Physiology

Ref.: Textbook of Medical Physiology.

Jordan Edition

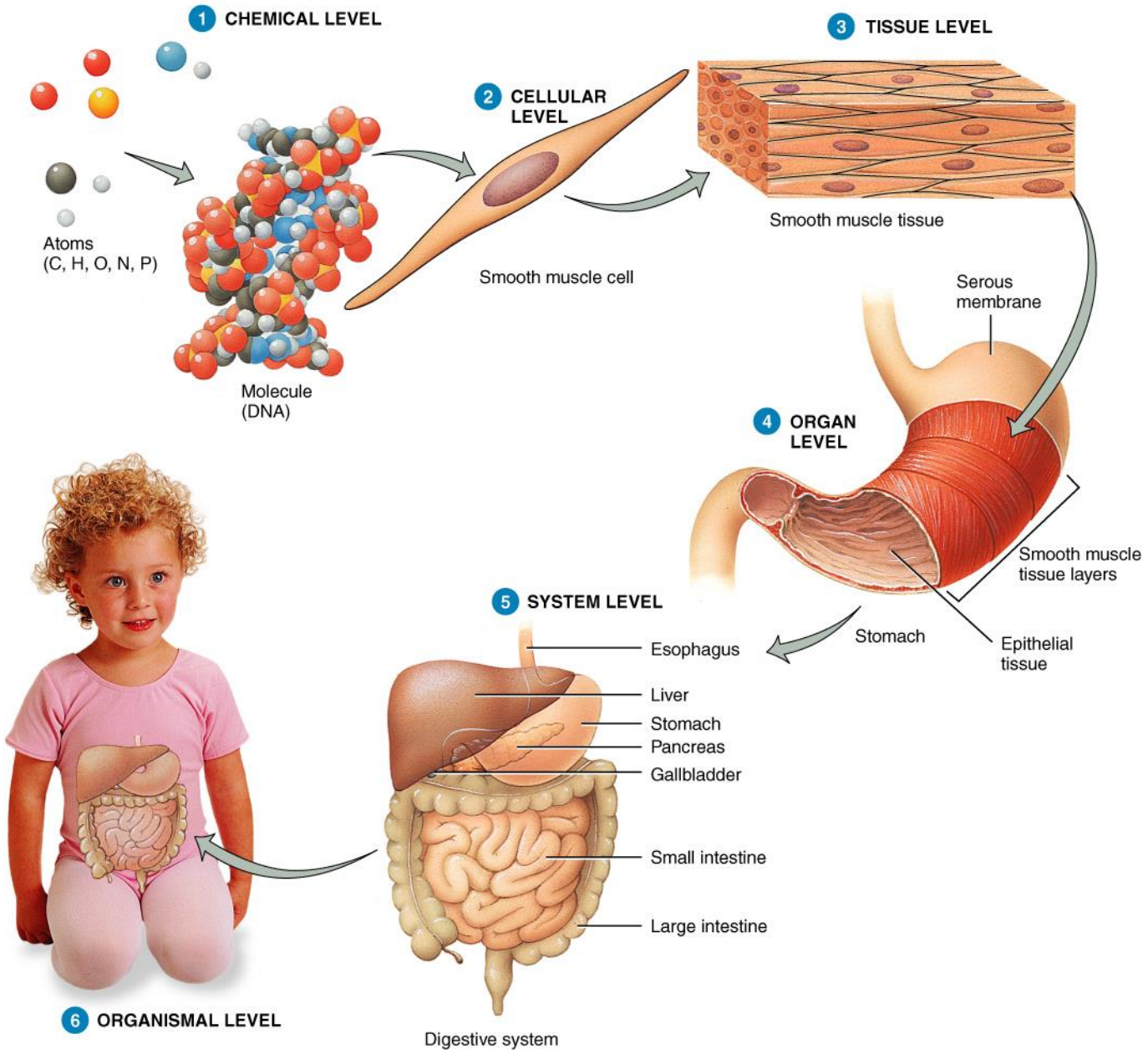
By, Guyton and Hall.

Subjects	Lect. No.	Pages in Guyton Jordan Ed.	
Introduction to Physiology: General outline of physiology. Homeostasis, control systems, negative & positive feedback mechanism	1	MK 3-19	
Cell Membrane : Recorded	2	MK 11-14	
Transport-I (Passive) A. Simple Diffusion B. Facilitated Diffusion C. Osmosis Units: moles, osmoles and equivalent. Osmosis and osmotic pressure Recorded	3	MK 47-54	
Transport-II (Active) A. Primary Active. B. Secondary Active: Co-and Counter-Transport C. Vesicular transport	4 (2)	MK 54-59	
Excitable Membranes: Resting Membrane Potential: Origin And Determinants. Distribution Of Different Ions Across Cell Membranes Electrochemical Equilibrium (Nernst Equation) As a Predictor For RMP -E_{Na+}, E_{K+}, E_{Ca++}, E_{Cl-} -Other Equations Which Predict RMP: Goldman-Hodgkin-Katz Equation And Chord Conductance Equation Recorded	5	MK 59-73	
Action potentials, All or none versus graded potential, phases	6 (3)		
Generation of action potentials in neural cells Recorded	7		
Review lecture	8 (4)		
Autonomic Nervous System (I) Organization: Sympathetic and Parasympathetic and -	9	773-785	

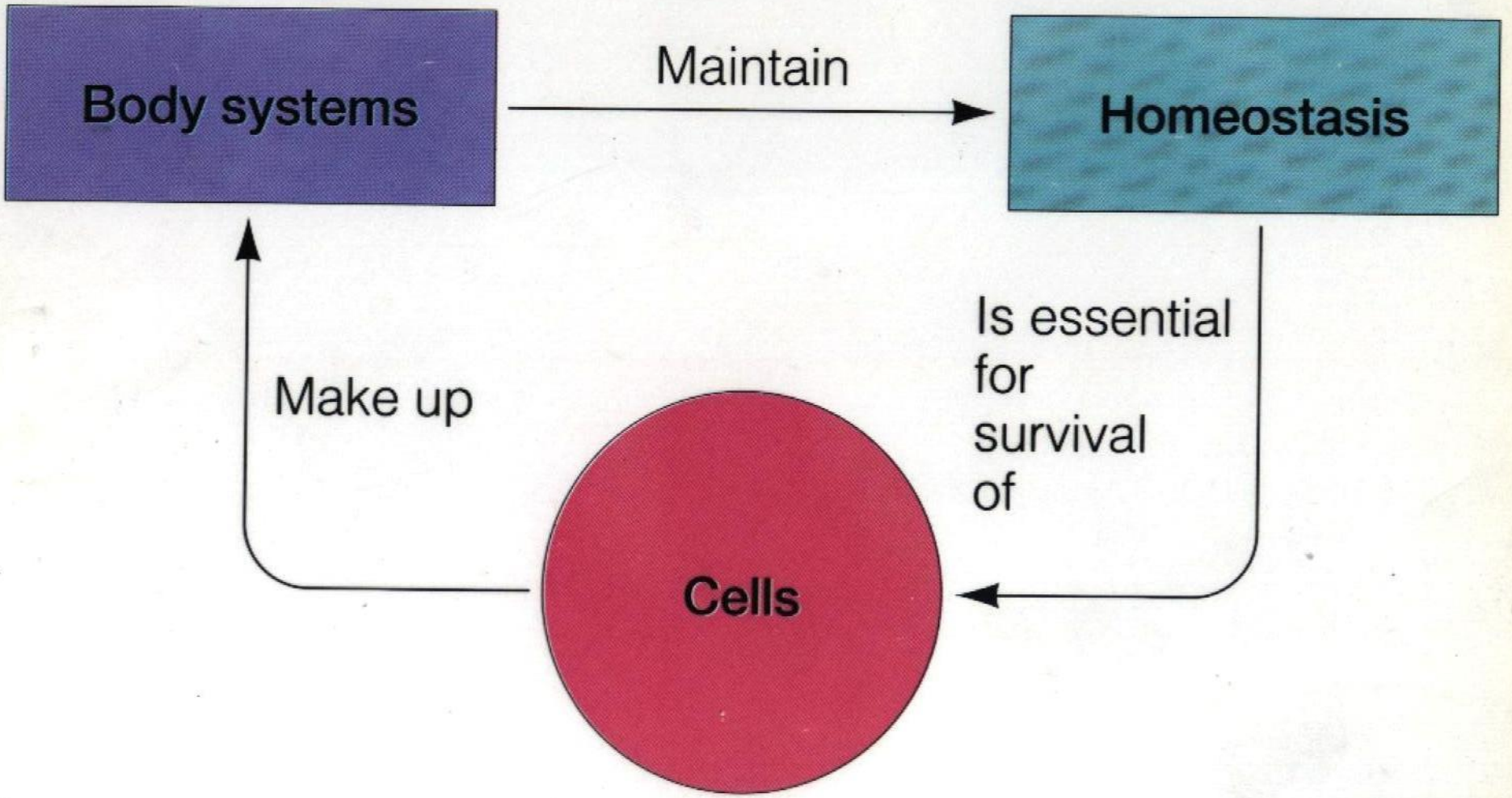
Physiology

Introduction

Fig. 01.01


1 CHEMICAL LEVEL
Atoms
(C, H, O, N, P)
Molecule
(DNA)
2 CELLULAR LEVEL
Smooth muscle cell
3 TISSUE LEVEL
Smooth muscle tissue
Serous membrane
4 ORGAN LEVEL
Smooth muscle tissue layers
Epithelial tissue
Stomach
5 SYSTEM LEVEL
Esophagus
Liver
Stomach
Pancreas
Gallbladder
Small intestine
Large intestine
Digestive system
6 ORGANISMAL LEVEL

Interdependent Relationship of Cells, Body Systems, and Homeostasis



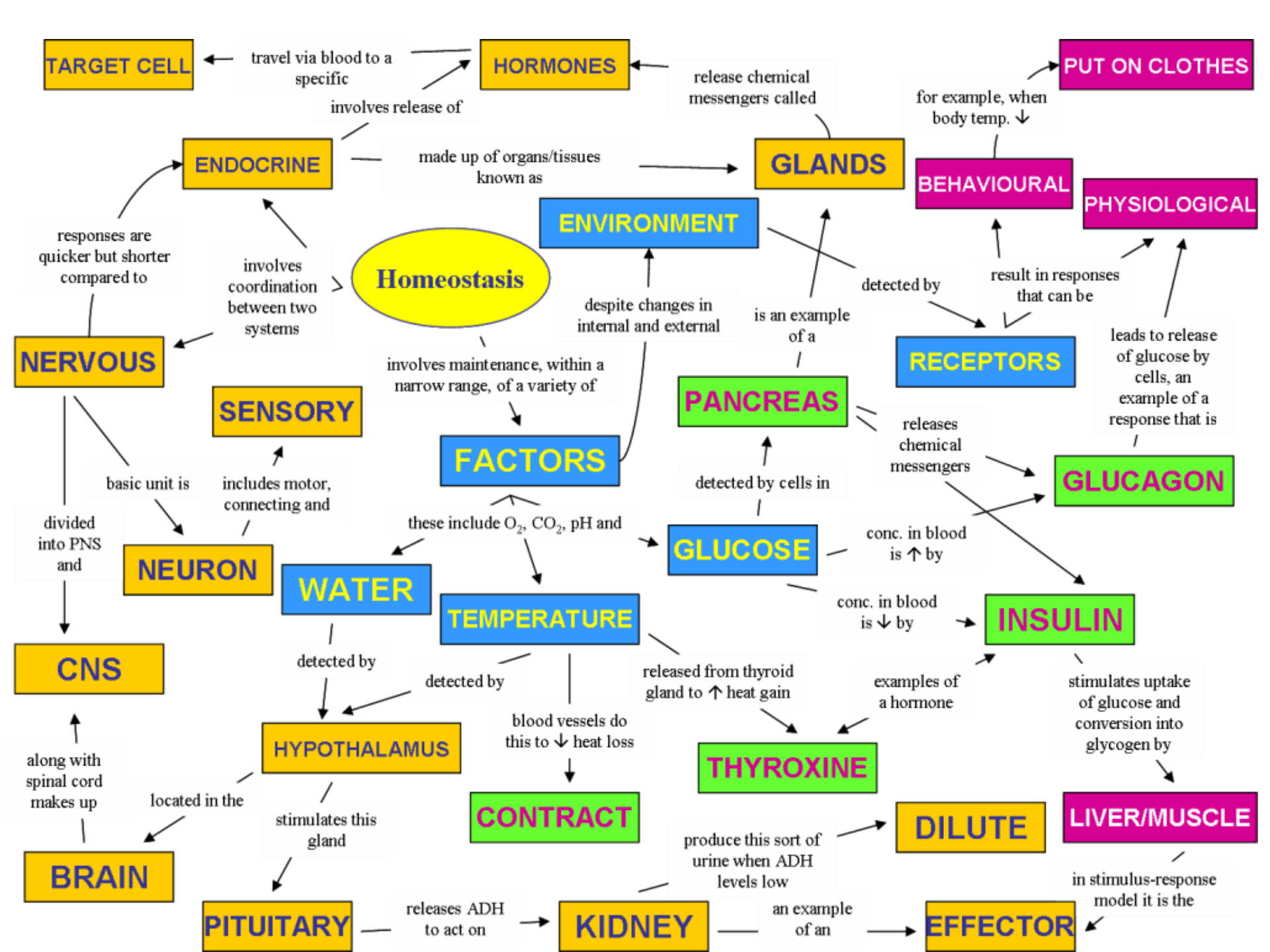
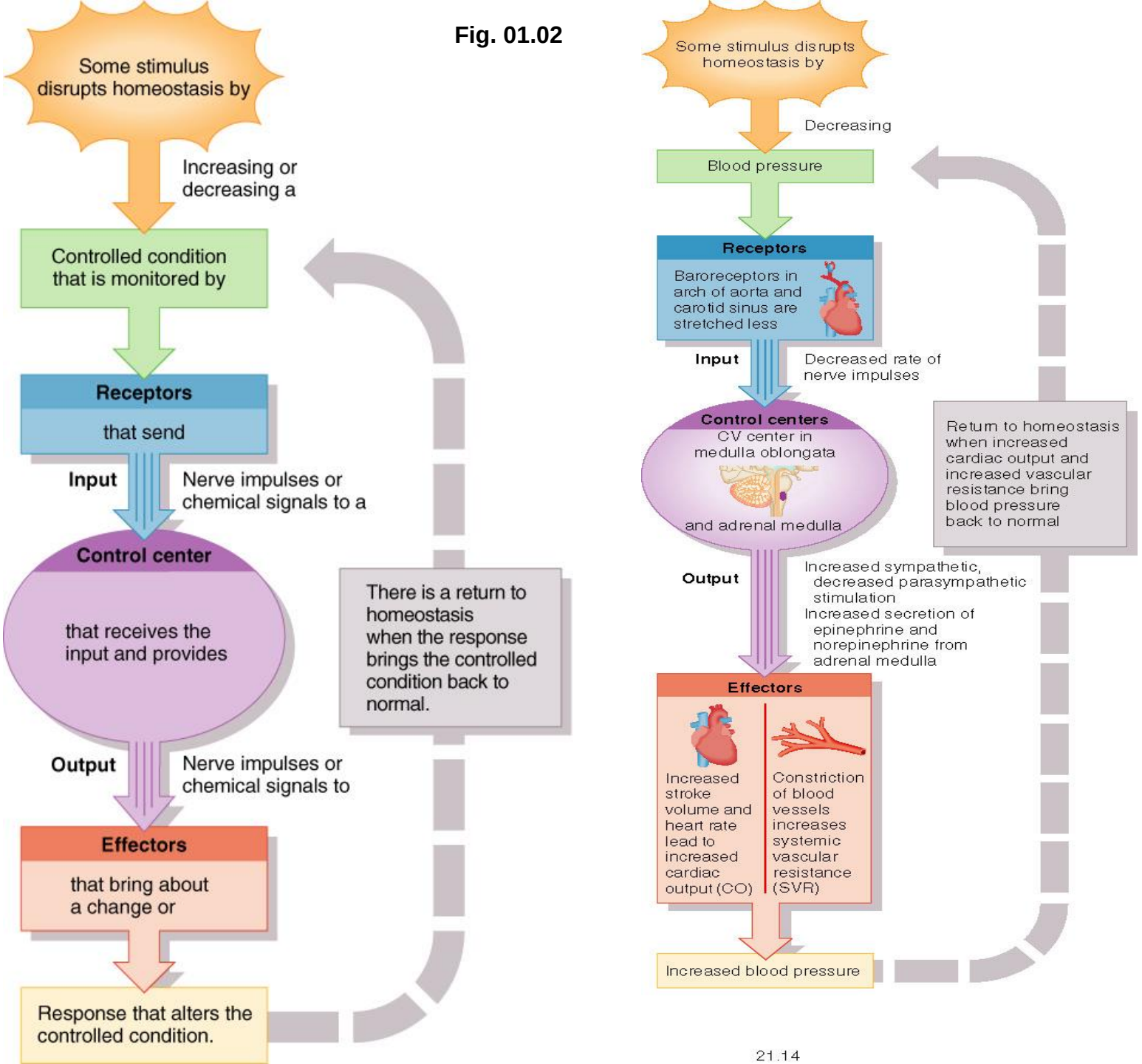
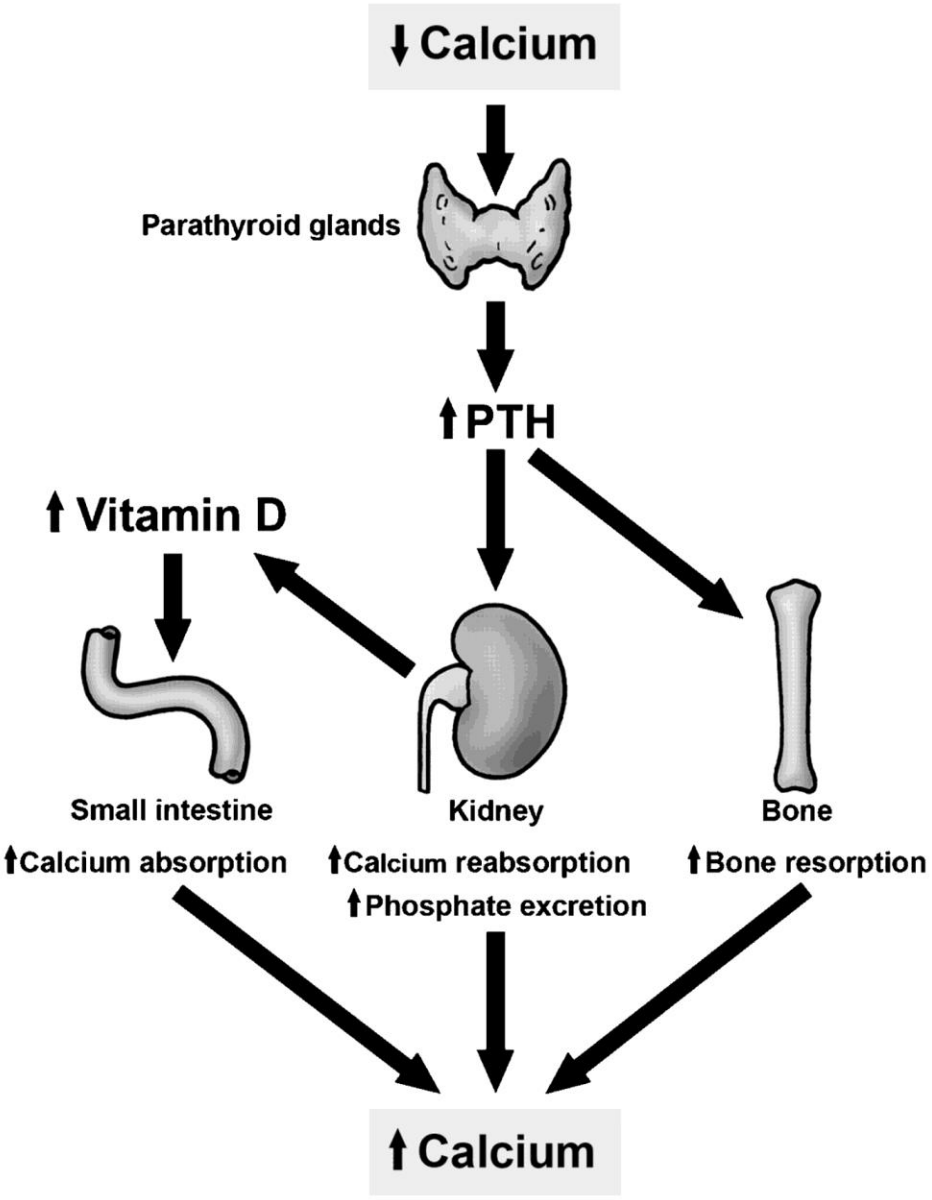
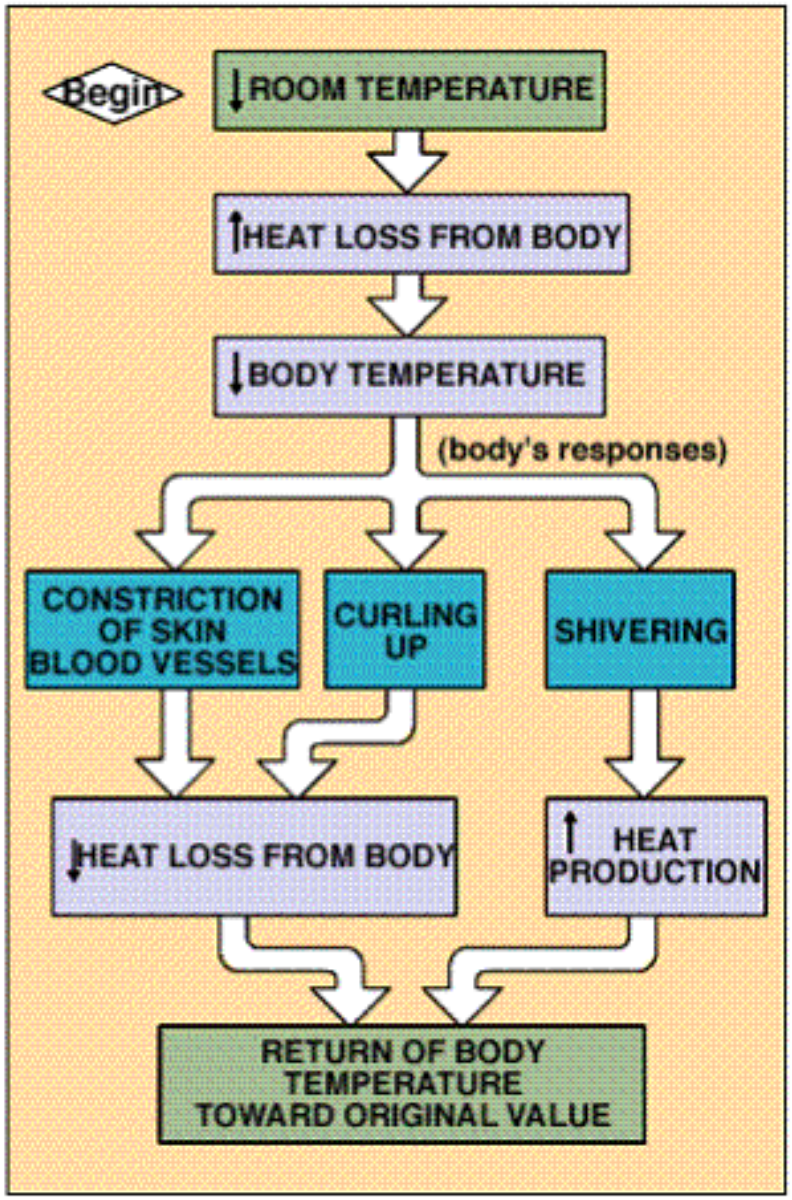

Homeostasis
involves coordination between two systems
involves maintenance, within a narrow range, of a variety of
despite changes in internal and external
ENVIRONMENT
detected by
RECEPTORS
result in responses that can be
BEHAVIOURAL
for example, when body temp. ↓
PUT ON CLOTHES
PHYSIOLOGICAL
leads to release of glucagon by cells, an example of a response that is
GLUCAGON
releases chemical messengers
PANCREAS
is an example of a
GLANDS
release chemical messengers called
HORMONES
travel via blood to a specific
TARGET CELL
involves release of
ENDOCRINE
made up of organs/tissues known as
responses are quicker but shorter compared to
NERVOUS
divided into PNS and
CNS
along with spinal cord makes up
BRAIN
basic unit is
NEURON
includes motor, connecting and
SENSORY
FACTORS
these include O_2, CO_2, pH and
WATER
detected by
HYPOTHALAMUS
located in the
stimulates this gland
PITUITARY
releases ADH to act on
KIDNEY
produce this sort of urine when ADH levels low
DILUTE
an example of an
EFFECTOR
in stimulus-response model it is the
LIVER/MUSCLE
stimulates uptake of glucose and conversion into glycogen by
INSULIN
conc. in blood is ↓ by
conc. in blood is ↑ by
GLUCOSE
detected by cells in
TEMPERATURE
detected by
blood vessels do this to ↓ heat loss
CONTRACT
released from thyroid gland to ↑ heat gain
THYROXINE
examples of a hormone

Fig. 01.02

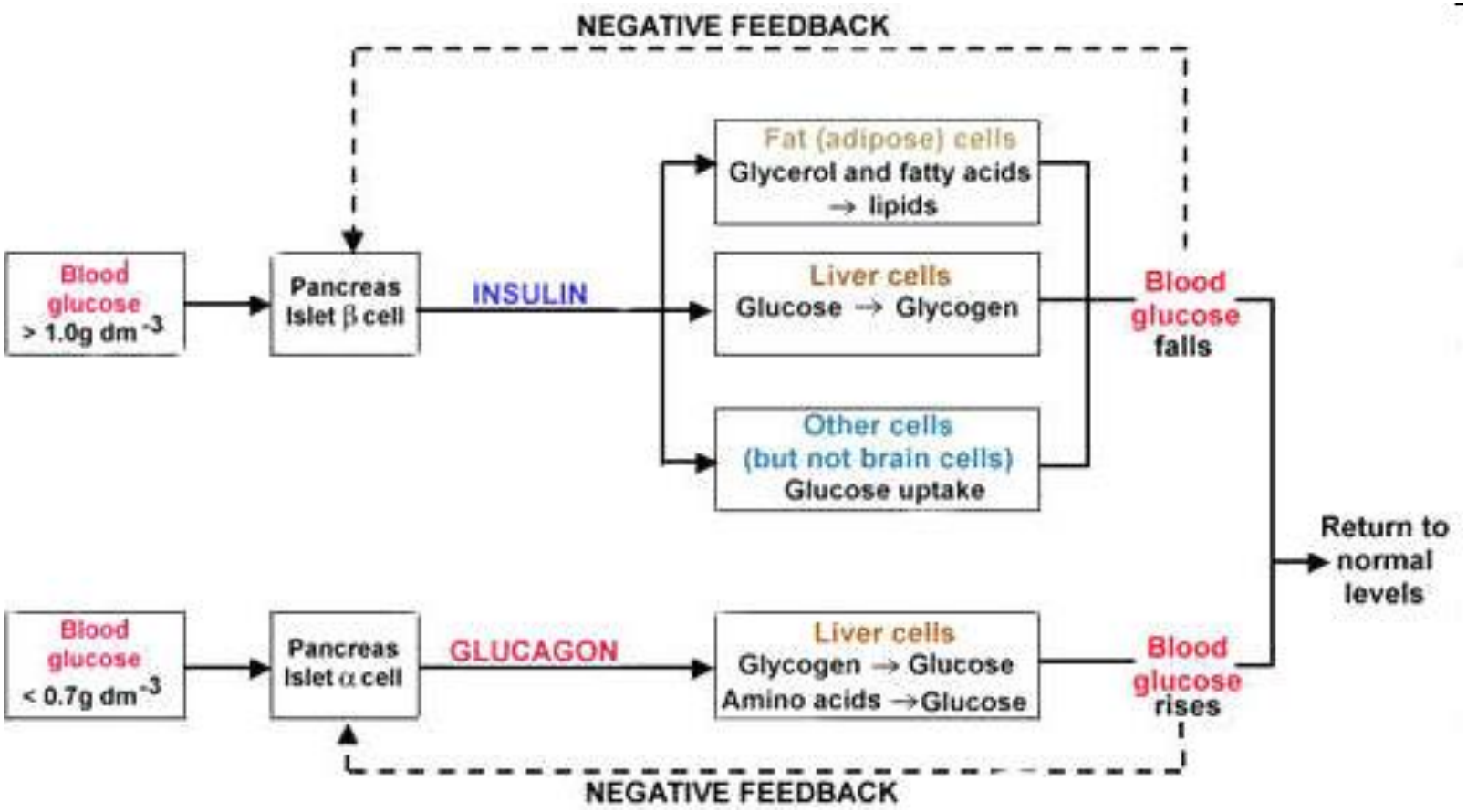

Some stimulus disrupts homeostasis by
Increasing or decreasing a
Controlled condition that is monitored by
Receptors
that send
Input
Nerve impulses or chemical signals to a
Control center
that receives the input and provides
Output
Nerve impulses or chemical signals to
Effectors
that bring about a change or
Response that alters the controlled condition.
There is a return to homeostasis when the response brings the controlled condition back to normal.
Some stimulus disrupts homeostasis by
Decreasing
Blood pressure
Receptors
Baroreceptors in arch of aorta and carotid sinus are stretched less
Input
Decreased rate of nerve impulses
Control centers
CV center in medulla oblongata
and adrenal medulla
Output
Increased sympathetic, decreased parasympathetic stimulation
Increased secretion of epinephrine and norepinephrine from adrenal medulla
Effectors
Increased stroke volume and heart rate lead to increased cardiac output (CO)
Constriction of blood vessels increases systemic vascular resistance (SVR)
Increased blood pressure
Return to homeostasis when increased cardiac output and increased vascular resistance bring blood pressure back to normal

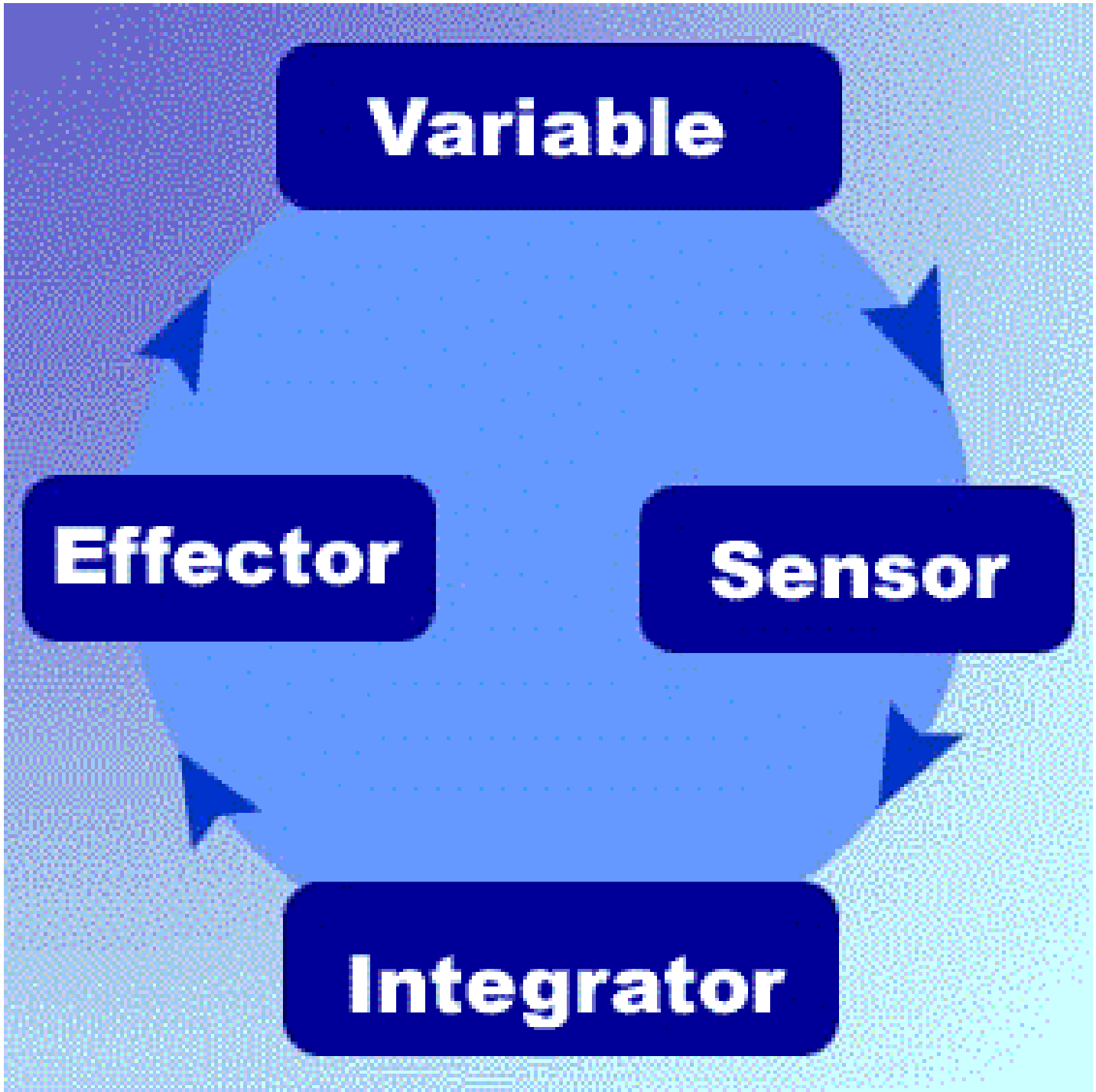

↓Calcium
Parathyroid glands
↑PTH
↑Vitamin D
Small intestine
↑Calcium absorption
Kidney
↑Calcium reabsorption
↑Phosphate excretion
Bone
↑Bone resorption
↑Calcium

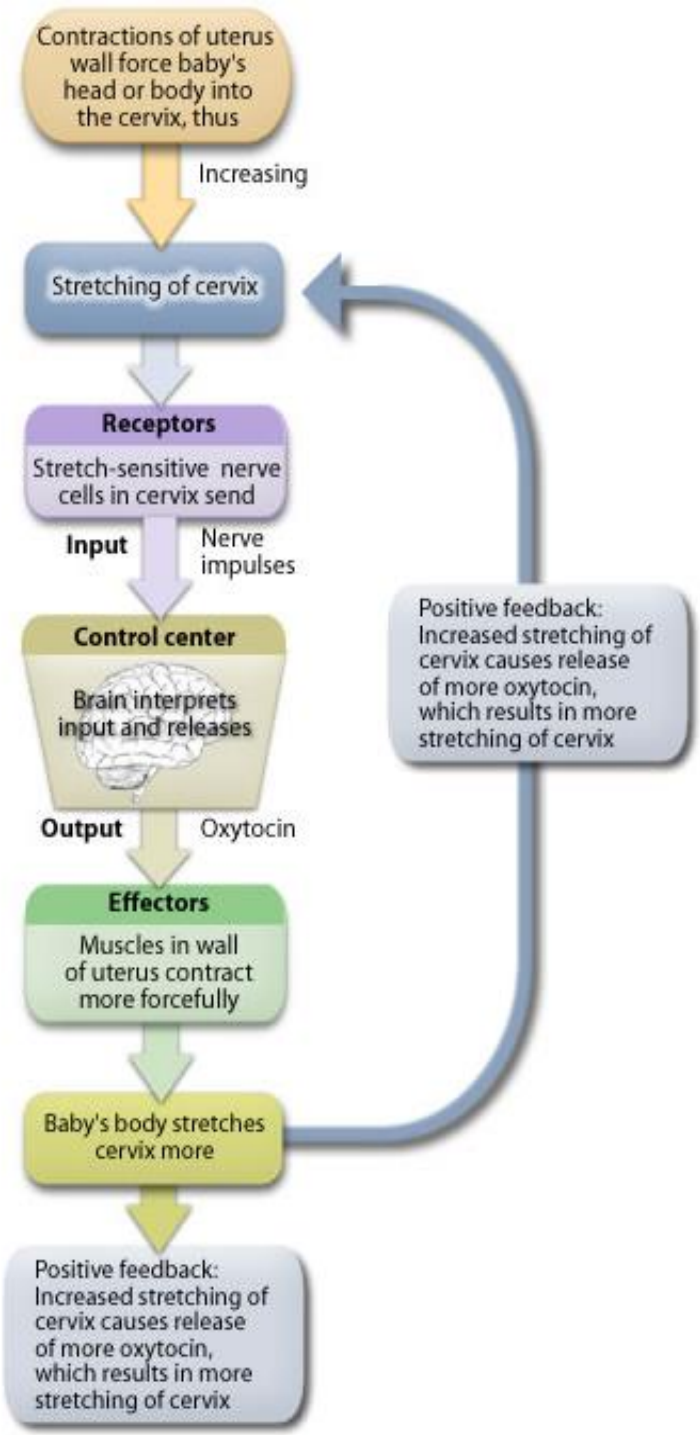
Homeostatic Control System



NEGATIVE FEEDBACK




Variable
Sensor
Integrator
Effector

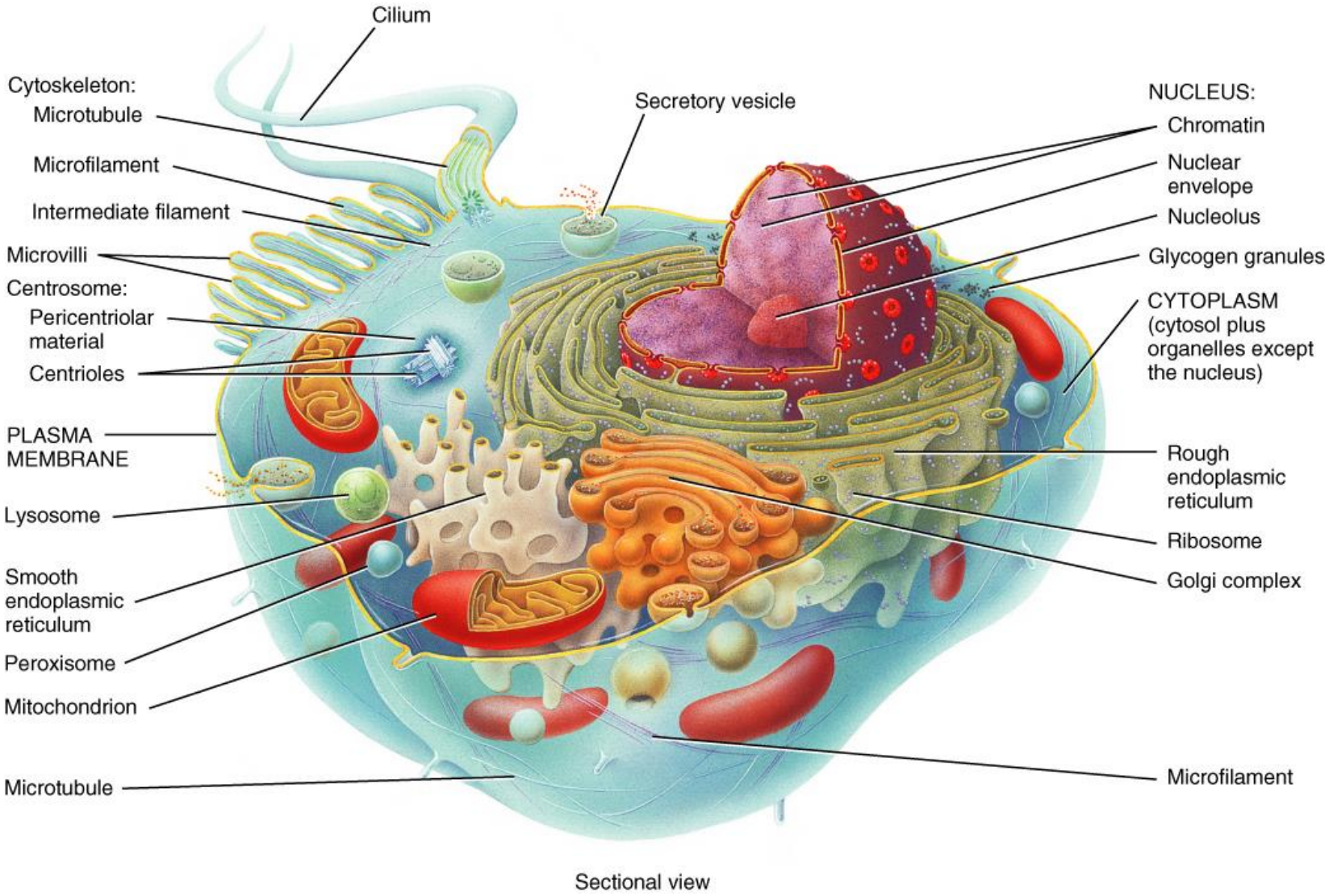


POSITIVE FEEDBACK

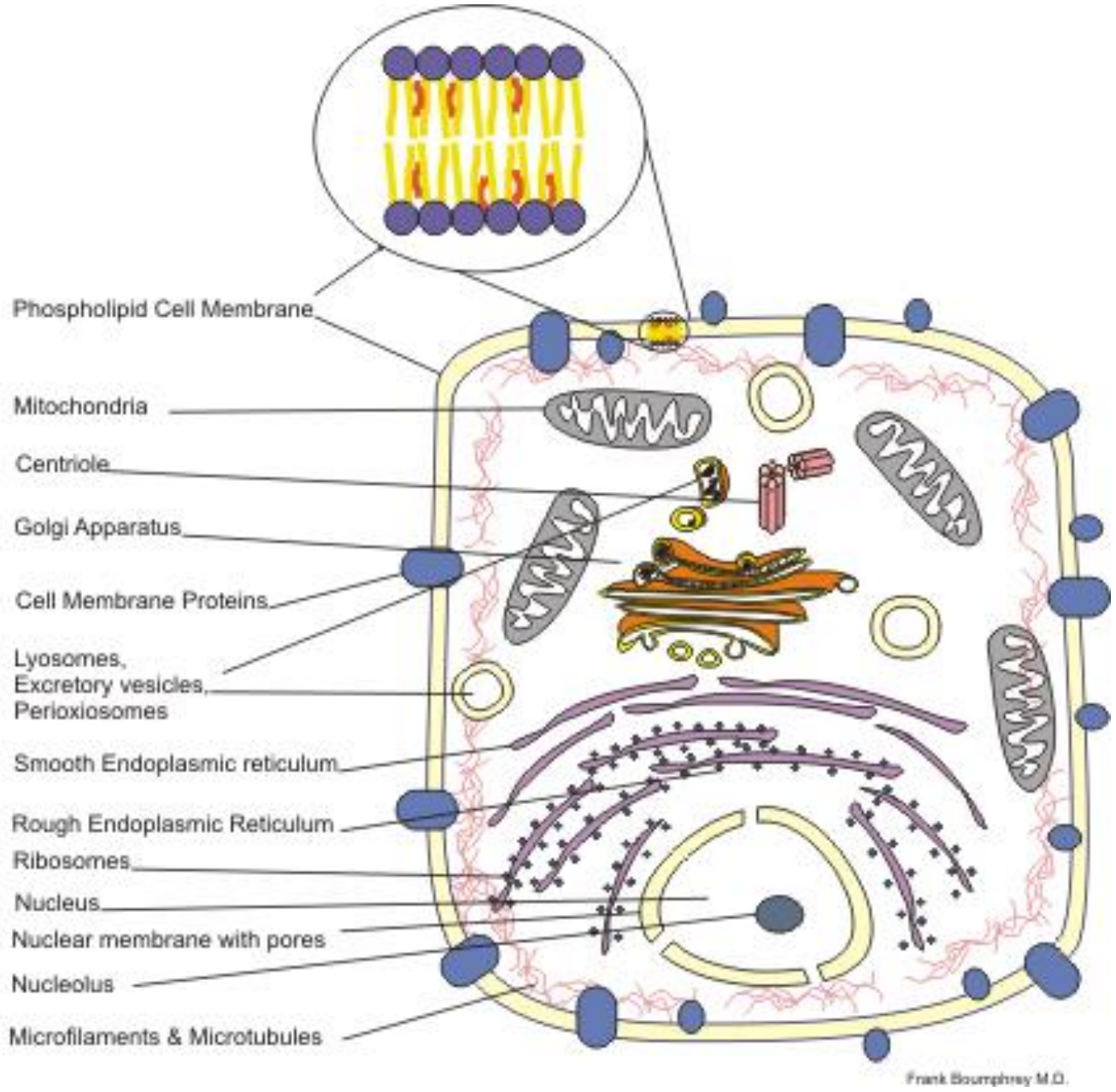
CELL STRUCTURES AND FUNCTIONS

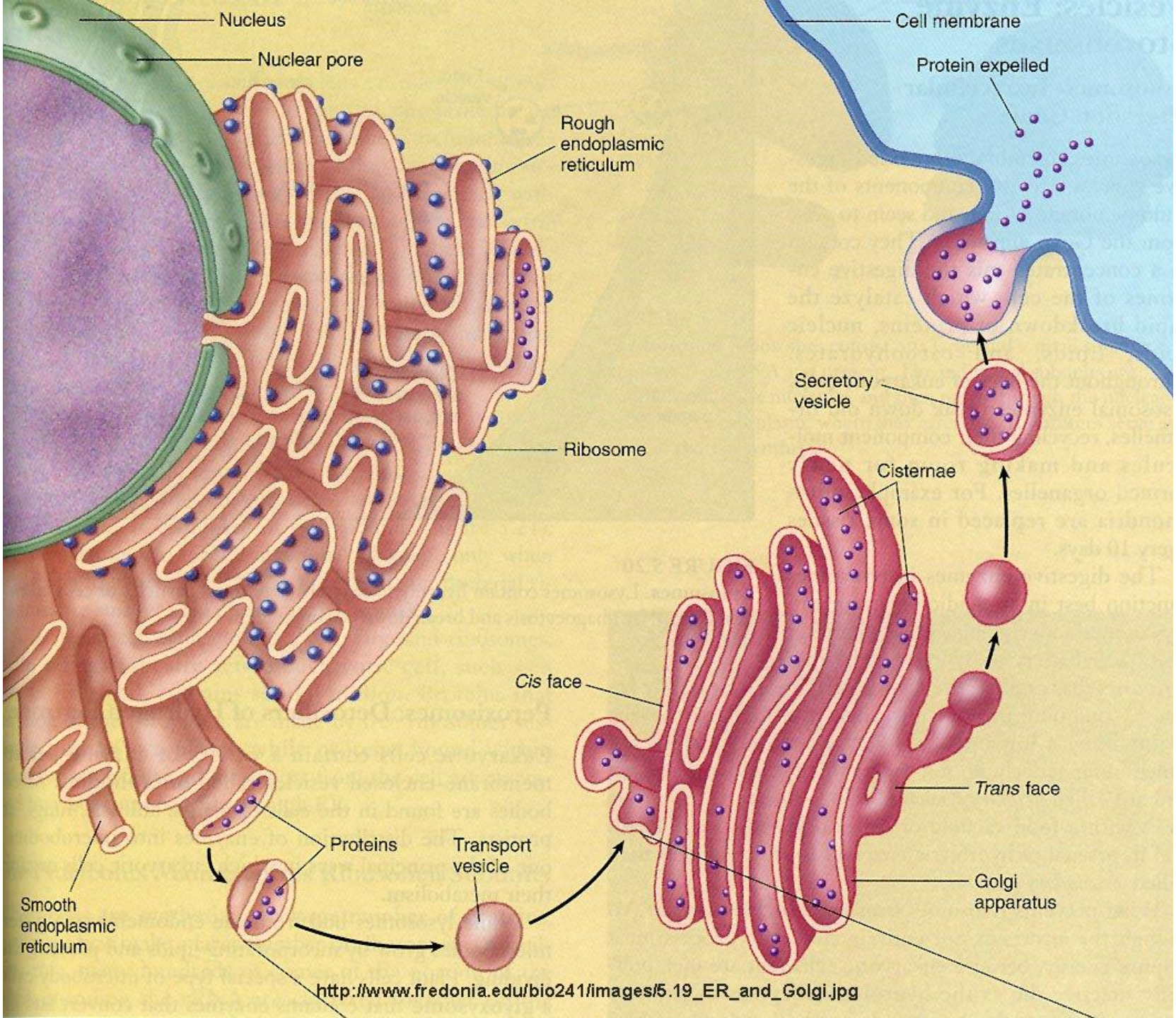
- https://www.youtube.com/watch?v=0xe1s65IH0w&t=9s

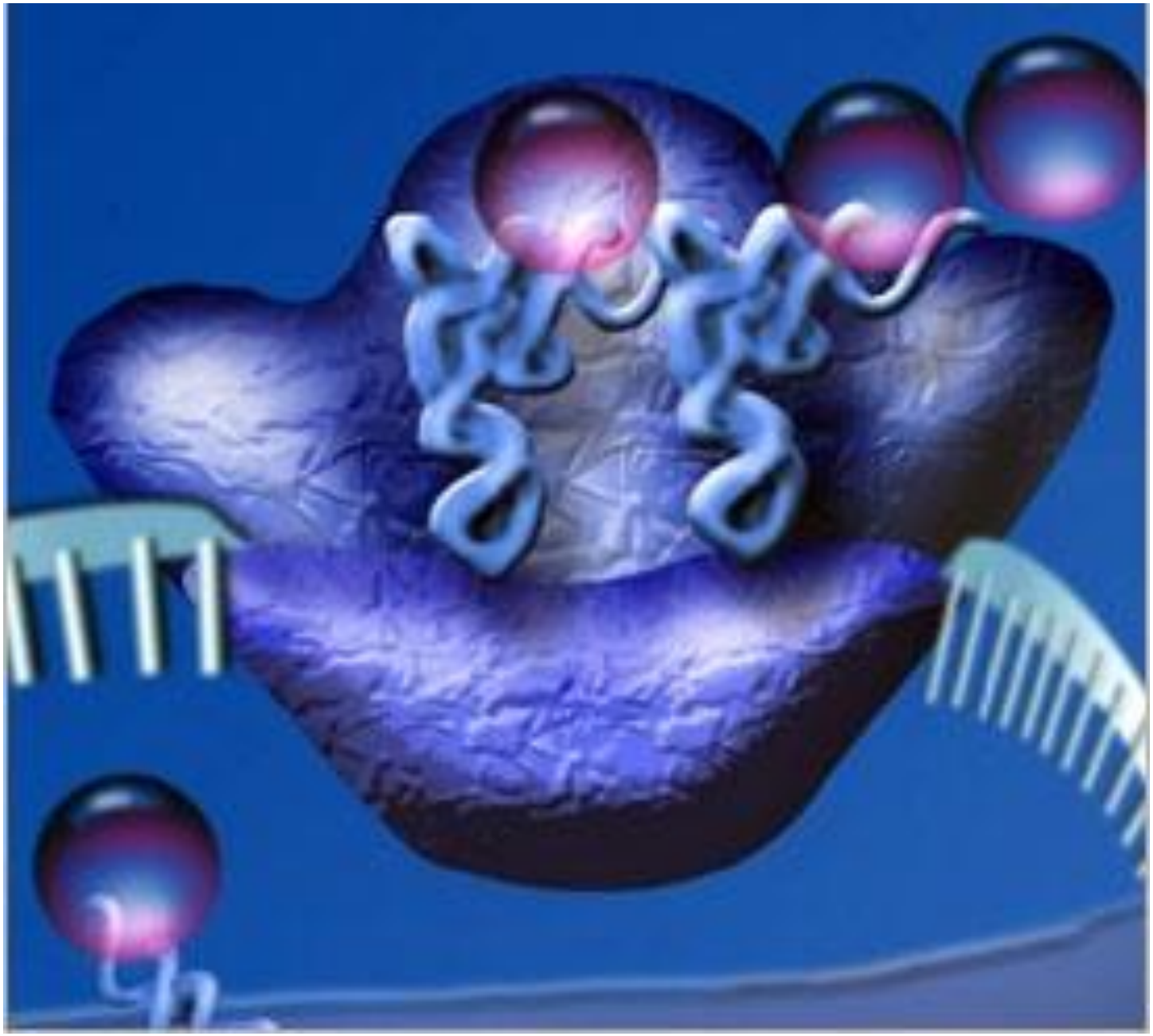
Fig. 03.01

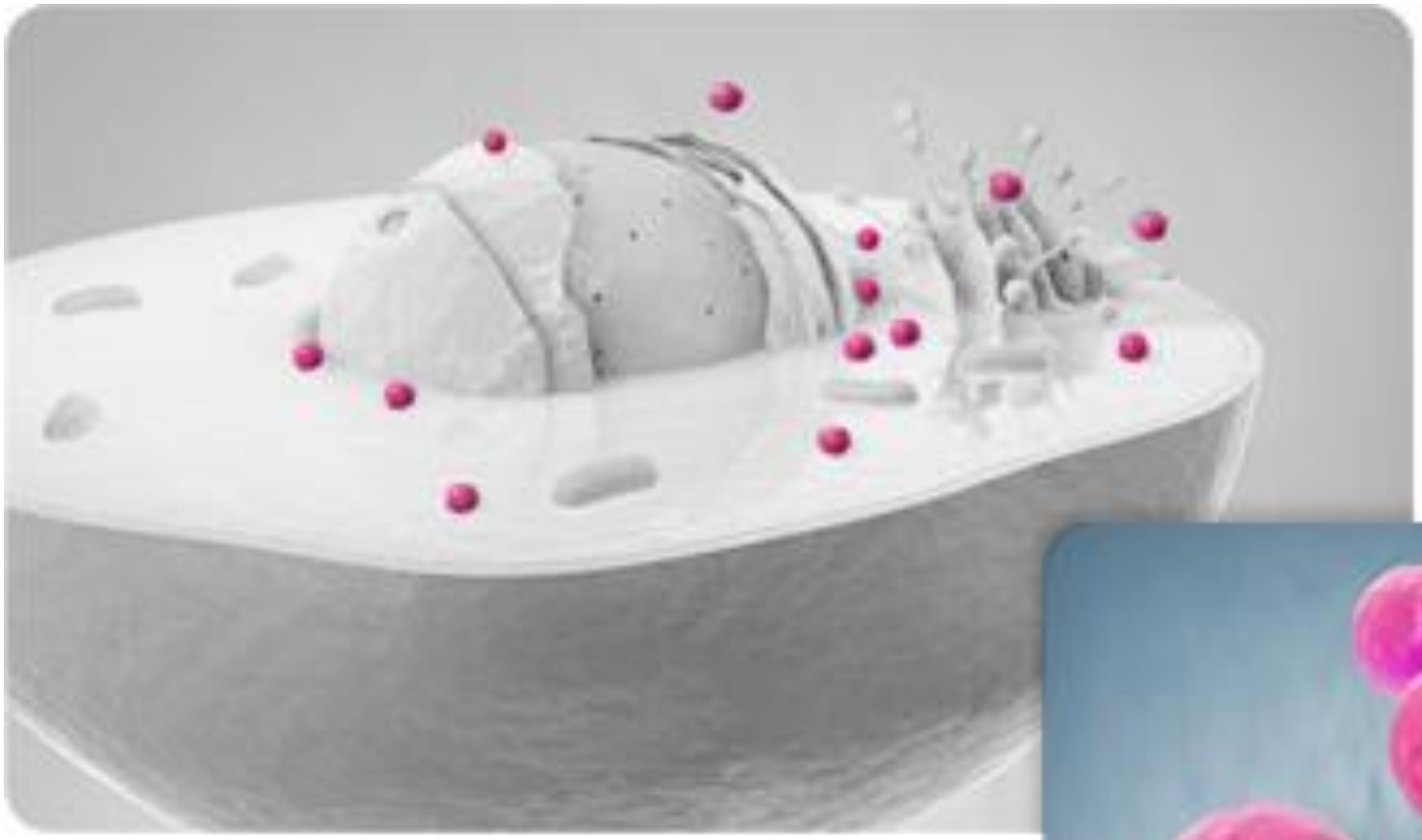


Sectional view


Phospholipid Cell Membrane
Mitochondria
Centriole
Golgi Apparatus
Cell Membrane Proteins
Lyosomes,
Excretory vesicles,
Perioxiosomes
Smooth Endoplasmic reticulum
Rough Endoplasmic Reticulum
Ribosomes
Nucleus
Nuclear membrane with pores
Nucleolus
Microfilaments & Microtubules
Frank Boumphrey M.D.


Nucleus
Nuclear pore
Rough endoplasmic reticulum
Ribosome
Cell membrane
Protein expelled
Secretory vesicle
Cisternae
Cis face
Trans face
Golgi apparatus
Proteins
Transport vesicle
Smooth endoplasmic reticulum
http://www.fredonia.edu/bio241/images/5.19_ER_and_Golgi.jpg

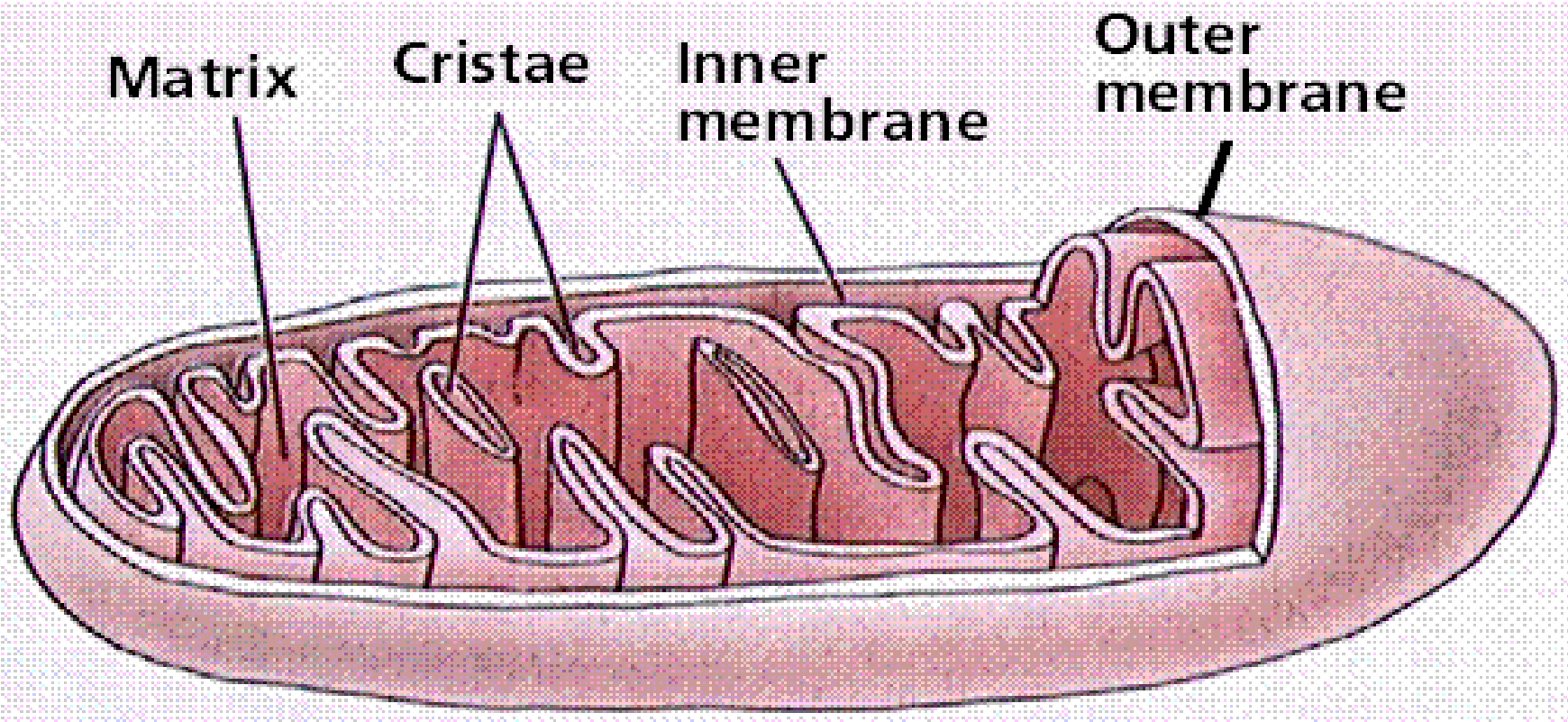




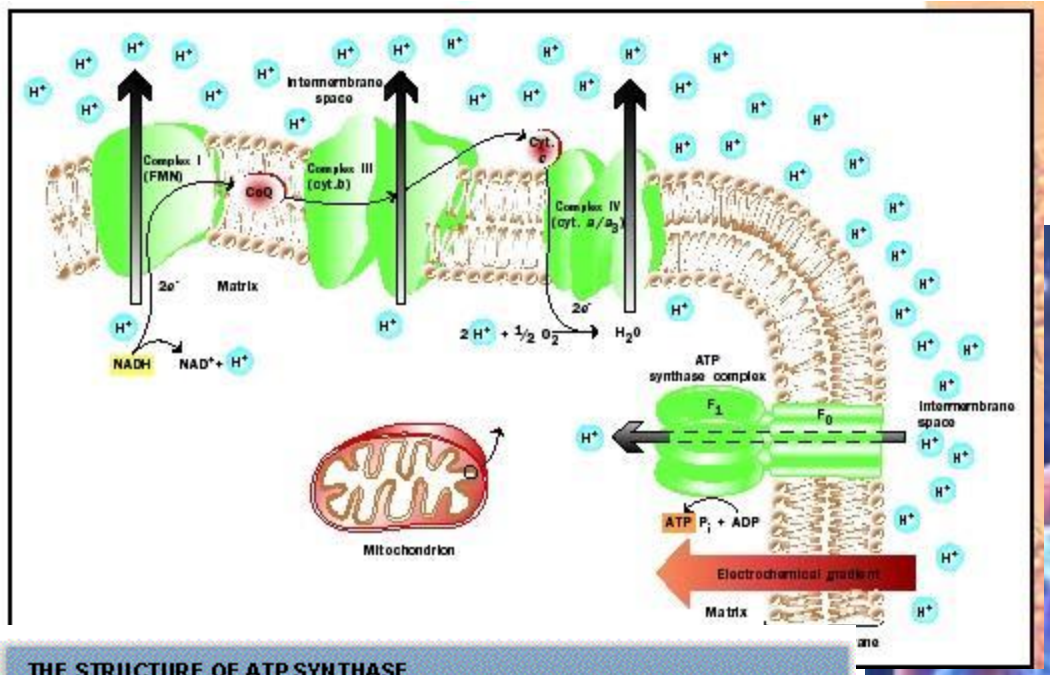
Lysosomes and peroxisomes

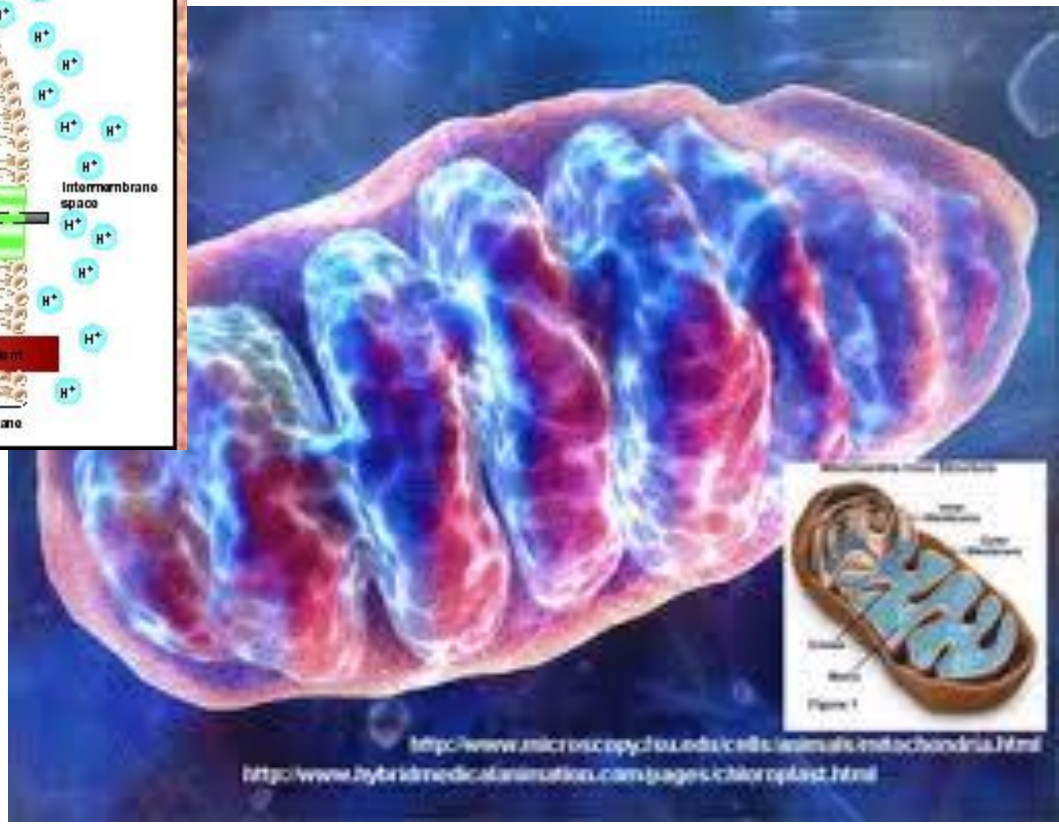
U.S. National Library of Medicine

Mitochondria



https://www.youtube.com/watch?v=c4JsEBI9u6I


Intermembrane space
Complex I (FMN)
CoQ
Complex III (cyt.b)
Cyt. c
Complex IV (cyt. a/a3)
2e⁻
Matrix
NADH
NAD⁺ + H⁺
2 H⁺ + ½ O2
H2O
ATP synthase complex
F1
F0
Intermembrane space
ATP Pi + ADP
Mitochondrion
Electrochemical gradient
Matrix


http://www.microscopyu.com/articles/animals/mitochondria.html
http://www.hybridmedicalanimation.com/pages/chloroplast.html

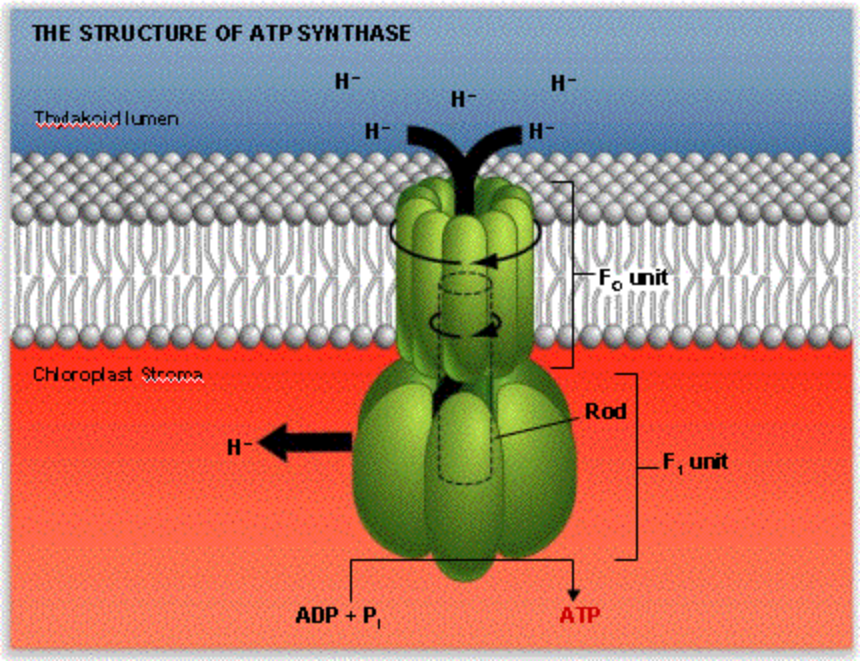
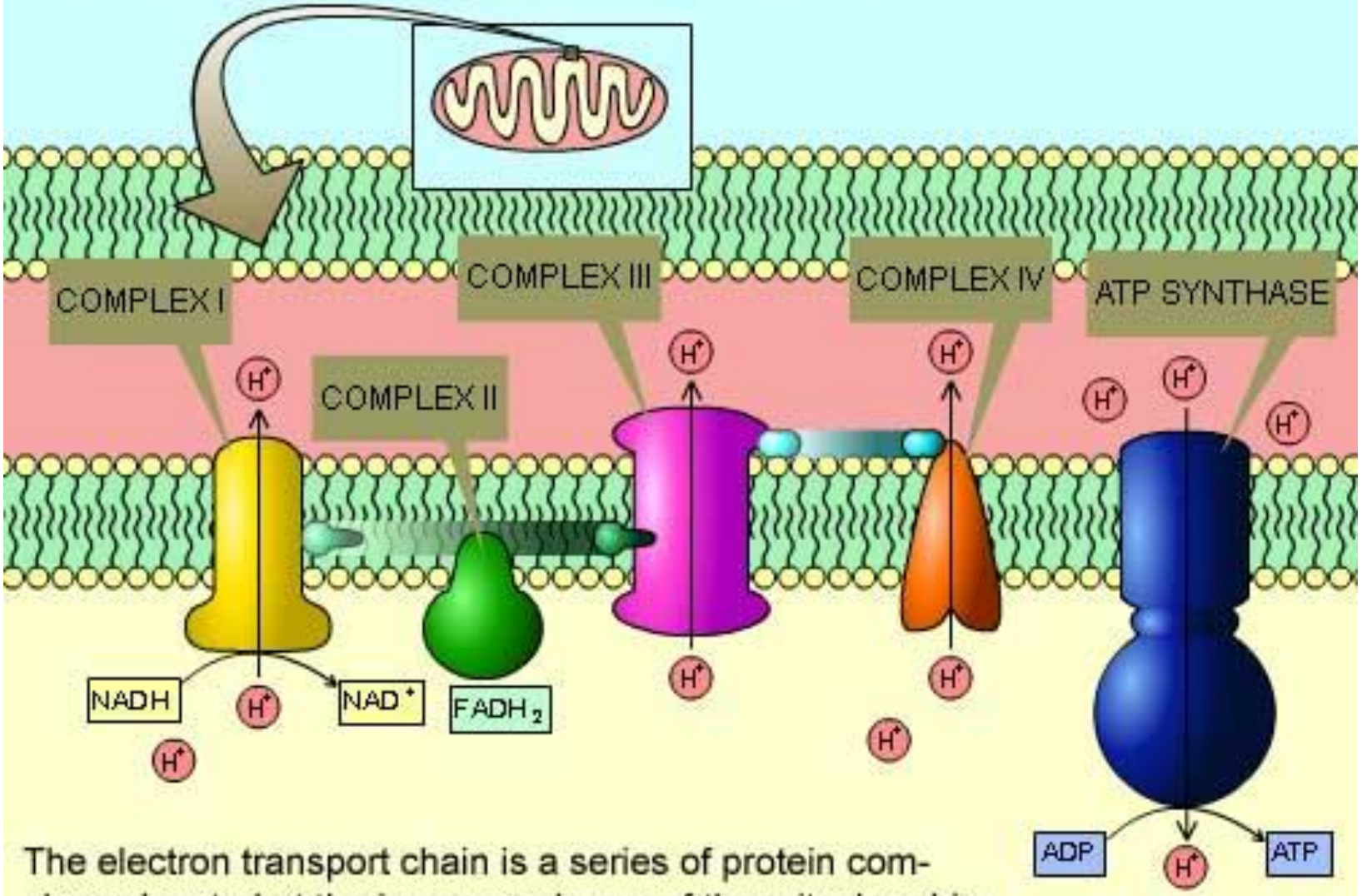
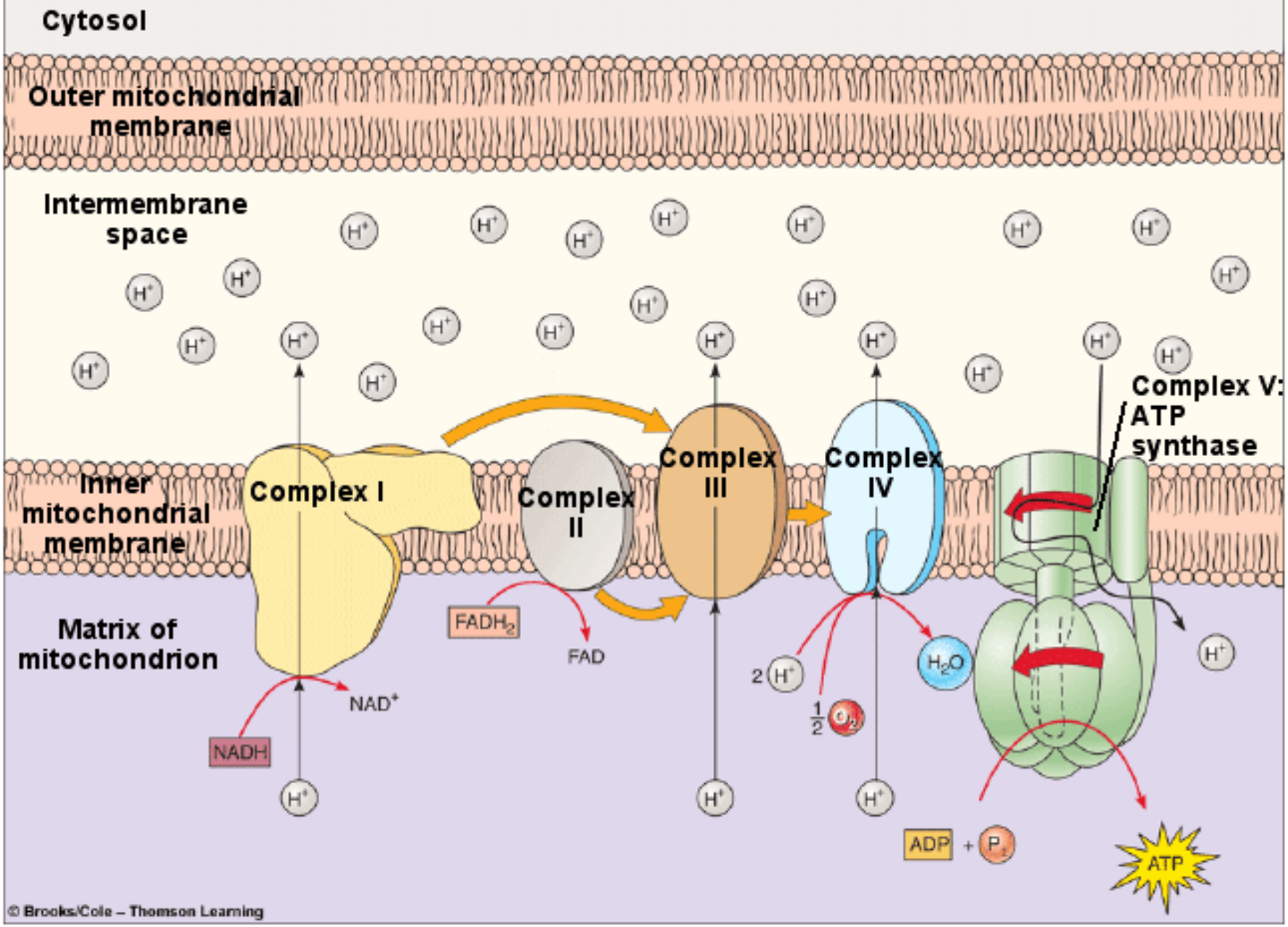

THE STRUCTURE OF ATP SYNTHASE
Thylakoid lumen
H⁻
Fo unit
Chloroplast Stroma
Rod
F1 unit
ADP + Pi
ATP

Figure J-13: Electron Transport Chain

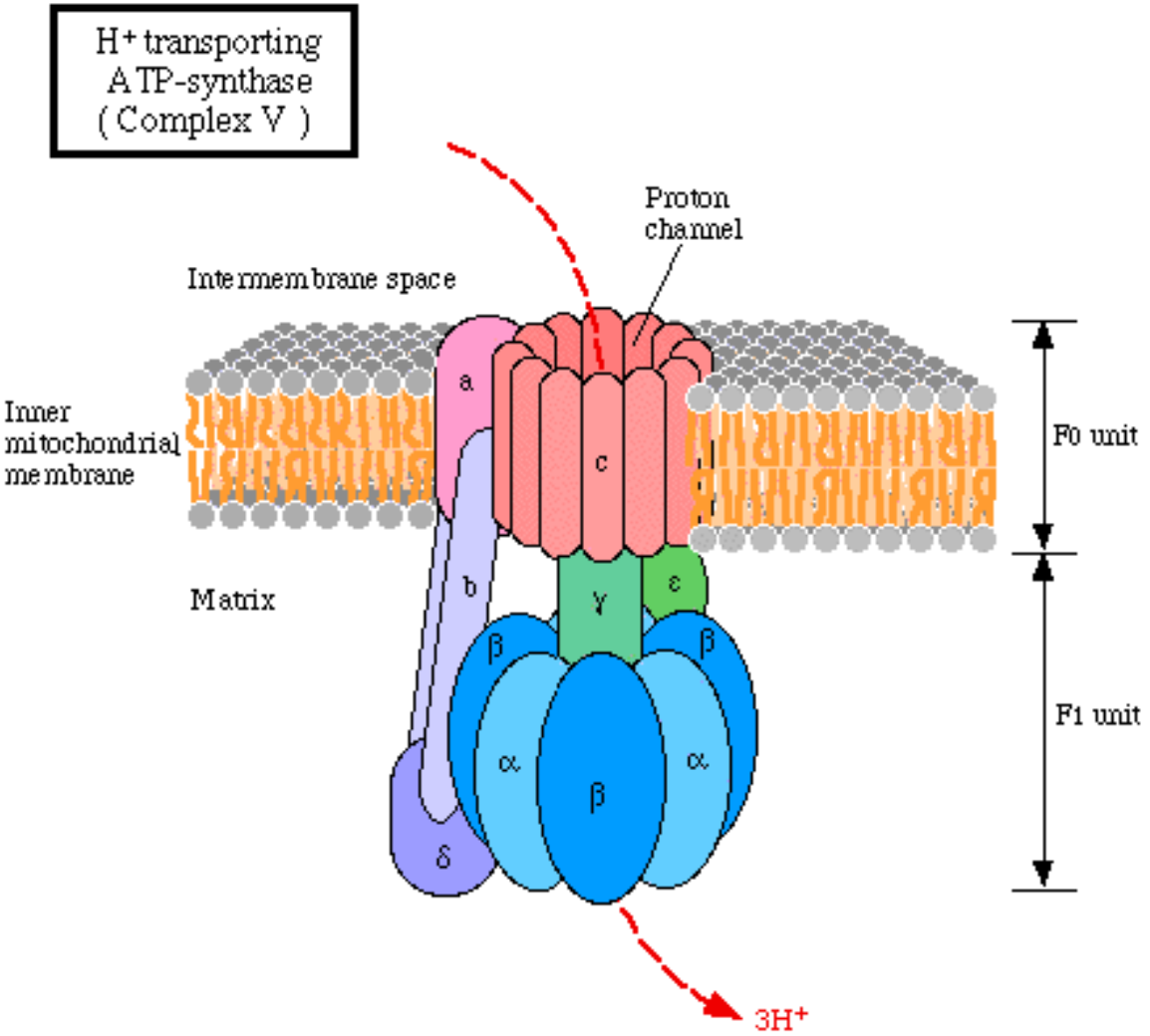


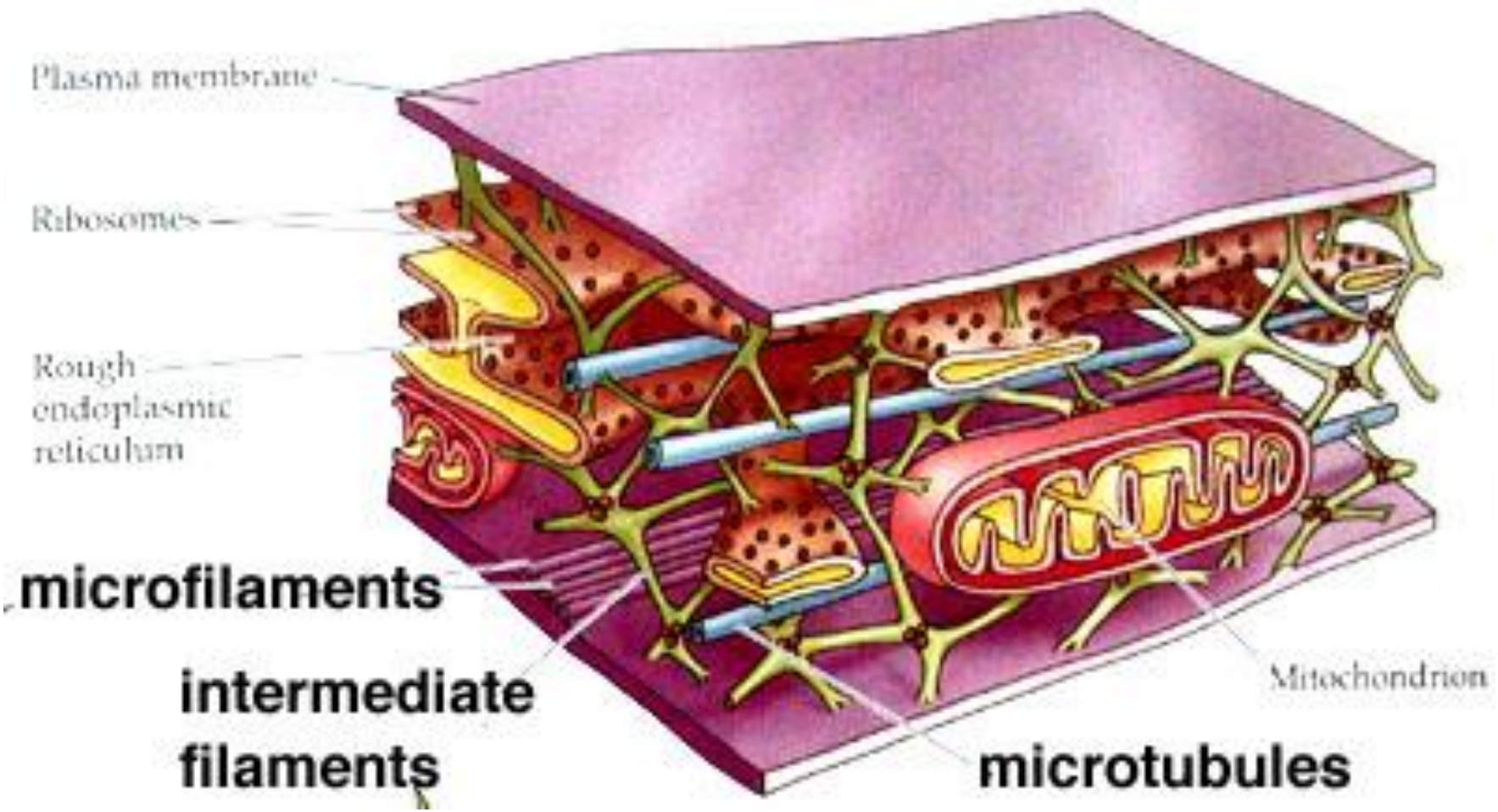
The electron transport chain is a series of protein complexes located at the inner membrane of the mitochondria.

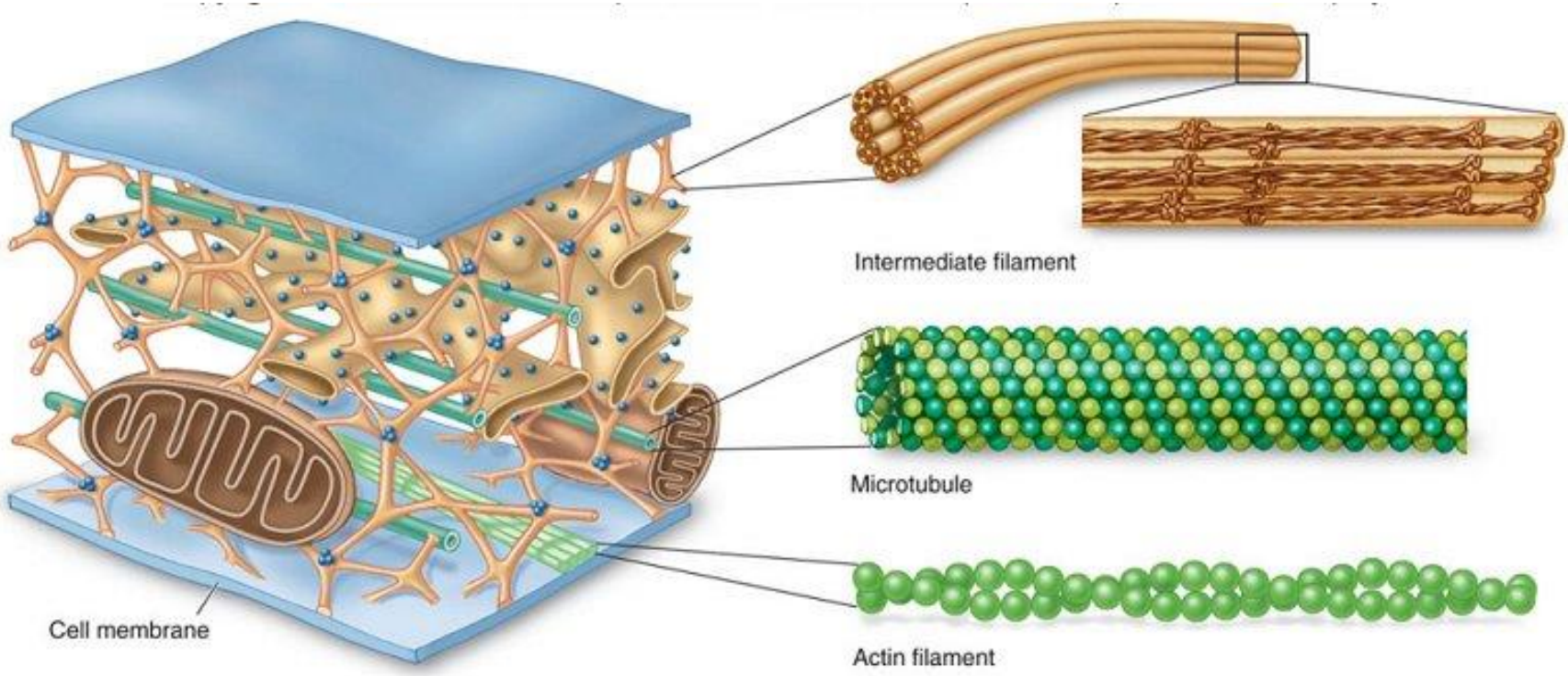


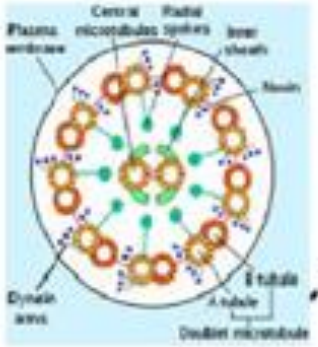
(a) https://www.youtube.com/watch?v=fHoL-vcMENw

Fig. 7-10a(2)
Page 149


H+ transporting
ATP-synthase
(Complex V)
Proton
channel
Intermembrane space
Inner
mitochondrial
membrane
Matrix
a
c
b
γ
ε
β
α
β
δ
F0 unit
F1 unit
3H+
03110 5/26/99


Plasma membrane
Ribosomes
Rough endoplasmic reticulum
microfilaments
intermediate filaments
Mitochondrion
microtubules


Intermediate filament
Microtubule
Actin filament
Cell membrane



Cross Section

Forward Stroke

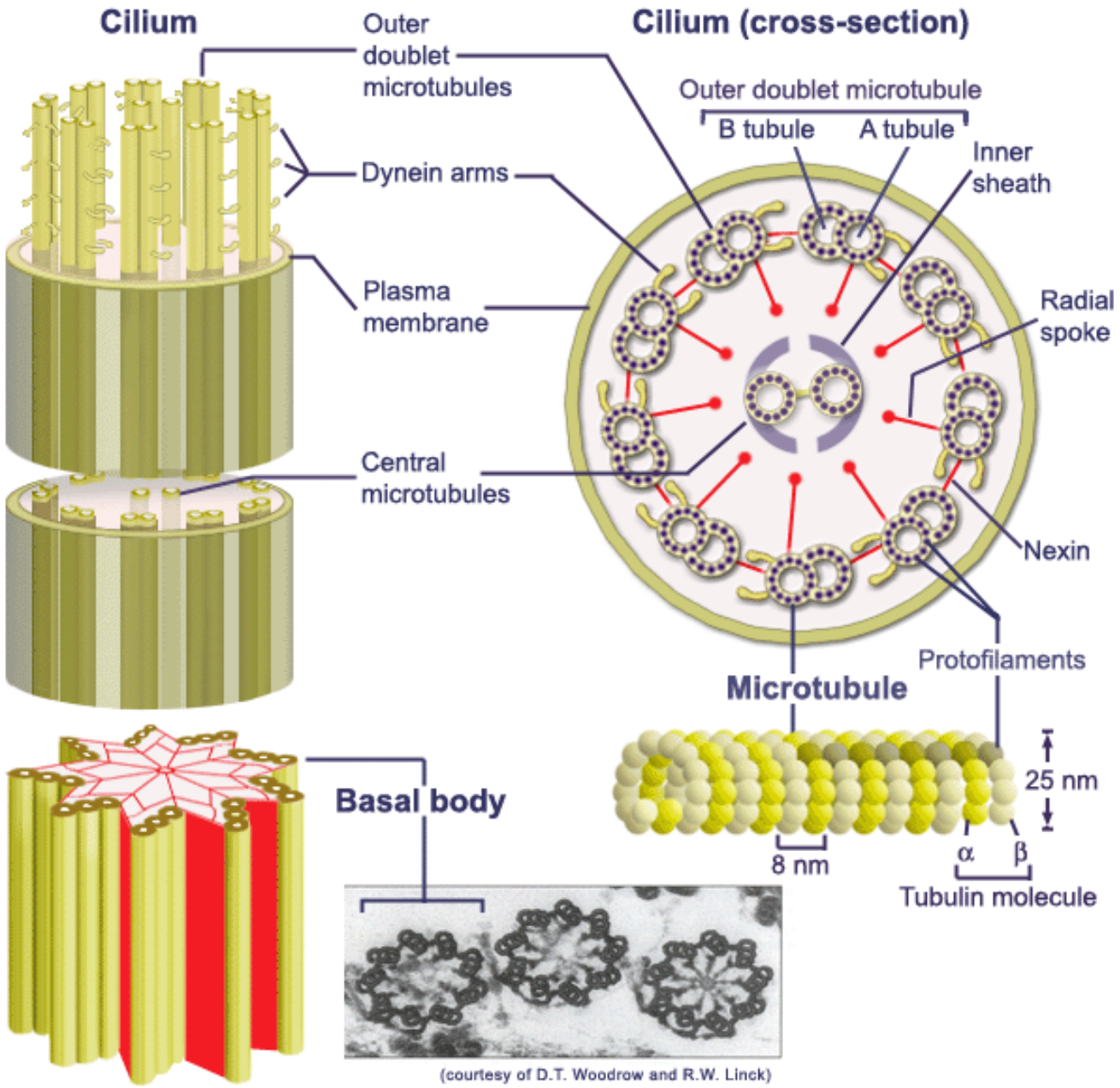
Filament

Membrane

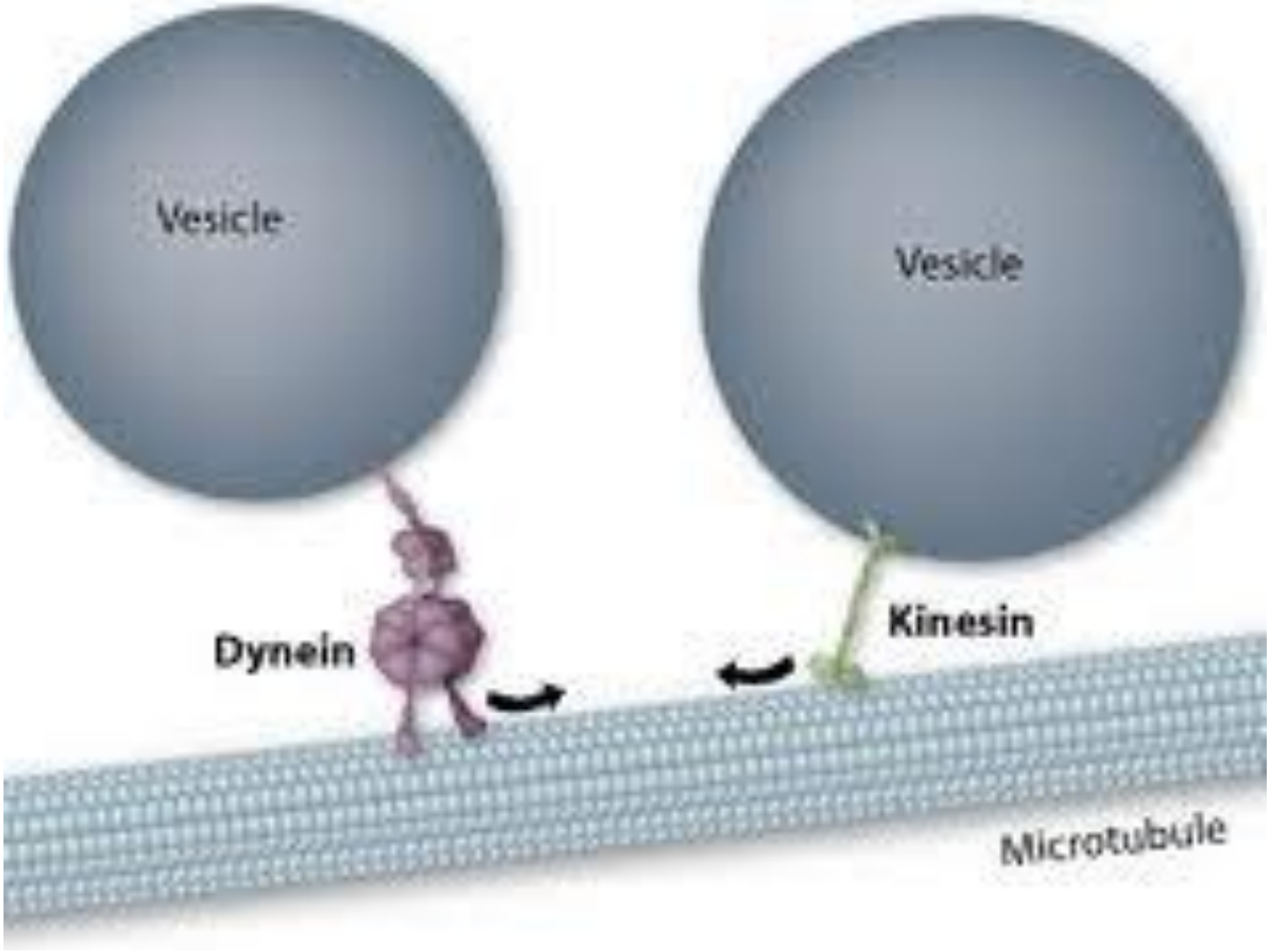
Basal Plate

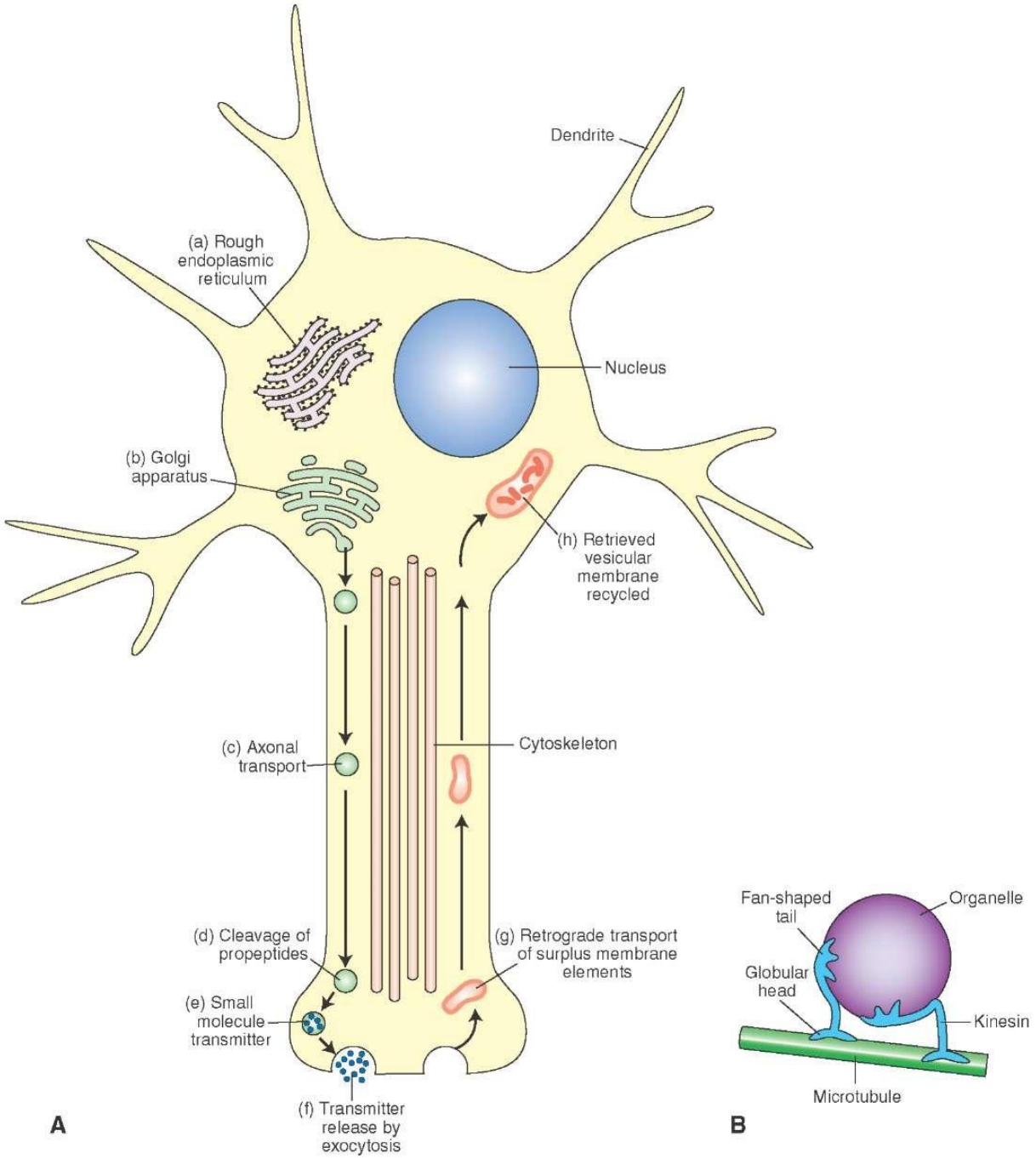
Cell Membrane

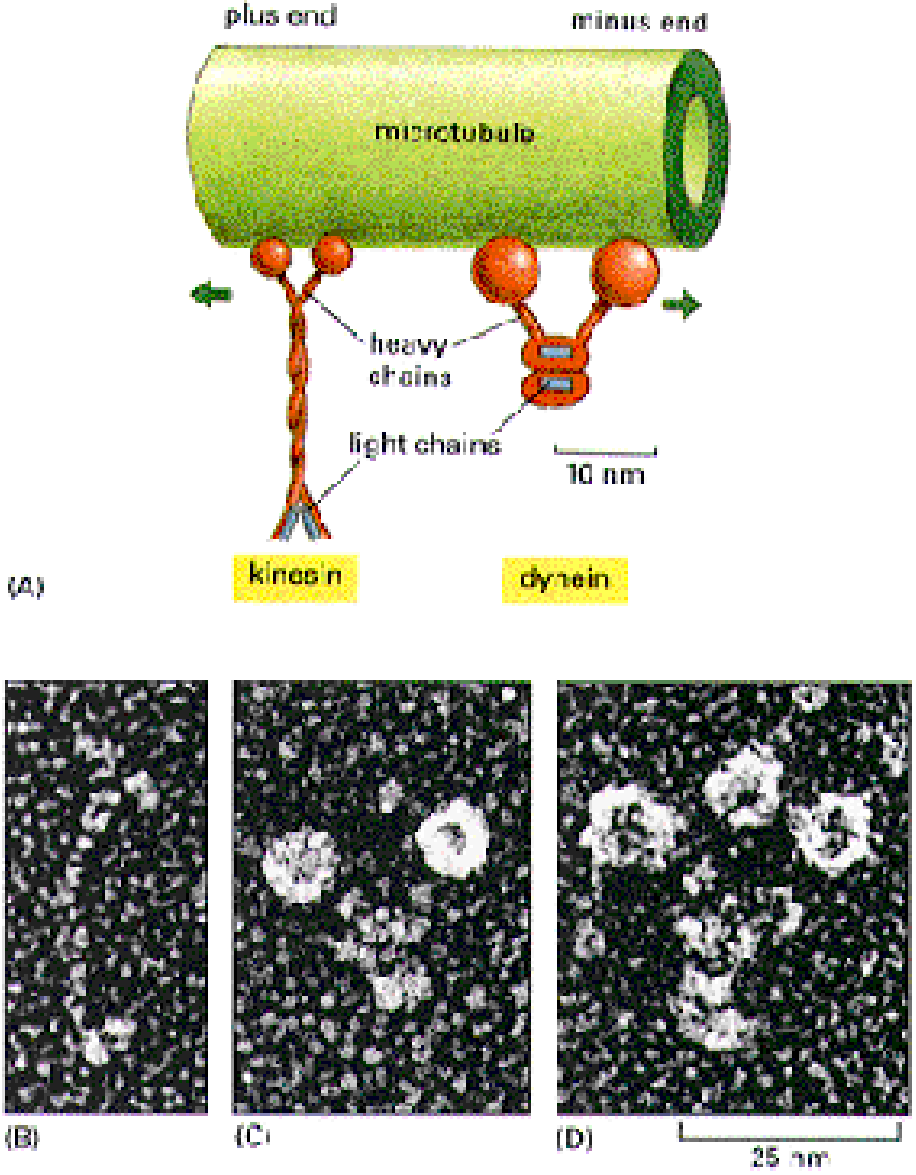
Basal Body


Cilium
Outer doublet microtubules
Dynein arms
Plasma membrane
Central microtubules
Basal body
Cilium (cross-section)
Outer doublet microtubule
B tubule
A tubule
Inner sheath
Radial spoke
Nexin
Protofilaments
Microtubule
25 nm
8 nm
α
β
Tubulin molecule
(courtesy of D.T. Woodrow and R.W. Linck)

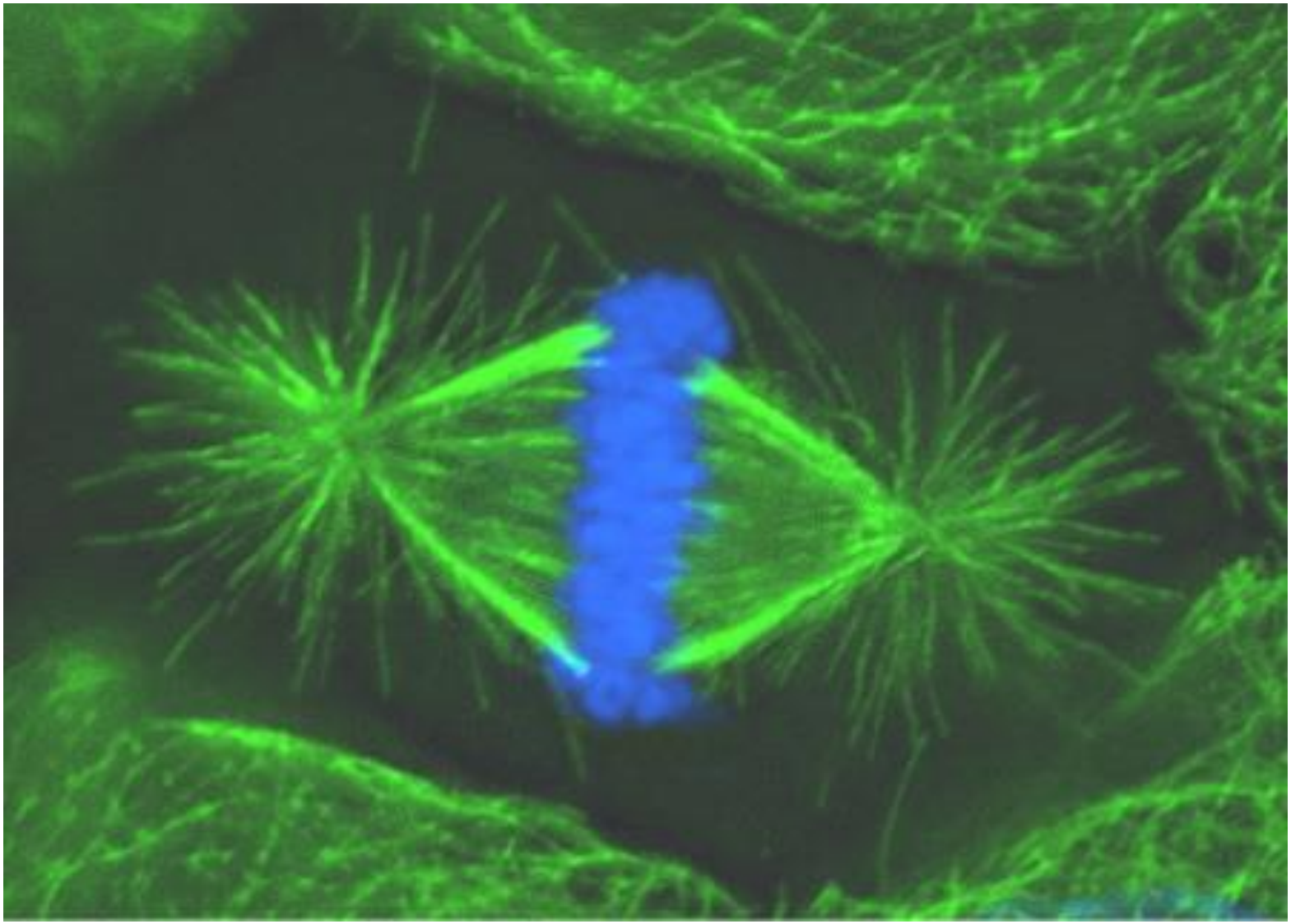
Vesicles Travel Cellular Highways



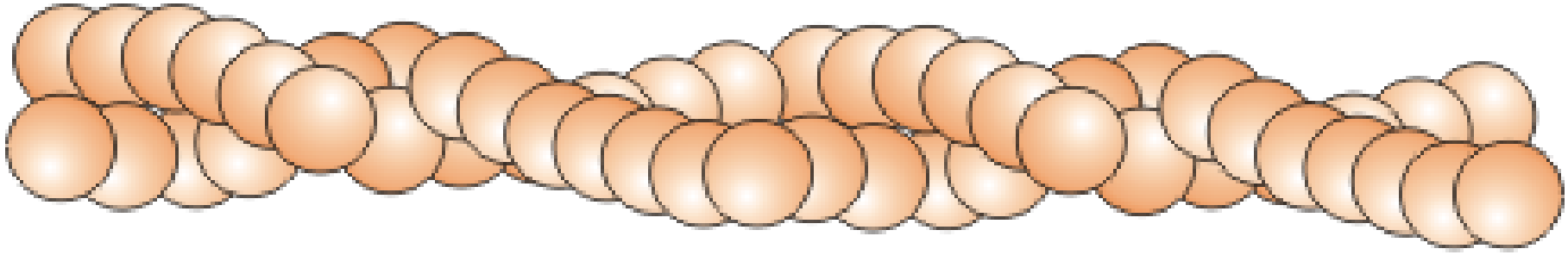

Dendrite
(a) Rough endoplasmic reticulum
Nucleus
(b) Golgi apparatus
(h) Retrieved vesicular membrane recycled
(c) Axonal transport
Cytoskeleton
(d) Cleavage of propeptides
(g) Retrograde transport of surplus membrane elements
(e) Small molecule transmitter
(f) Transmitter release by exocytosis
A
Fan-shaped tail
Organelle
Globular head
Kinesin
Microtubule
B


plus end
minus end
microtubule
heavy chains
light chains
10 nm
kinesin
dynein
(A)
(B)
(C)
(D)
25 nm

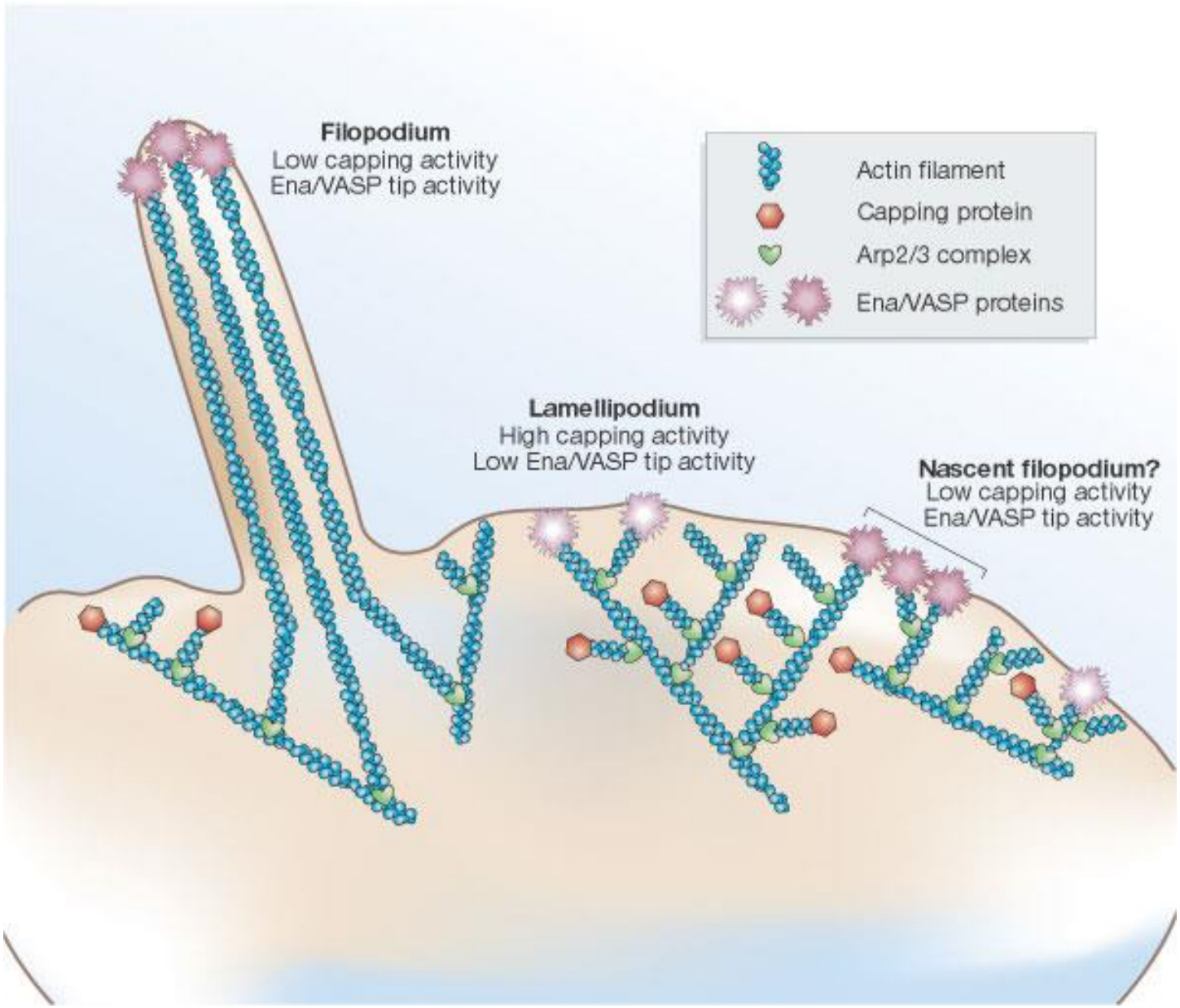
Mitotic spindle



Actin filaments



Actin Strand

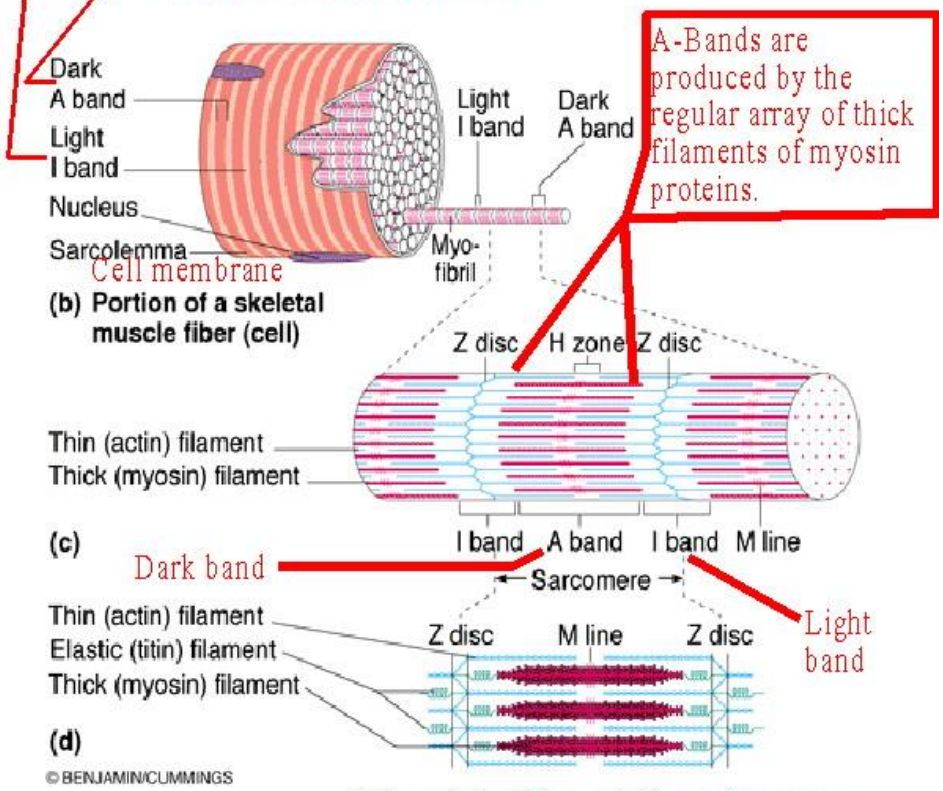

Filopodium
Low capping activity
Ena/VASP tip activity
Actin filament
Capping protein
Arp2/3 complex
Ena/VASP proteins
Lamellipodium
High capping activity
Low Ena/VASP tip activity
Nascent filopodium?
Low capping activity
Ena/VASP tip activity

Structural Elements of a Muscle Cell

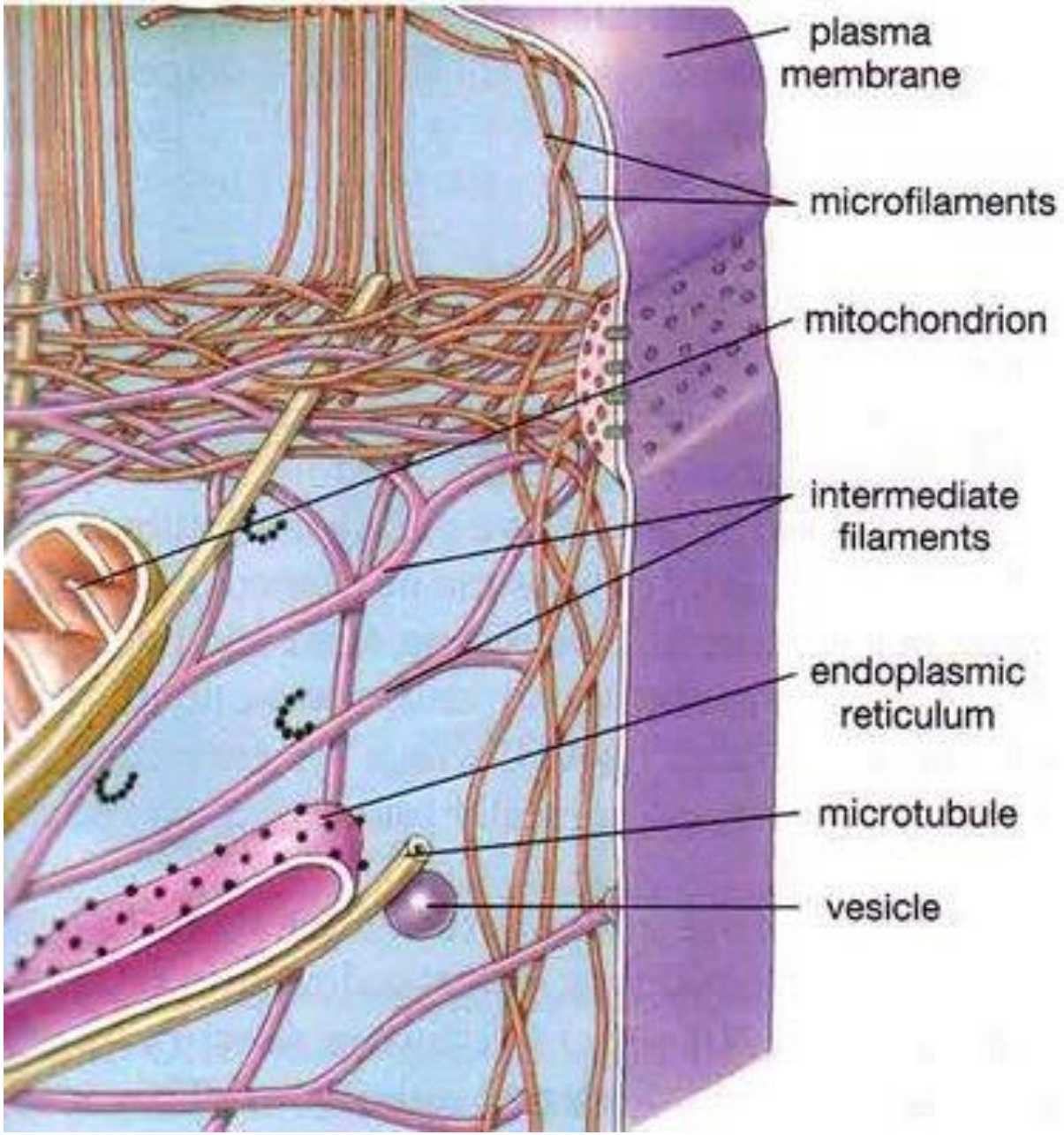
I Band - I stands for isotropic meaning the light passes through this area evenly. These are the light bands between the dark striations.

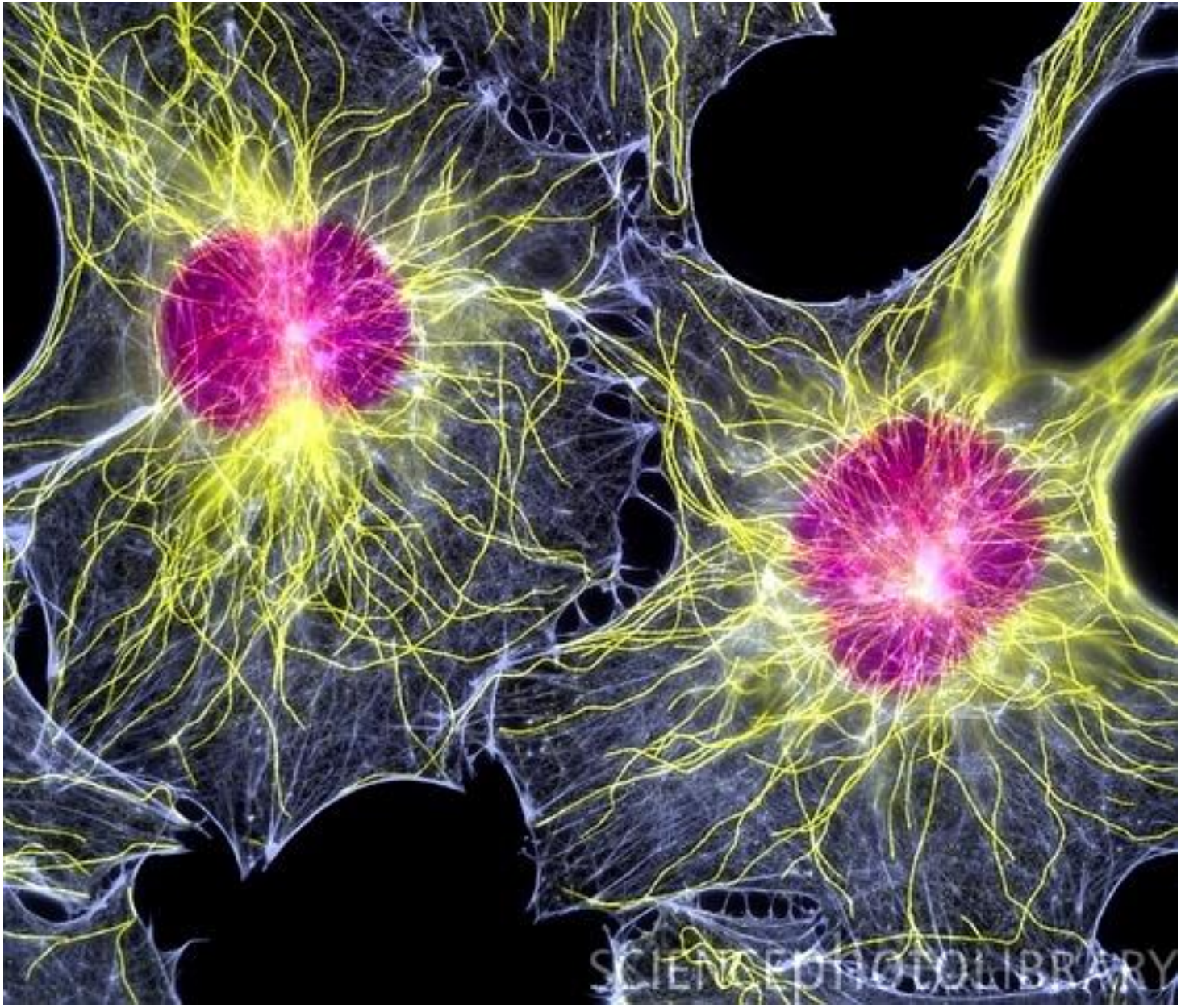
Striations = A Bands, for anisotropic (not isotropic) meaning the light does not pass evenly, it is refracted. These are the dark striations.

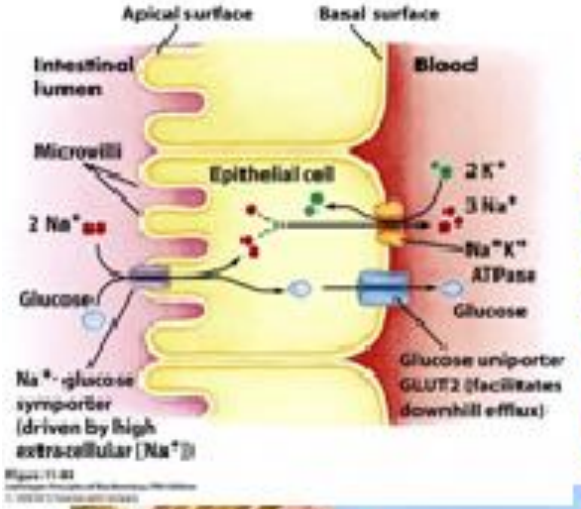
A-Bands are produced by the regular array of thick filaments of myosin proteins.

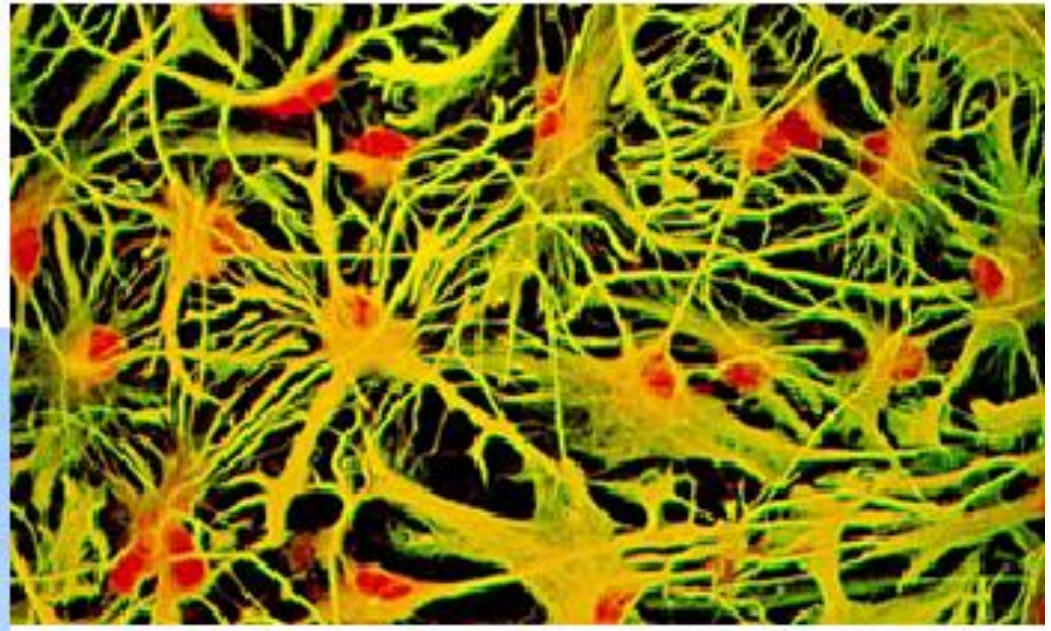


Although the filaments themselves run longitudinally along the myofibril, the A and I bands run perpendicularly to the myofibril, produced by the stacking of the filaments.

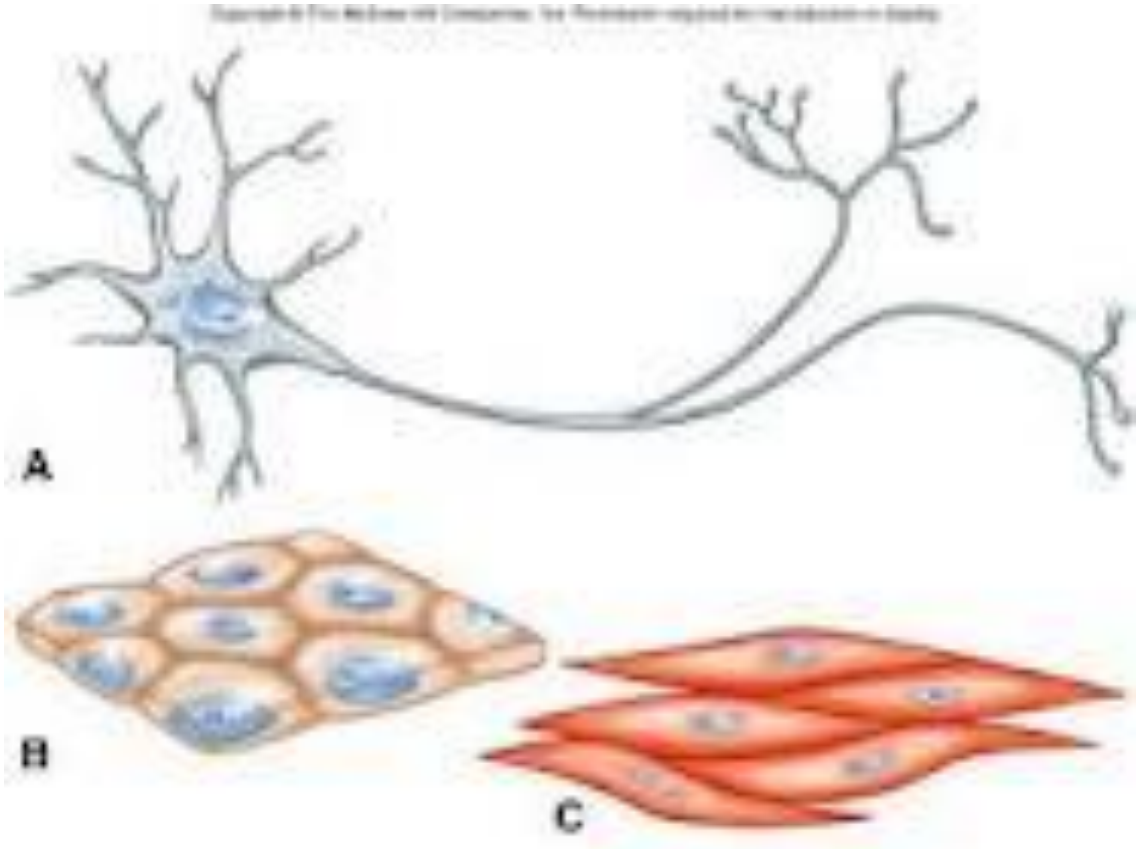

plasma membrane
microfilaments
mitochondrion
intermediate filaments
endoplasmic reticulum
microtubule
vesicle

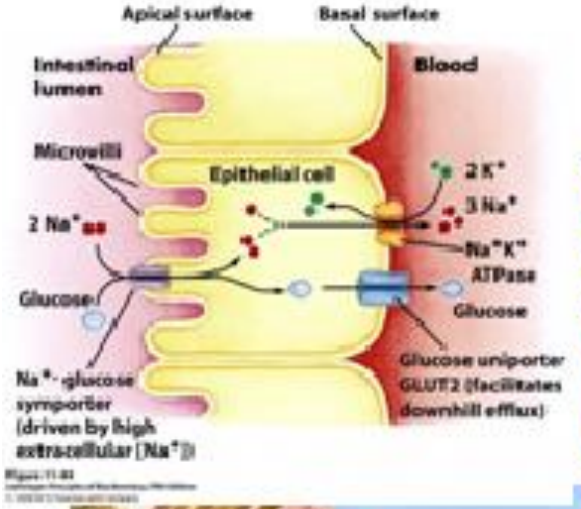

SCIENCE PHOTO LIBRARY


Apical surface
Basal surface
Intestinal lumen
Blood
Microvilli
Epithelial cell
2 K+
3 Na+
2 Na+
Na+K+ ATPase
Glucose
Glucose
Na+-glucose symporter (driven by high extra-cellular [Na+])
Glucose uniporter GLUT2 (facilitates downhill efflux)



THE IMPORTANCE OF CELL SHAPE FOR FUNCTIONS


A
B
C


Apical surface
Basal surface
Intestinal lumen
Blood
Microvilli
Epithelial cell
2 K+
3 Na+
2 Na+
Na+K+ ATPase
Glucose
Glucose
Na+-glucose symporter (driven by high extra-cellular [Na+])
Glucose uniporter GLUT2 (facilitates downhill efflux)