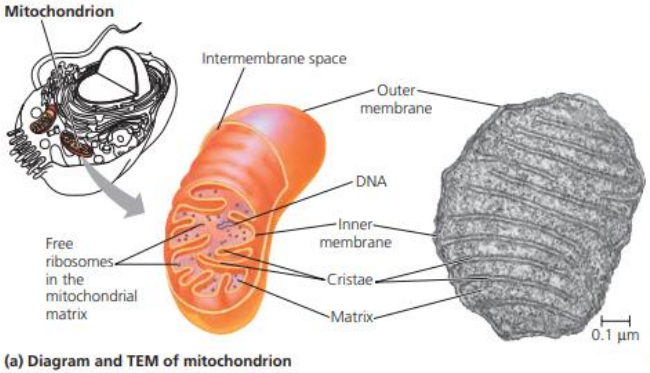
Endomembran

Nukleus → RE kasar dan RE halus → vesikel → aparatus golgi → lisosom → membran sel

MITOKONDRIA

- Tempat produksi energi → aktifitas sel (identik dengan kloroplas→ energi → aktifitas)

-Organel semiotonom dan tidak tergolong dalam endomembran, karena:



(a) Diagram and TEM of mitochondrion

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

▲ **Figure 6.17 The mitochondrion, site of cellular respiration. (a)** The inner and outer membranes of the mitochondrion are evident in the drawing and electron micrograph (TEM). The cristae are infoldings of the inner membrane, which increase its surface area. The cutaway drawing shows the two compartments bounded by the membranes: the intermembrane space and the mitochondrial matrix. Many respiratory enzymes are found in the inner membrane and the matrix. Free ribosomes are also present in the matrix. The DNA molecules are usually circular and are attached to the inner mitochondrial membrane. **(b)** The light micrograph shows an entire unicellular protist (*Euglena gracilis*) at a much lower magnification than the TEM. The mitochondrial matrix has been stained green. The mitochondria form a branched tubular network. The nuclear DNA is stained red, and the molecules of mitochondrial DNA appear as bright yellow spots.

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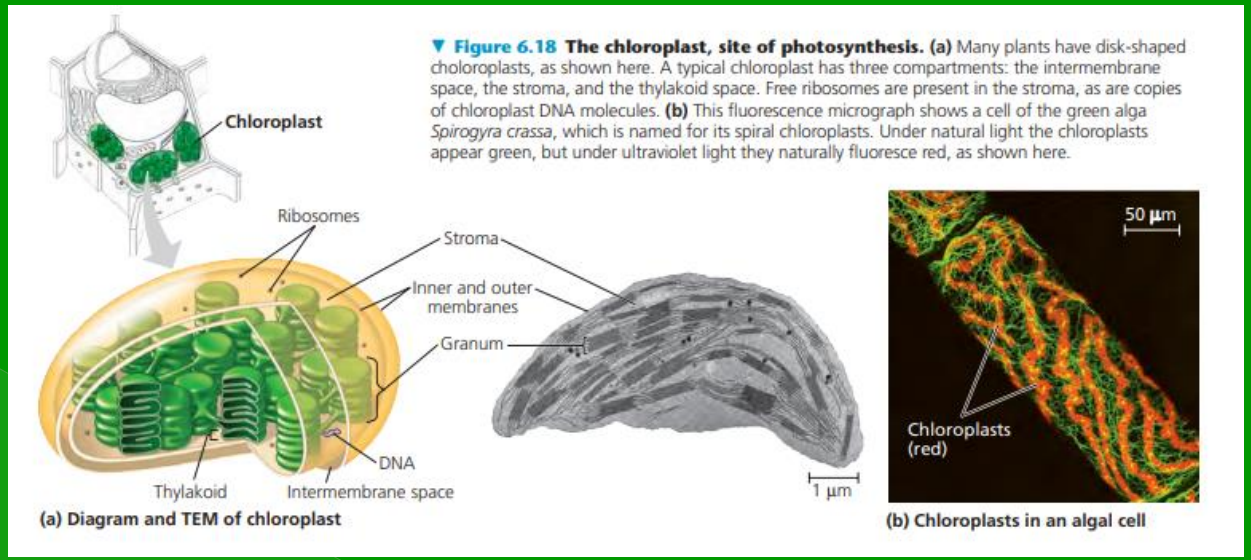
(a) membran tidak dari RE tetapi dari protein hasil sintesis ribosom bebas
(b) mempunyai DNA untuk program sintesis protein dalam ribosom bebas
-DNA nukleus : menghasilkan protein sitosol yang menyusun sebagian besar organel sel

KLOROPLAS

Tempat fotosintesis



▼ **Figure 6.18 The chloroplast, site of photosynthesis. (a)** Many plants have disk-shaped choloroplasts, as shown here. A typical chloroplast has three compartments: the intermembrane space, the stroma, and the thylakoid space. Free ribosomes are present in the stroma, as are copies of chloroplast DNA molecules. **(b)** This fluorescence micrograph shows a cell of the green alga *Spirogyra crassa*, which is named for its spiral chloroplasts. Under natural light the chloroplasts appear green, but under ultraviolet light they naturally fluoresce red, as shown here.

(a) Diagram and TEM of chloroplast

(b) Chloroplasts in an algal cell

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Mempunyai 2 membran :

Membran dalam berfungsi melingkupi cairan (stroma). Tumpukan tilakoid (membran dalam kloroplas) membentuk grana. Antar grana dihubungkan oleh tubula tipis

SITOSKELETON

Fungsi :

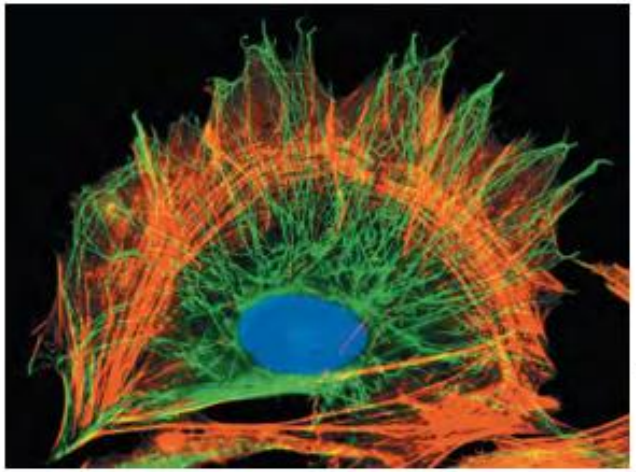
pengorganisasian struktur,

Memberi dukungan mekanis sel,

Pertahanan bentuk sel, dan

Aktivitas atau motilitas sel

Sitoskeleton = molekul motor untuk gerak (silia dan flagela)



▲ **Figure 6.20 The cytoskeleton.** As shown in this fluorescence micrograph, the cytoskeleton extends throughout the cell. The cytoskeletal elements have been tagged with different fluorescent molecules: green for microtubules and red for microfilaments. A third component of the cytoskeleton, intermediate filaments, is not evident here. (The DNA in the nucleus is blue.)

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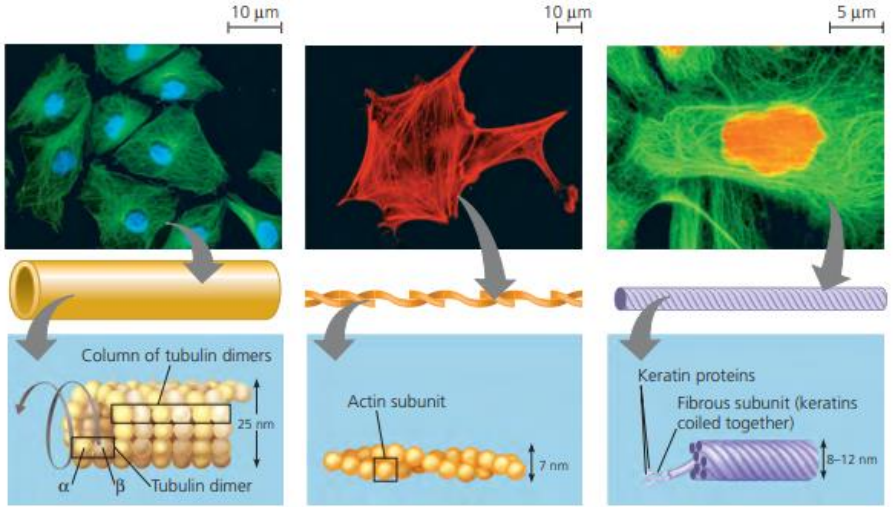
SITOSKELETON

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



Fluorescence micrographs of fibroblasts, a favorite cell type for cell biology studies. In each, the structure of interest has been tagged with fluorescent molecules. In the first and third micrographs, the DNA in the nucleus has also been tagged (blue or orange).

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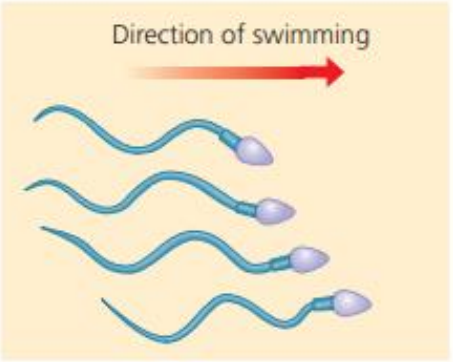
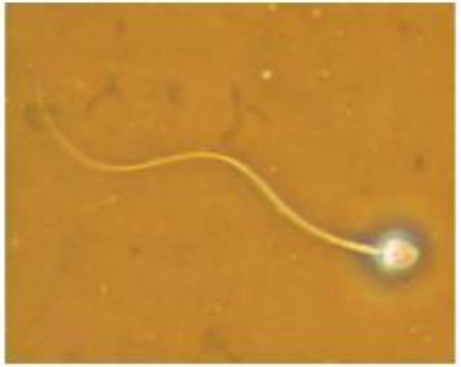
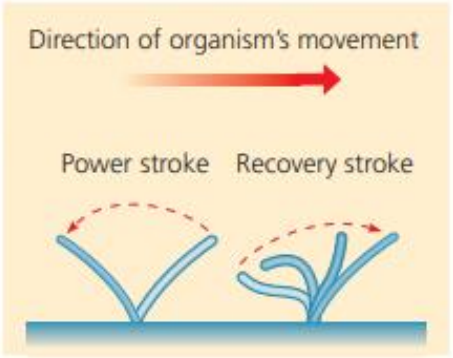
(a) Motion of flagella. A flagellum usually undulates, its snakelike motion driving a cell in the same direction as the axis of the flagellum. Propulsion of a human sperm cell is an example of flagellate locomotion (LM).





(b) Motion of cilia. Cilia have a back-and-forth motion. The rapid power stroke moves the cell in a direction perpendicular to the axis of the cilium. Then, during the slower recovery stroke, the cilium bends and sweeps sideways, closer to the cell surface. A dense nap of cilia, beating at a rate of about 40 to 60 strokes a second, covers this *Colpidium*, a freshwater protist (colorized SEM).



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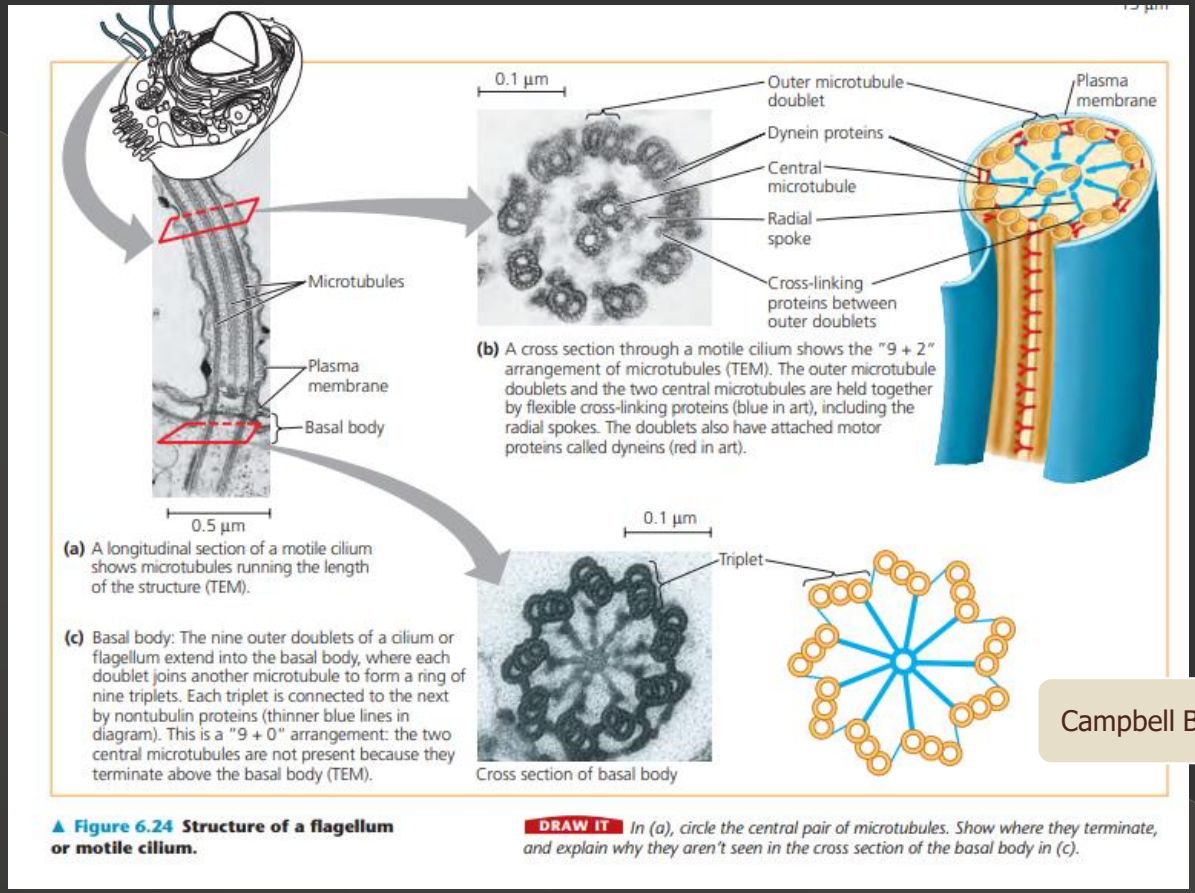

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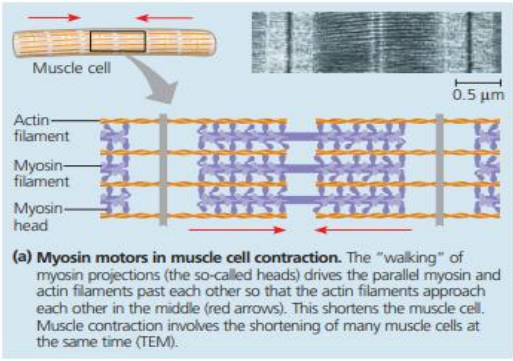
Ultrastruktur silia atau flagel eukariotik

Mekanisme gerak dalam sel

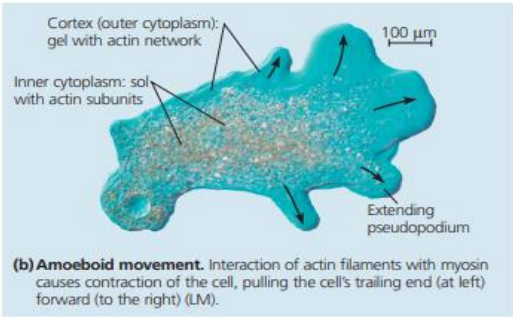
Sel otot : filamen aktin (jingga) terletak sejajar dengan filamen miosin (ungu). Miosin sebagai motor → memendek

Gerak amuboid : aktin diorganisasi membentuk kortek mirip padatan (gel) terletak di bagian luar, sedang bagian dalam mirip cair (sol)

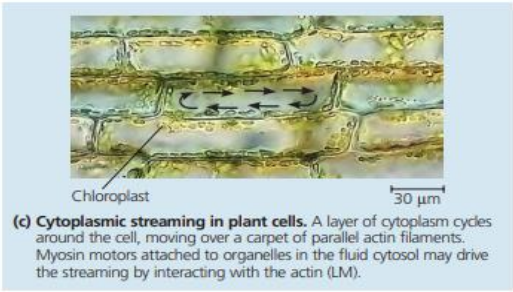
Gerak sitoplasma : aktin sebagai hamparan dan bersama motor miosin menggerakkan aliran sitoplasma



(a) Myosin motors in muscle cell contraction. The "walking" of myosin projections (the so-called heads) drives the parallel myosin and actin filaments past each other so that the actin filaments approach each other in the middle (red arrows). This shortens the muscle cell. Muscle contraction involves the shortening of many muscle cells at the same time (TEM).



(b) Amoeboid movement. Interaction of actin filaments with myosin causes contraction of the cell, pulling the cell's trailing end (at left) forward (to the right) (LM).



(c) Cytoplasmic streaming in plant cells. A layer of cytoplasm cycles around the cell, moving over a carpet of parallel actin filaments. Myosin motors attached to organelles in the fluid cytosol may drive the streaming by interacting with the actin (LM).

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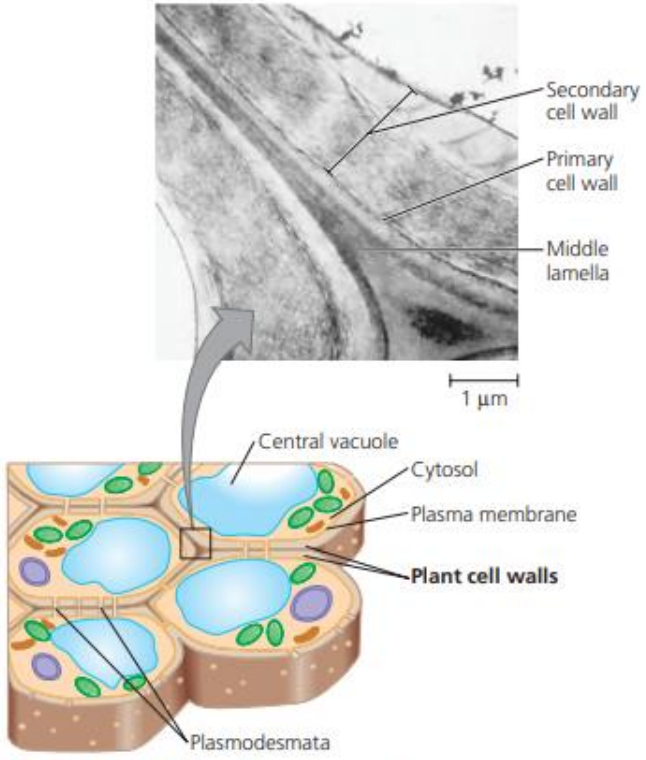
Dinding sel tumbuhan

Sel muda tersusun oleh dinding primer tipis, berkembang dengan penambahan dinding sekunder di antara dinding primer.

Plasmodesmata = celah



▲ **Figure 6.28 Plant cell walls.** The drawing shows several cells, each with a large vacuole, a nucleus, and several chloroplasts and mitochondria. The transmission electron micrograph shows the cell walls where two cells come together. The multilayered partition between plant cells consists of adjoining walls individually secreted by the cells.

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Matrik ekstraseluler

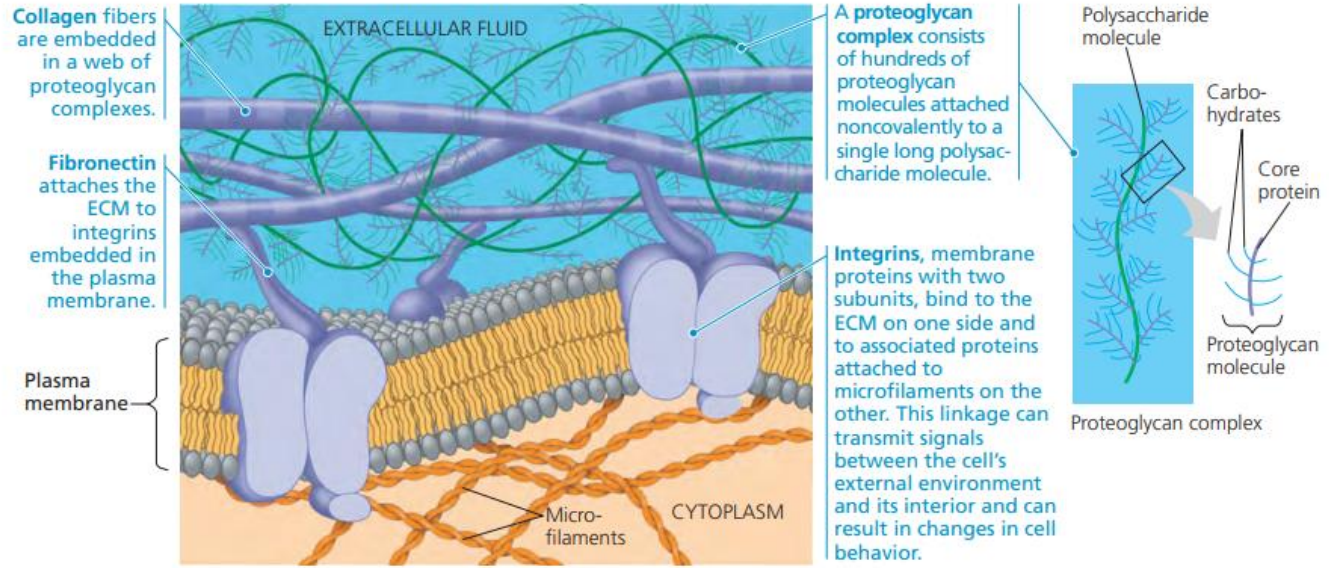
Fungsi :

-Penyangga

-Perekatan

-Pergerakan

-Pengaturan



▲ **Figure 6.30 Extracellular matrix (ECM) of an animal cell.** The molecular composition and structure of the ECM vary from one cell type to another. In this example, three different types of ECM molecules are present: proteoglycans, collagen, and fibronectin.

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Junction pada sel hewan

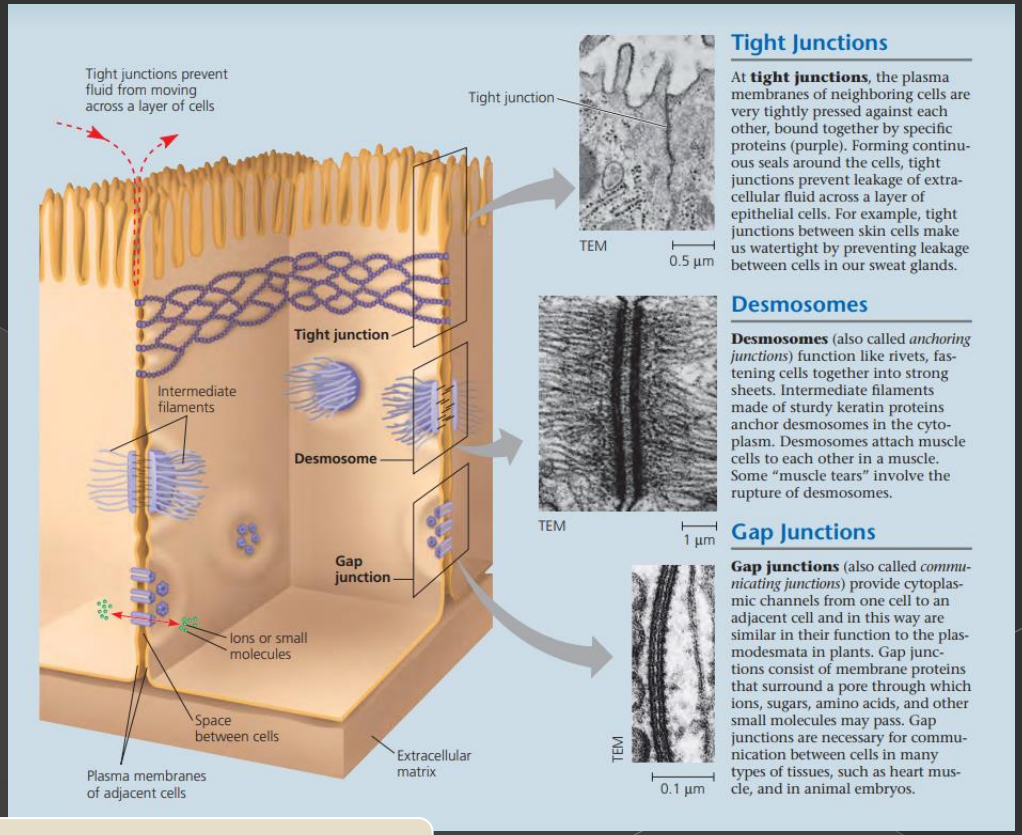
Merupakan saluran atau sambungan sel yang menghubungkan sel dengan sel tetangganya.

Fungsi :

-Komunikasi

-Suplai nutrisi

-Tempat melekat (jangkar) pada epitel



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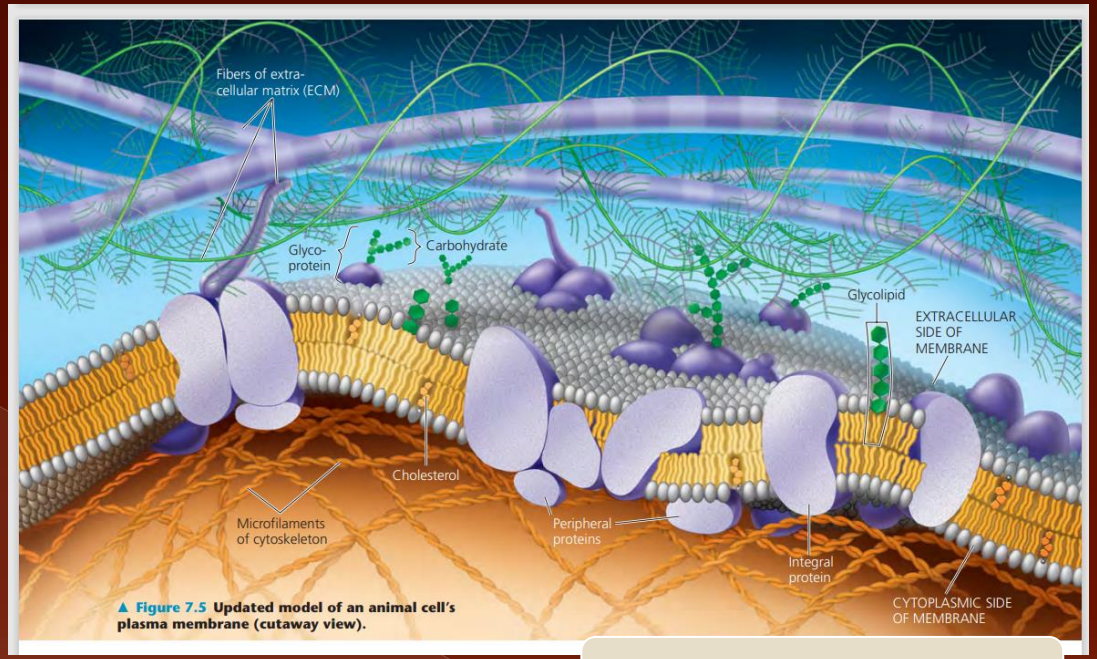
MEMBRAN SEL

* STRUKTUR :
    - -LIPID (LEMAK)
    - -PROTEIN
    - -KARBOHIDRAT
* FUNGSI :
    - -BATAS PEMISAH
    - -PELINDUNG/SELUBUNG
    - -LALULINTAS MOLEKUL (PERMEABEL SELEKTIF



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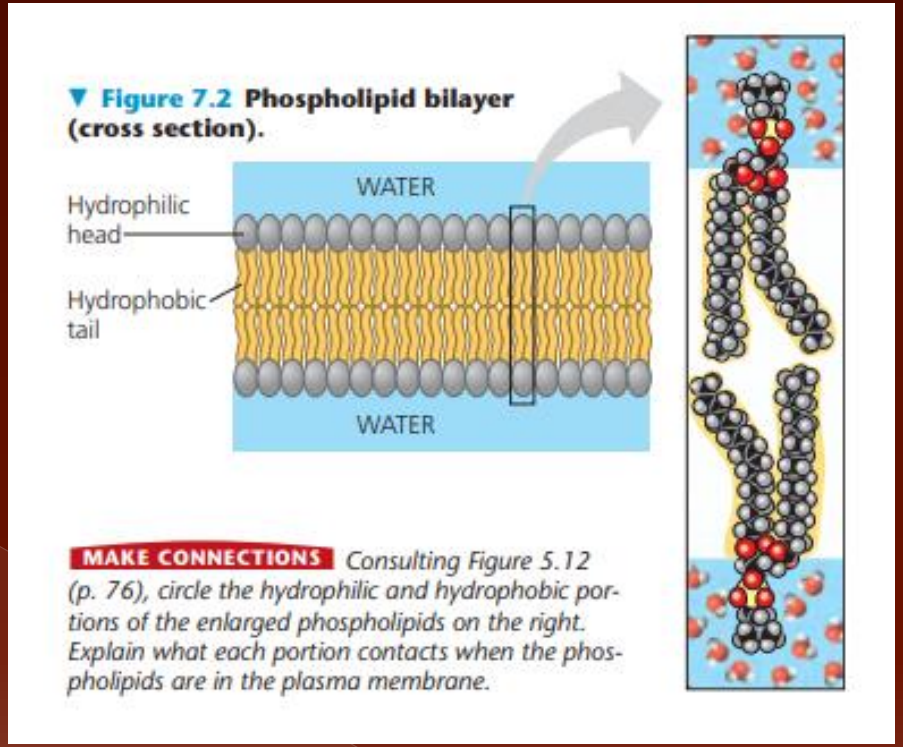


MEMBRAN SEL :

-Bilayer lipid

-Lipid bersifat AMFIPATIK dengan kepala polar HIDROFILIK yang menghadap ke luar dan ekor HIDROFOBIK menghadap ke dalam

-Protein (hidrofilik) terbenam dalam bilayer lipid (protein transmembran) dan dipermukaan bilayer lipid (protein perifer)→ model mosaik fluida

SISI MEMBRAN :

-Bagian luar dan dalam

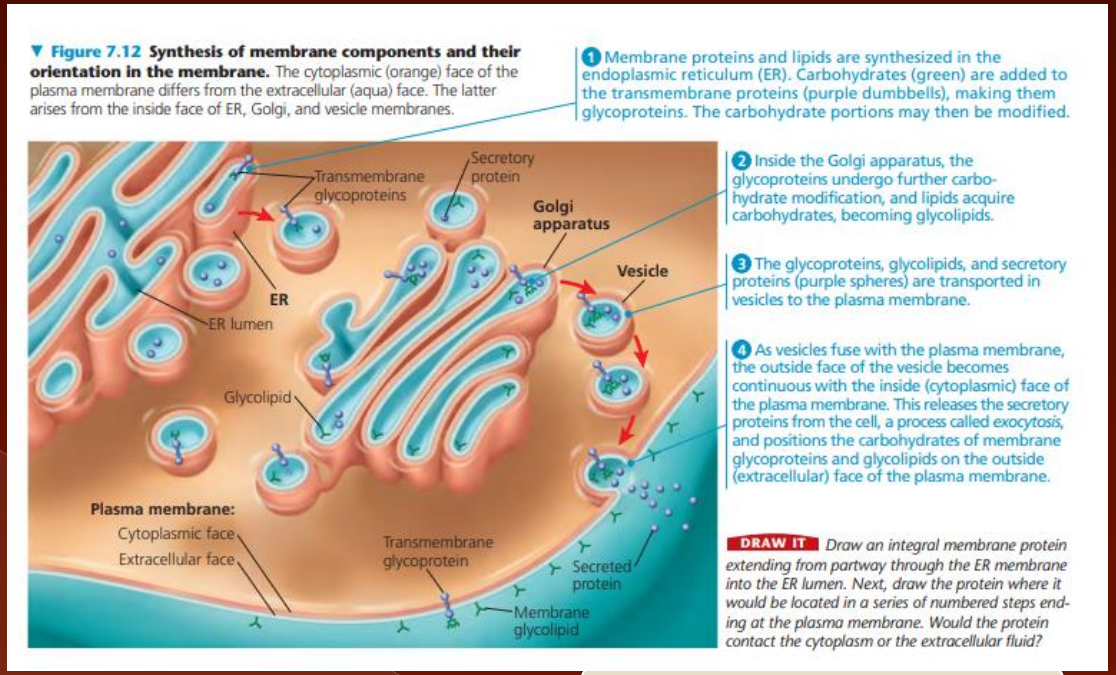
-Distribusi lipid, protein dan karbohidrat →

asimetris

-Karbohidrat → oligosakarida

-Berikatan dengan lipid → glikolipid

-Berikatan dengan protein → glikoprotein



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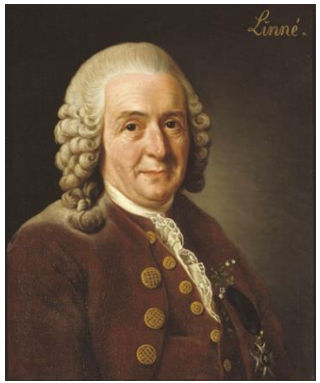

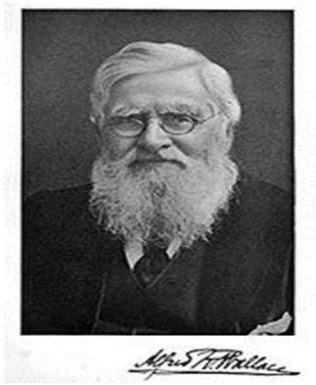

Terima kasih !