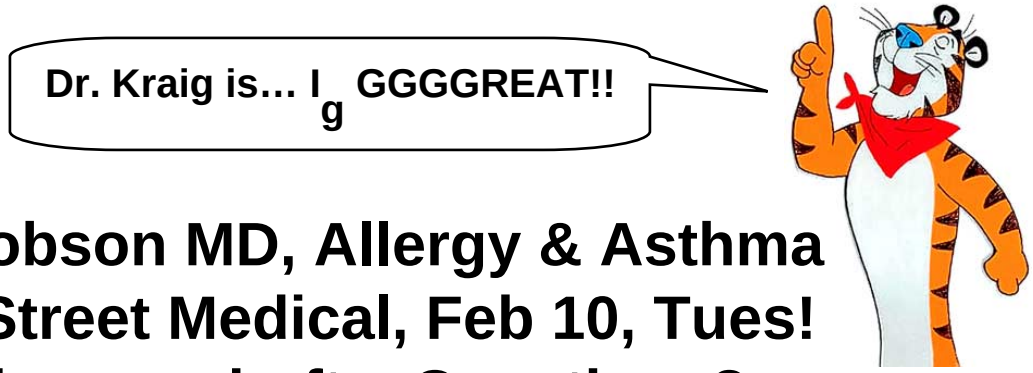
BI 358 Lecture 8



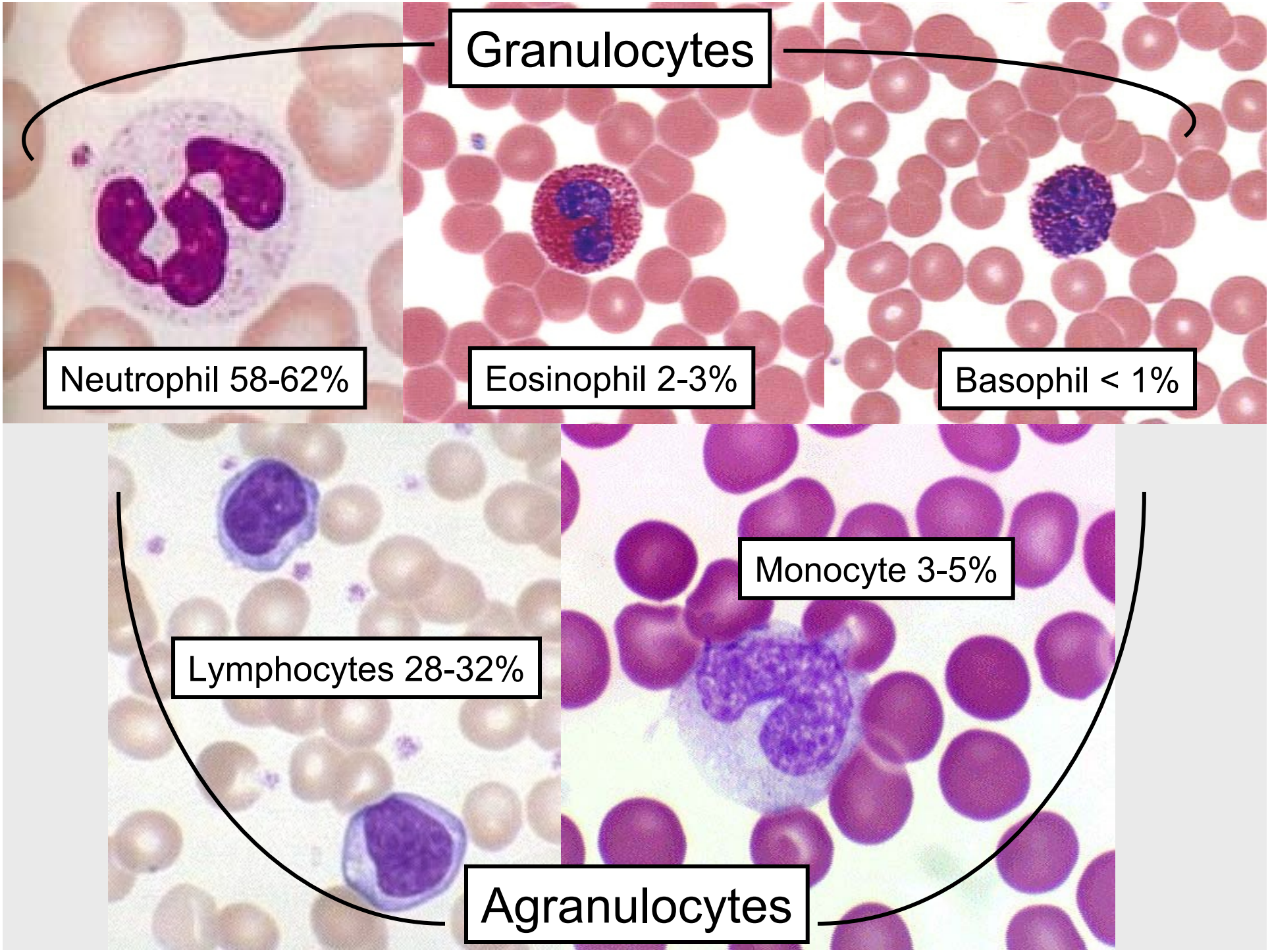
I. Announcements **Kraig Jacobson MD, Allergy & Asthma Research Associates, Oak Street Medical, Feb 10, Tues! Last update on outlines and paper drafts. Questions?**

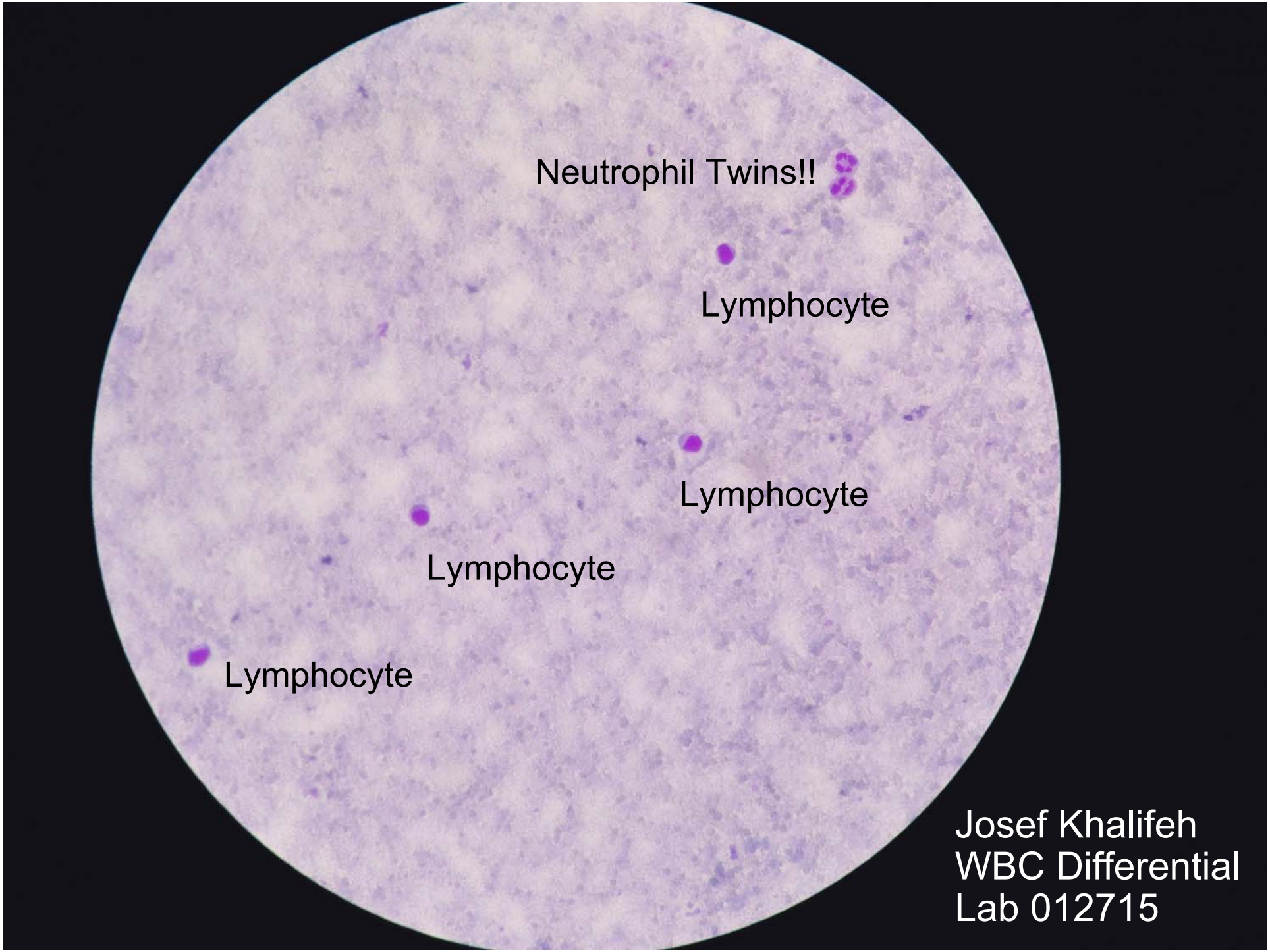
II. Immunology Connections **Ab=Ig structure, Mom's Milk, Immune Regulation + Allergy: *The Wars Within*, Lennart Nilsson**

III. Cardiovascular Physiology **Torstar Books, G&H, Katz, LS,...**

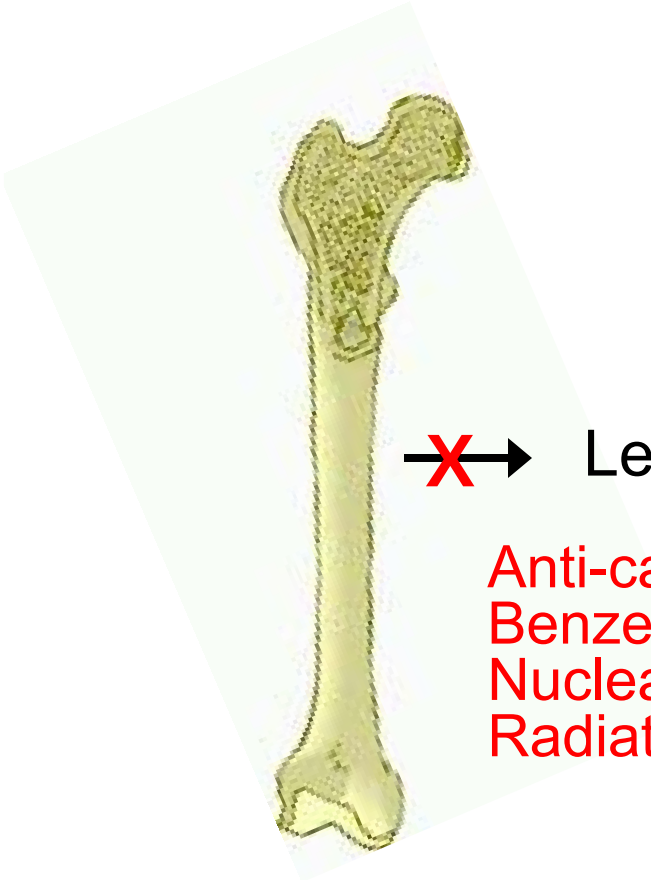
- **A. Cardiovascular system? Figure-8 loop D Chiras (DC), LS**
- **B. Fetal development & circulation Torstar…, G&H fig 83- 4**
- **C. Layers: peri-, epi-, myo- & endocardium Torstar Books**
- **D. ♥ structure & function G&H fig 9-7, LS1...**
- **E. Blood flow through ♥ & periphery G&H fig 9-1, LS, DC**
- **F. Coronary circulation & the cardiac cycle, composite events G&H fig 21-3, Katz, G&H fig 21-5, 21-6, 21-4; ch 9 fig 9-6**
- **G. Autorhythmic cells & ♥'s electrical highway G&H fig 10-1**

III. Lymphatic System **Torstar Books, DC, LS +…**


Granulocytes
Neutrophil 58-62%
Eosinophil 2-3%
Basophil < 1%
Lymphocytes 28-32%
Monocyte 3-5%
Agranulocytes


Neutrophil Twins!!
Lymphocyte
Lymphocyte
Lymphocyte
Lymphocyte
Josef Khalifeh
WBC Differential
Lab 012715

WBC Adverse Effects



X → Leukocytes

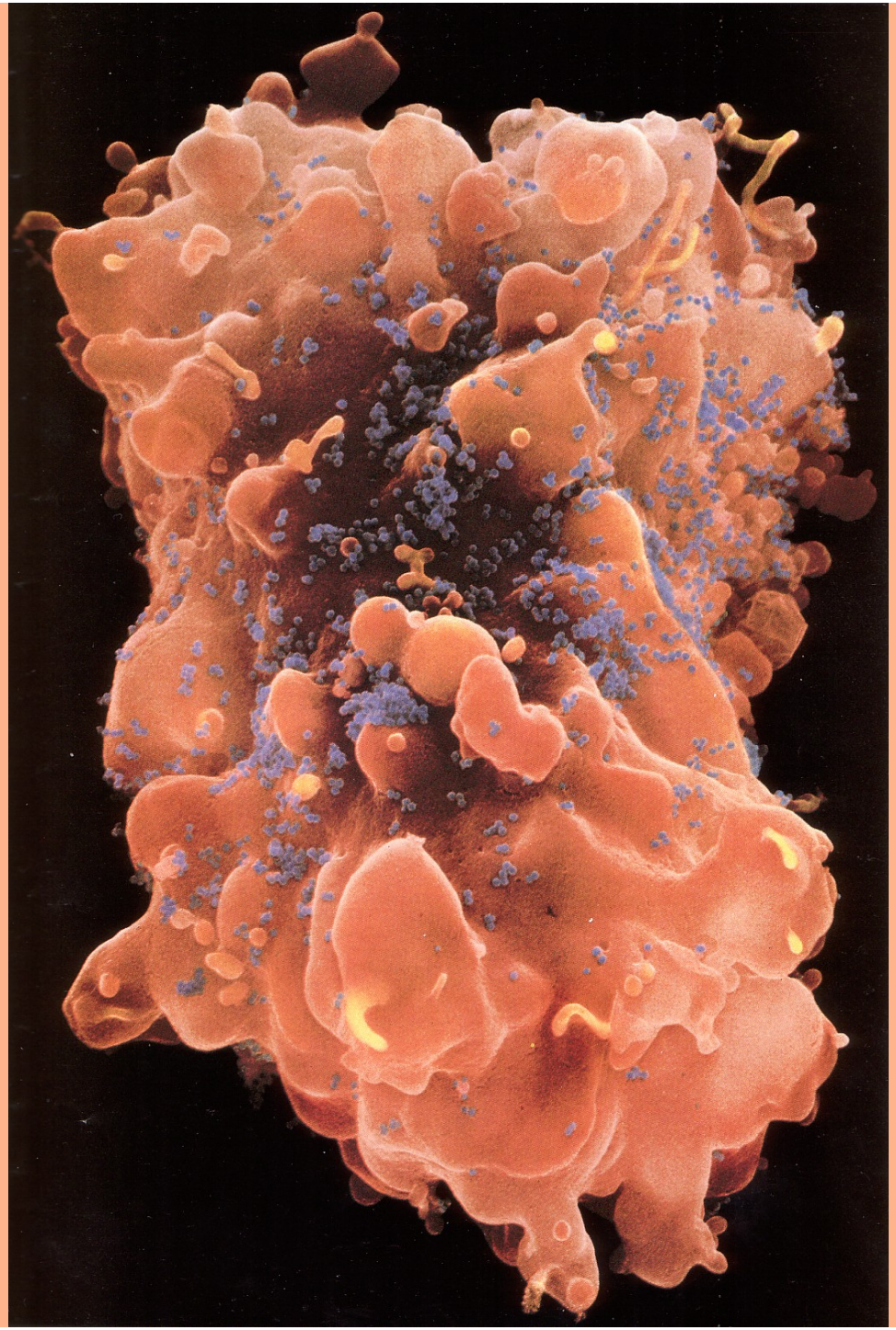
Anti-cancer drugs
Benzene
Nuclear blast
Radiation

↓ Body defense vs. μ organisms!

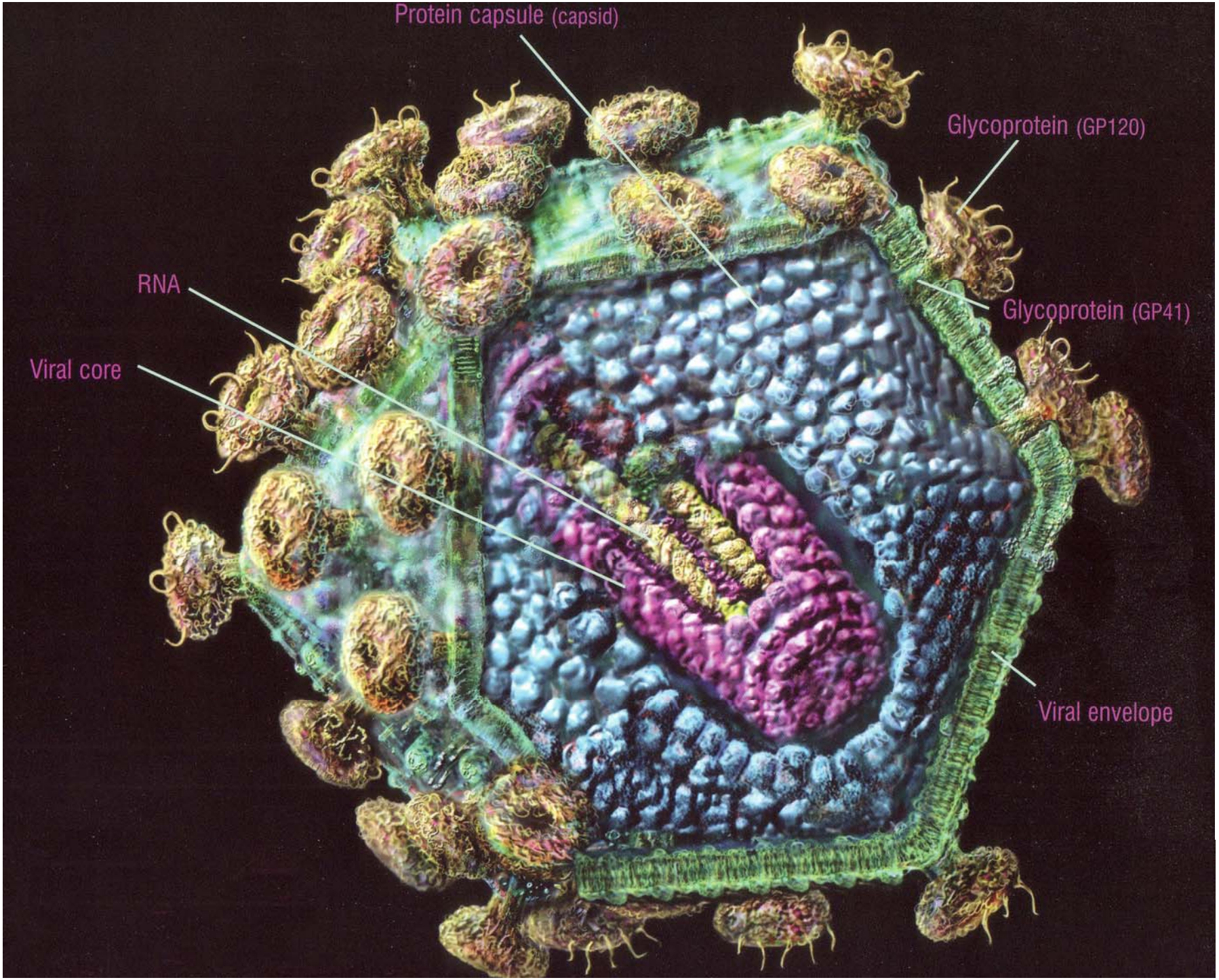
↓ Professional phagocytes esp:
Neutrophils
Macrophages

Savior Lymphoid tissues or bone marrow transplant?

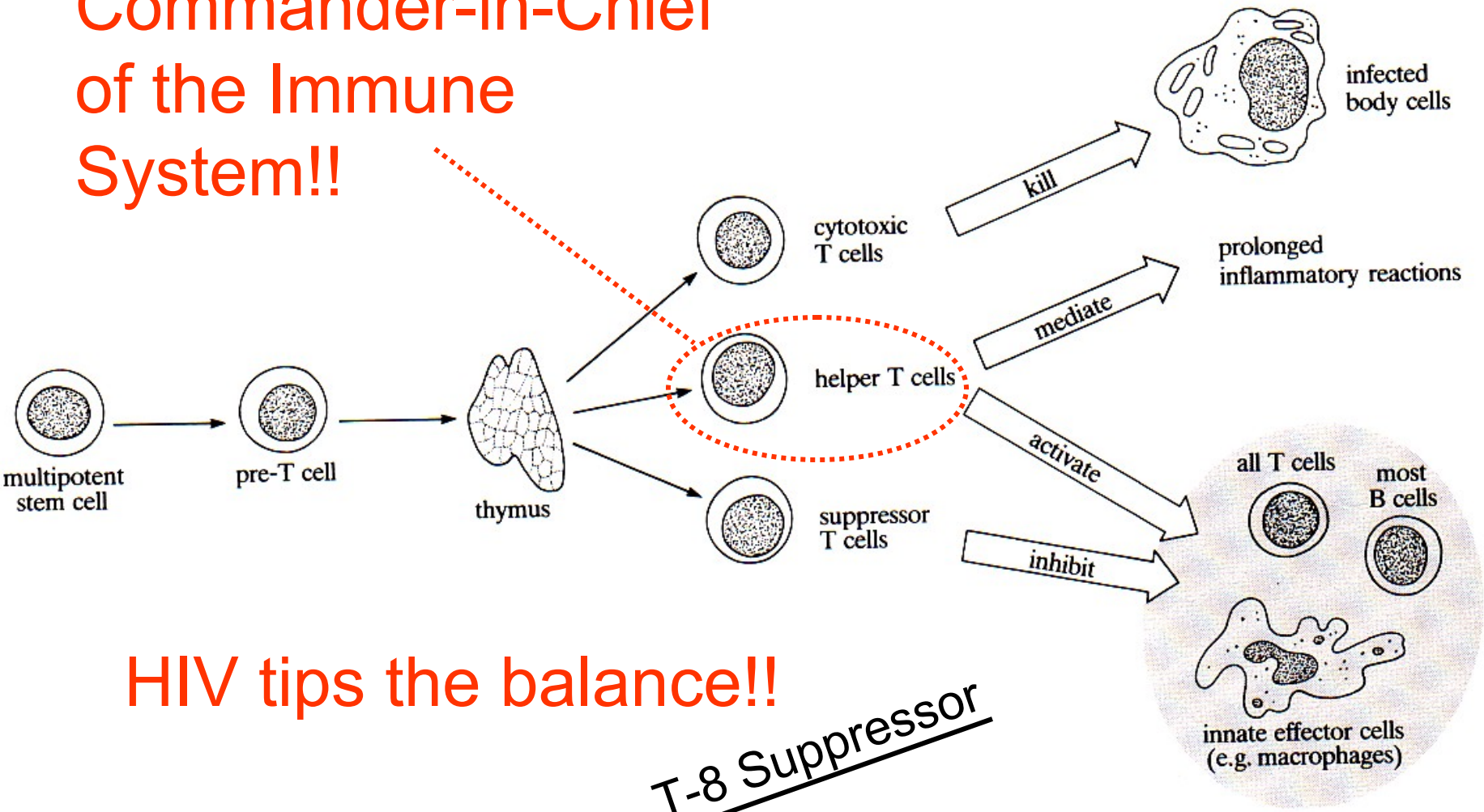
cf: *Leukemia* ≡ uncontrolled WBC proliferation, yet inadequate defense → other cell lines displaced → overwhelming infections & bleeding...



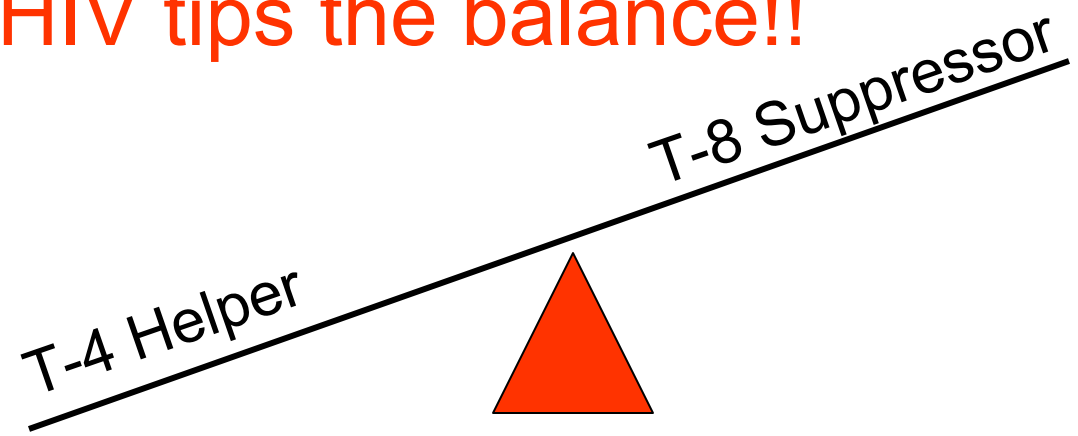
30,000 x GMBH
Nat Geog 1986


Protein capsule (capsid)
Glycoprotein (GP120)
RNA
Glycoprotein (GP41)
Viral core
Viral envelope

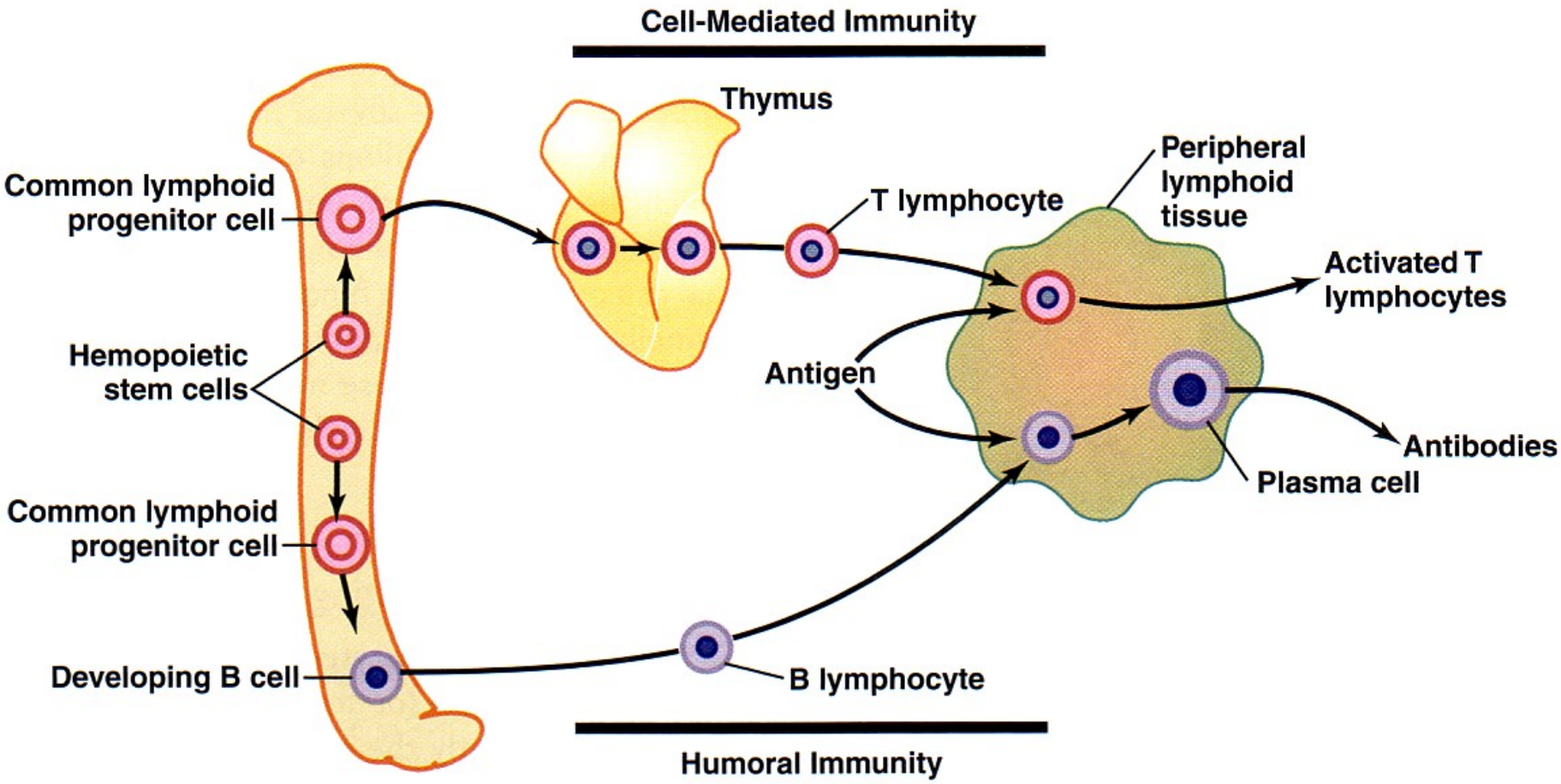
Commander-in-Chief of the Immune System!!



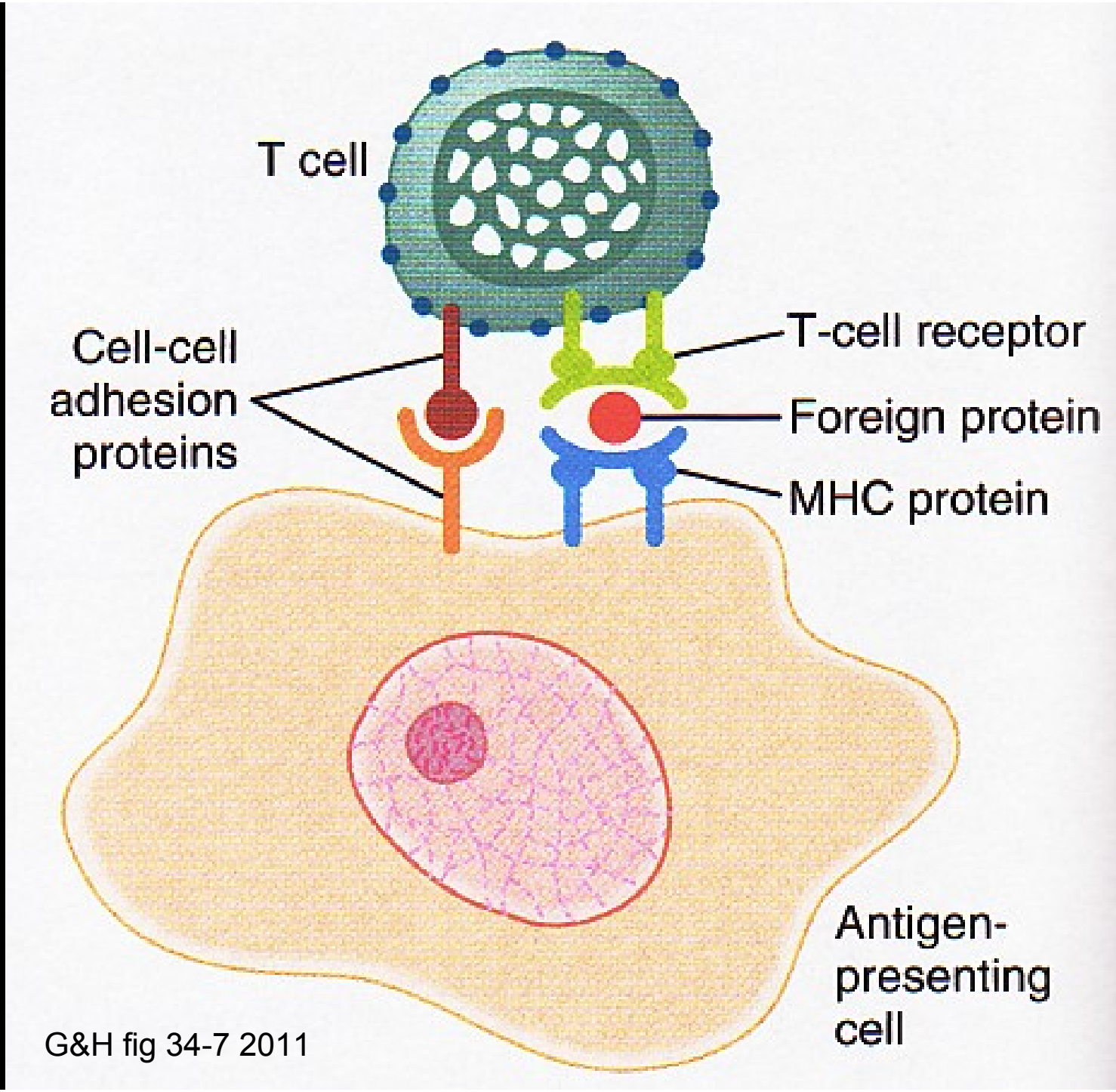
HIV tips the balance!!



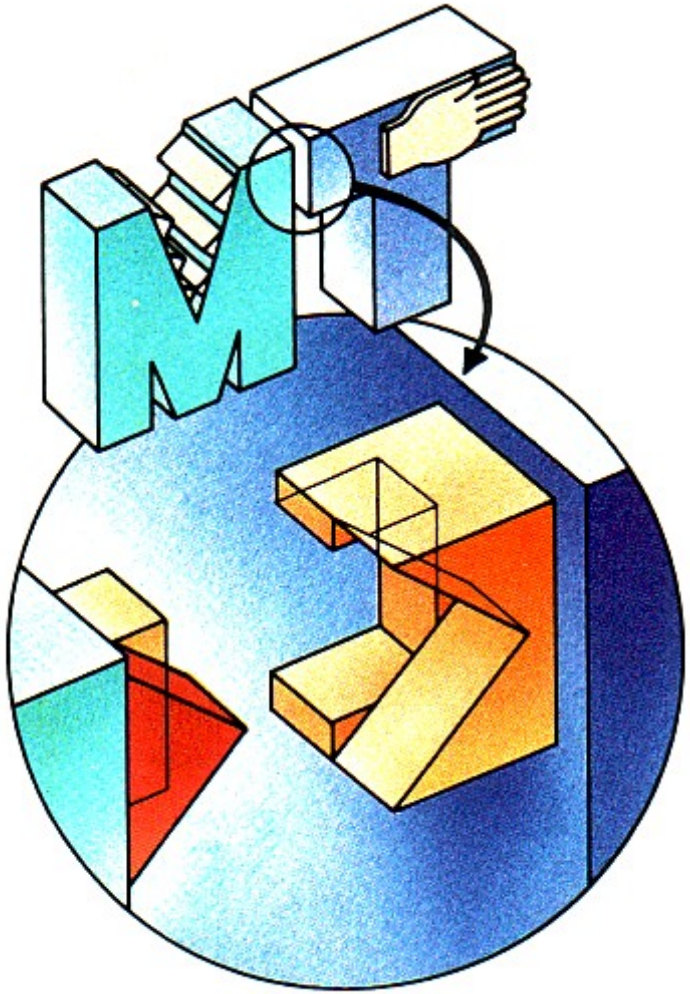
Davey 1990 p 30



G&H fig 34-1 2011



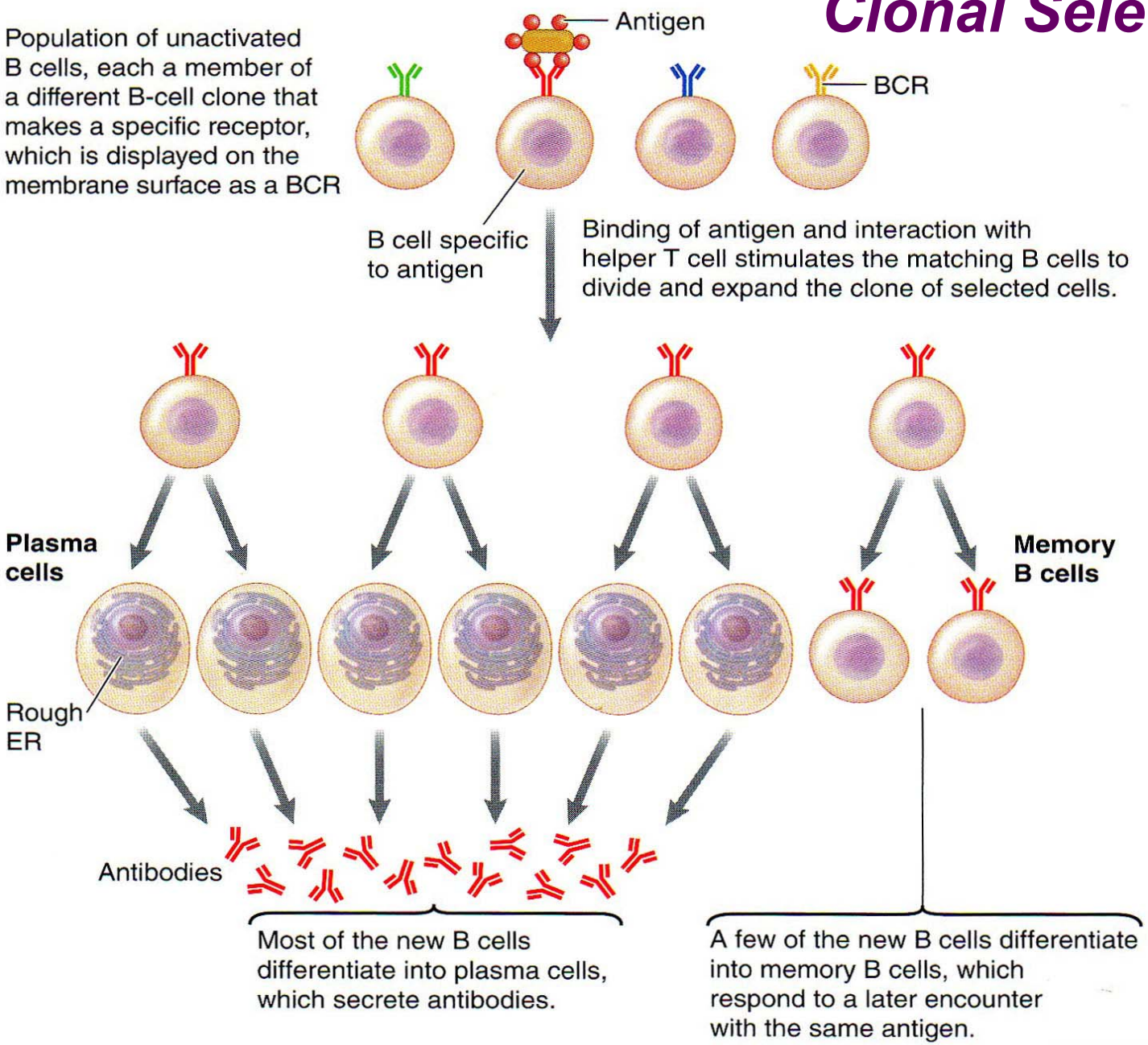
G&H fig 34-7 2011



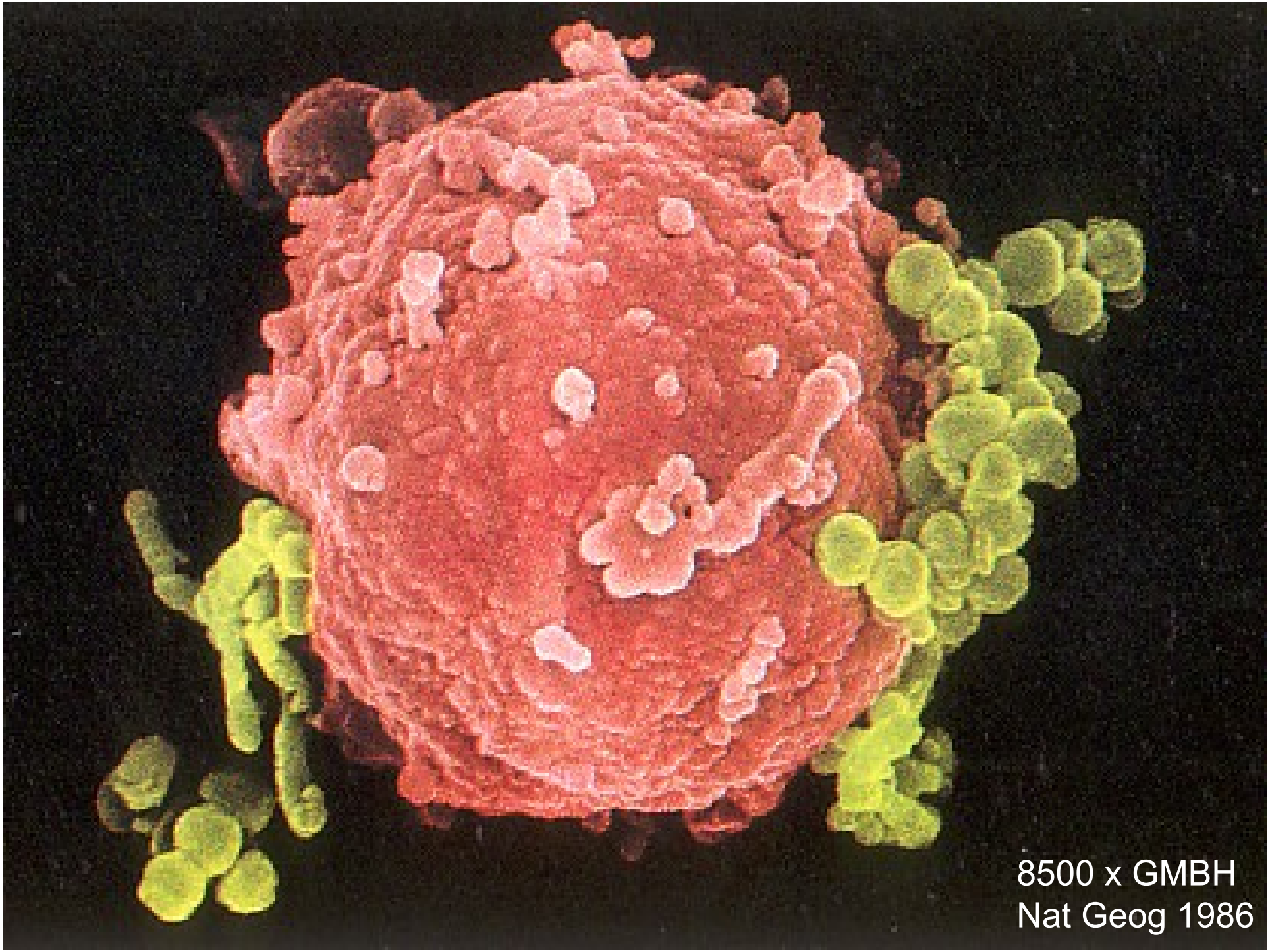
The vital union *that activates a helper T cell takes place only when the T cell recognizes both a "self" marker (rectangle) and a "nonself" antigen (triangle) on a macrophage.*

Nat Geog 1986, p 710

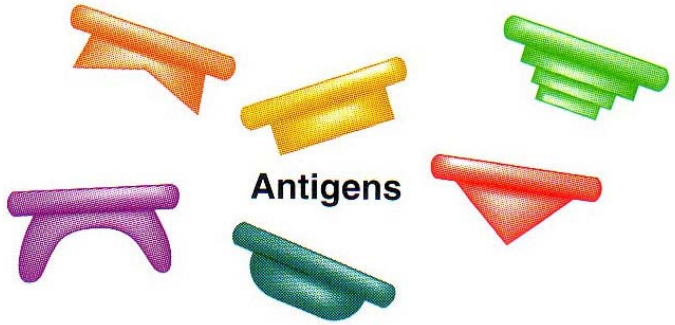
Clonal Selection



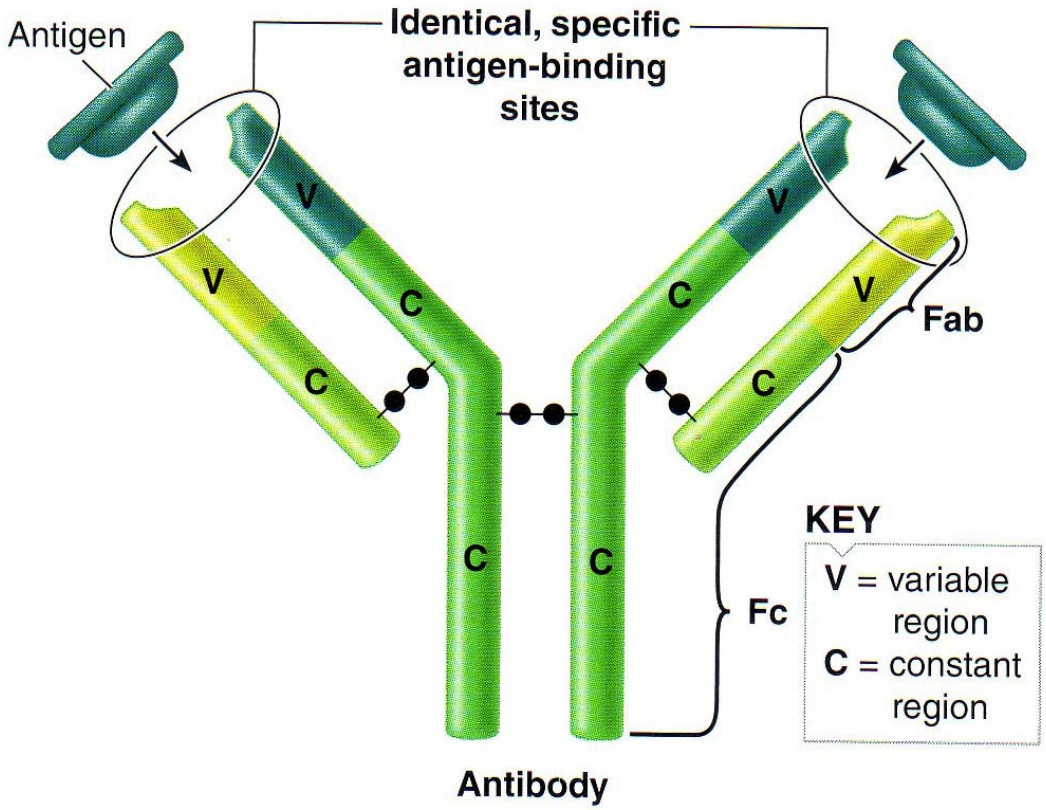
L Sherwood 2012; *cf*: G&H fig 34-2


8500 x GMBH
Nat Geog 1986

Typical IgG Antibody Structure

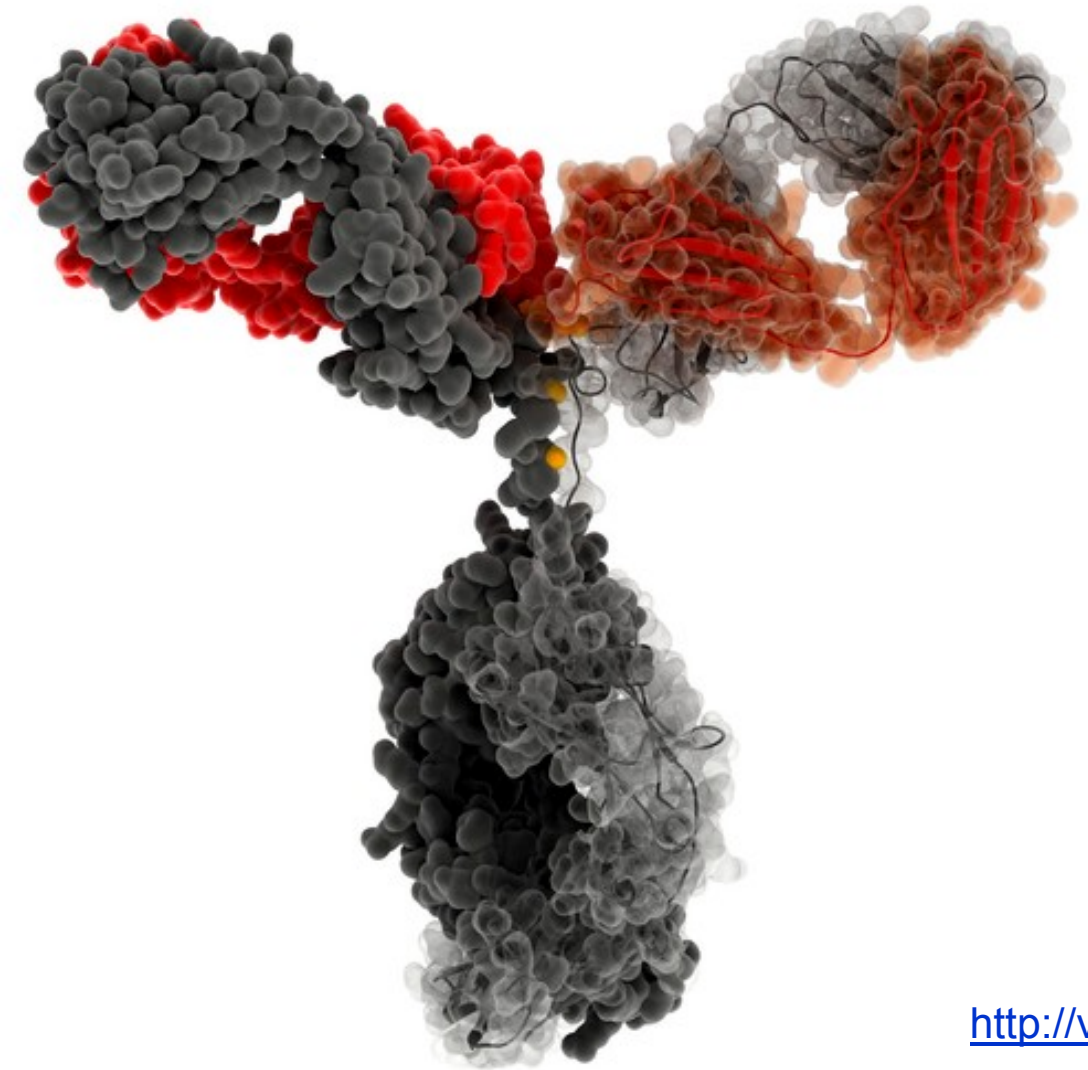


How do antibodies work?



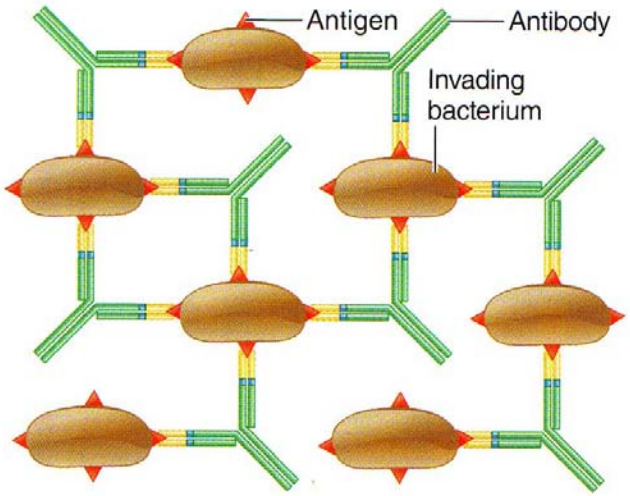
L Sherwood 2012; *cf*: G&H, fig 34-4

Immunoglobulin G

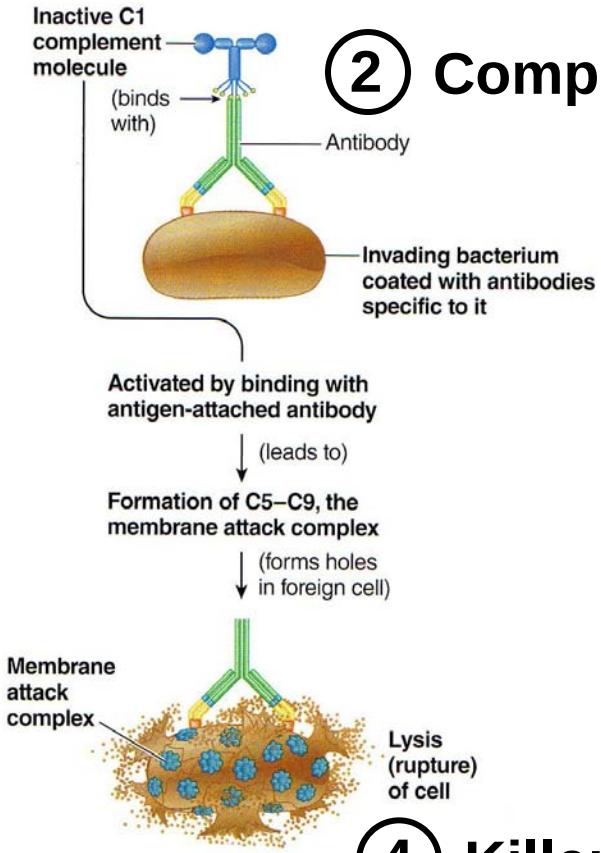


Source:
Visual Science
http://visualscience.ru/en/

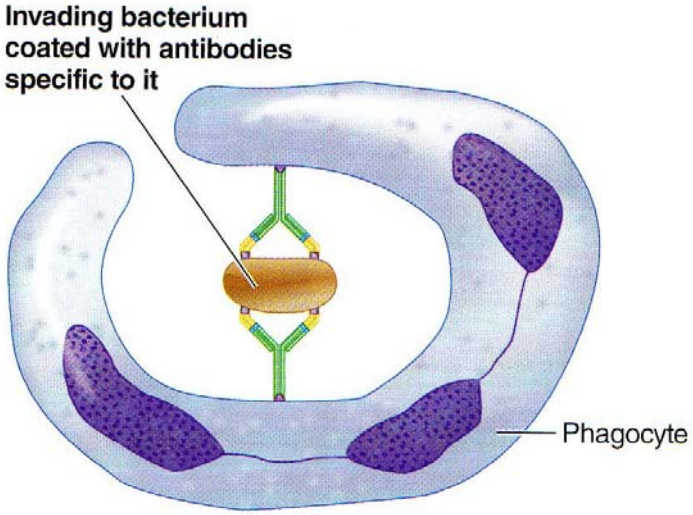
① Agglutination



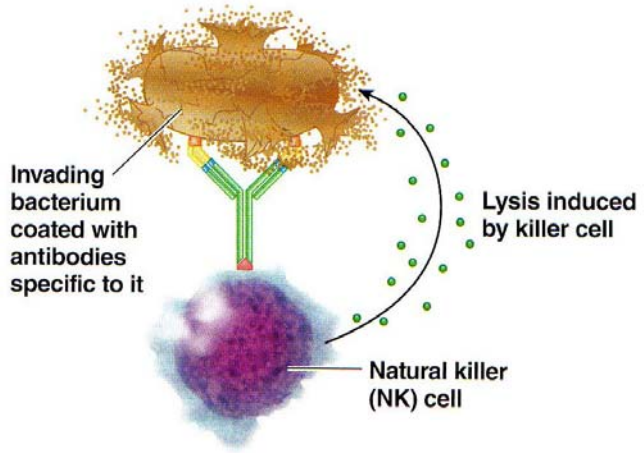
② Complement



③ Opsonization



④ Killer Cells



L Sherwood 2012

TABLE 4.1 Characteristics and functions of the human immunoglobulin classes

G A M D ⇄ E

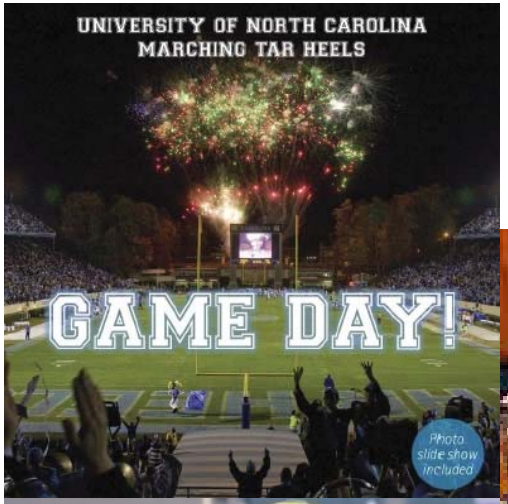
immunoglobulin class	IgG	IgA	IgM	IgD	IgE
heavy-chain type	γ	α	μ	δ	ε
number of constant domains in each heavy chain	3	3	4	3	4
relative molecular mass (M_r) of monomer	150 000	160 000	180 000	185 000	200 000
normally found as polymer?	no	dimer	pentamer	no	no
valency: number of antigen binding sites in normal form (i.e. monomer or polymer)	2	4	10	2	2
percentage of total immunoglobulin in serum	70–80	13–20	6–10	0–1	0.002
serum half-life (days)	23	5.8	5.1	2.8	2.3
ability to trigger complement cascade*	+ +	—	+ + +	—	—
can cross placenta from mother to foetus*	+	—	—	—	—
binds to Staphylococcal cell walls*	+	—	—	—	—
binds to macrophage Fc receptors*	+	—	(+)?	—	—
binds to neutrophil Fc receptors*	+	+	(+)?	—	—
binds to mast cell and basophil Fc receptors	—	—	—	—	+ + +
binds to platelets	+	—	—	—	—

* For IgG this refers only to some subclasses.

IgE skyrockets in allergies, parasitism, vasculitis, Hodgkin's disease!

Davey 1990 p 49

G A M E D!


UNIVERSITY OF NORTH CAROLINA
MARCHING TAR HEELS
GAME DAY!
Photo slide show included


GAMEDAY


G A M E D

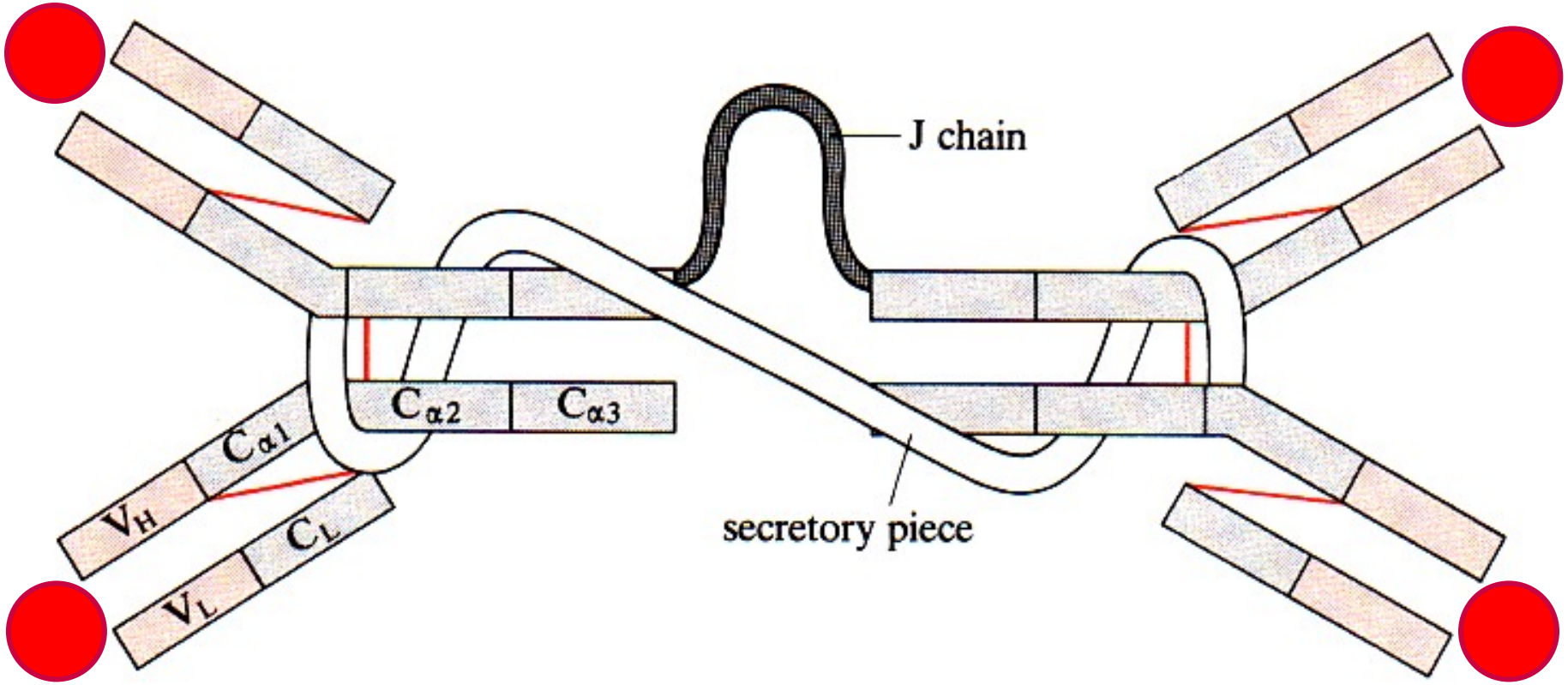

ESPN
COLLEGE GAMEDAY
THE HOME DEPOT


THE HOME DEPOT

IgA = Secretory A_b

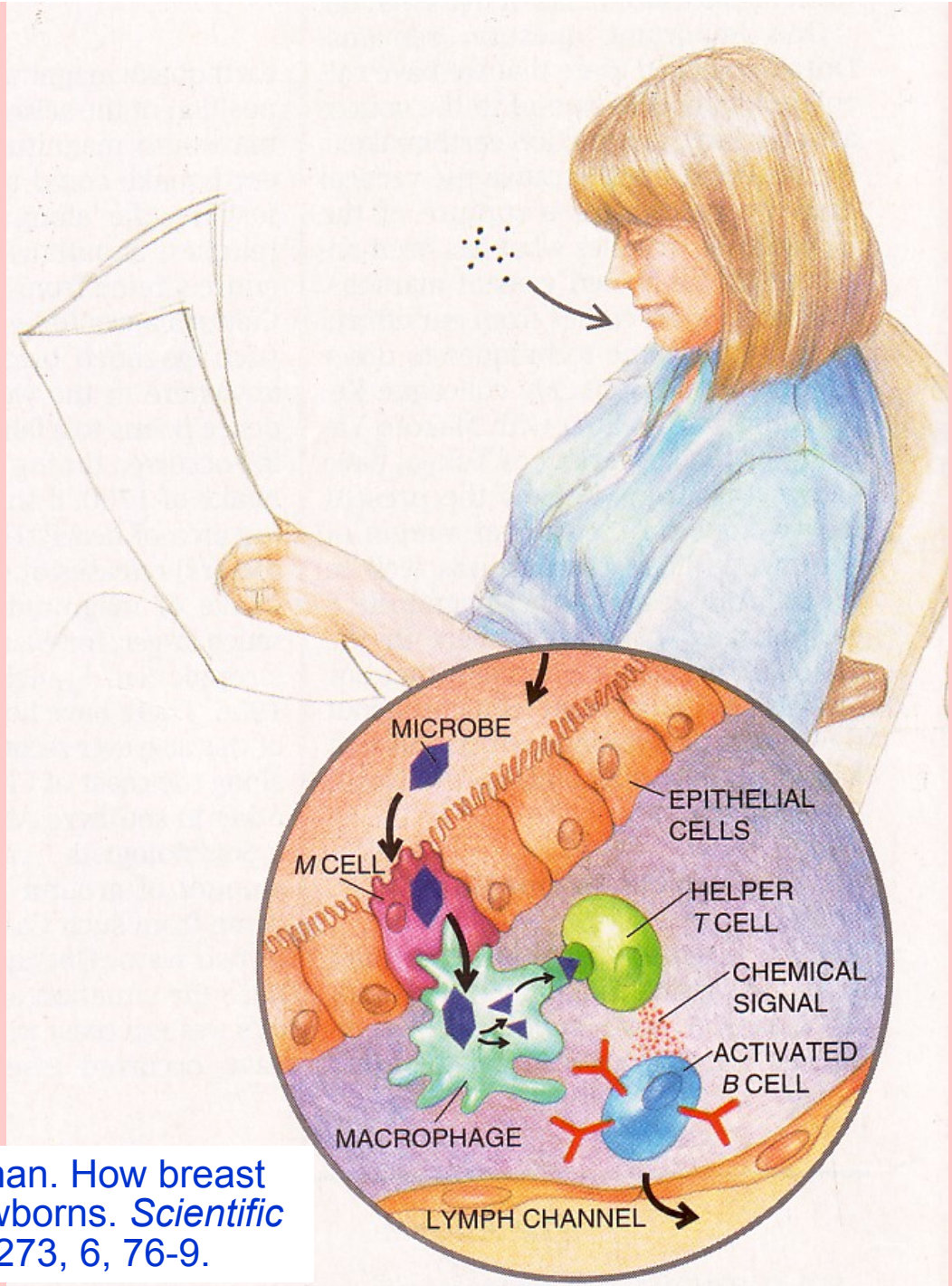
Dimer!!

Antigen/A_g



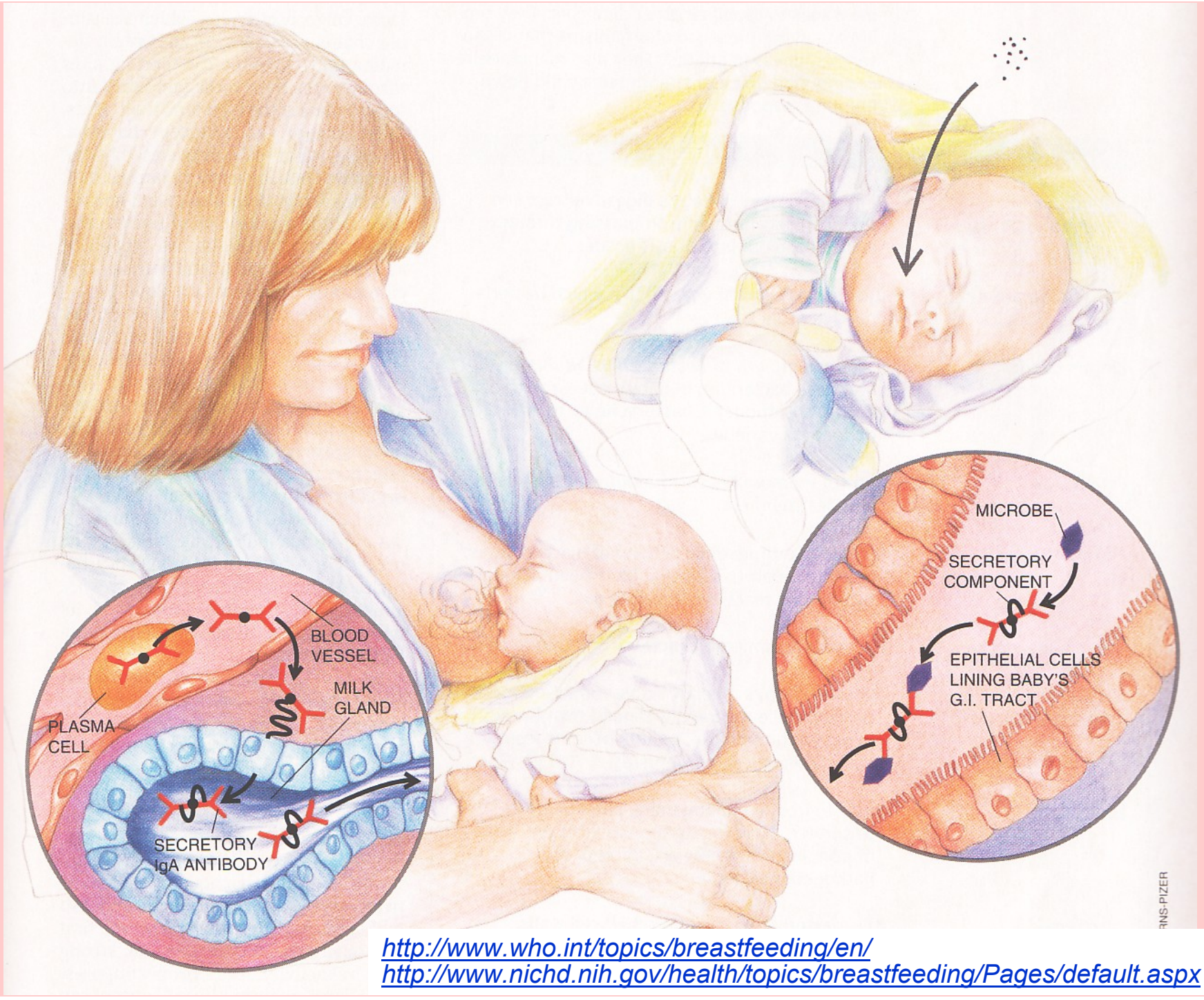
Valence? 4

Davey 1990 p 50



SOURCE: J Newman. How breast milk protects newborns. *Scientific American* 1995, 273, 6, 76-9.

Sci Am Dec 1995
Dana Burns-Pizer



http://www.who.int/topics/breastfeeding/en/
http://www.nichd.nih.gov/health/topics/breastfeeding/Pages/default.aspx

Immune Benefits of Breast Milk at a Glance

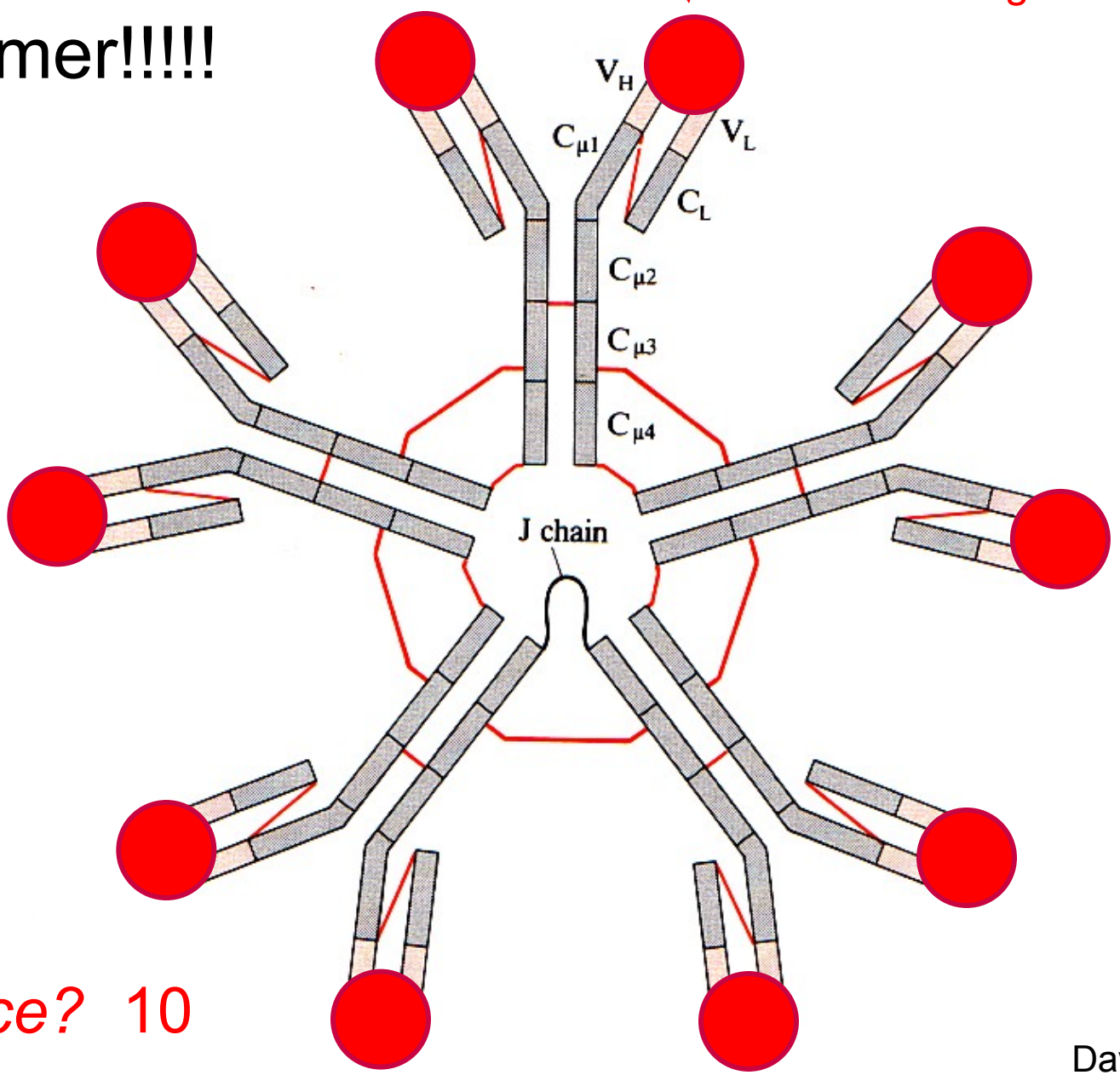
Component	Action
	White Blood Cells
B lymphocytes	Give rise to antibodies targeted against specific microbes.
Macrophages	Kill microbes outright in the baby's gut, produce lysozyme and activate other components of the immune system.
Neutrophils	May act as phagocytes, injesting bacteria in baby's digestive system.
T lymphocytes	Kill infected cells directly or send out chemical messages to mobilize other defenses. They proliferate in the presence of organisms that cause serious illness in infants. They also manufacture compounds that can strengthen a child's own immune response.

Molecules	
Antibodies of secretory IgA class	Bind to microbes in baby's digestive tract and thereby prevent them from passing through walls of the gut into body's tissues.
B_{12} binding protein	Reduces amount of vitamin B_{12}, which bacteria need in order to grow.
Bifidus factor	Promotes growth of *Lactobacillus bifidus*, a harmless bacterium, in baby's gut. Growth of such nonpathogenic bacteria helps to crowd out dangerous varieties.
Fatty acids	Disrupt membranes surrounding certain viruses and destroy them.
Fibronectin	Increases antimicrobial activity of macrophages; helps to repair tissues that have been damaged by immune reactions in baby's gut.
Gamma-interferon	Enhances antimicrobial activity of immune cells.

Hormones and growth factors	Stimulate baby's digestive tract to mature more quickly. Once the initially "leaky" membranes lining the gut mature, infants become less vulnerable to microorganisms.
Lactoferrin	Binds to iron, a mineral many bacteria need to survive. By reducing the available amount of iron, lactoferrin thwarts growth of pathogenic bacteria.
Lysozyme	Kills bacteria by disrupting their cell walls.
Mucins	Adhere to bacteria and viruses, thus keeping such microorganisms from attaching to mucosal surfaces.
Oligosaccharides	Bind to microorganisms and bar them from attaching to mucosal surfaces.

http://www.scientificamerican.com/article.cfm?id=got-smarts-mothers-milk-m
http://www.mcclatchydc.com/2012/08/28/163784/duke-study-pinpoints-breast-milk.html

IgM = Macroglobulin Pentamer!!!!!



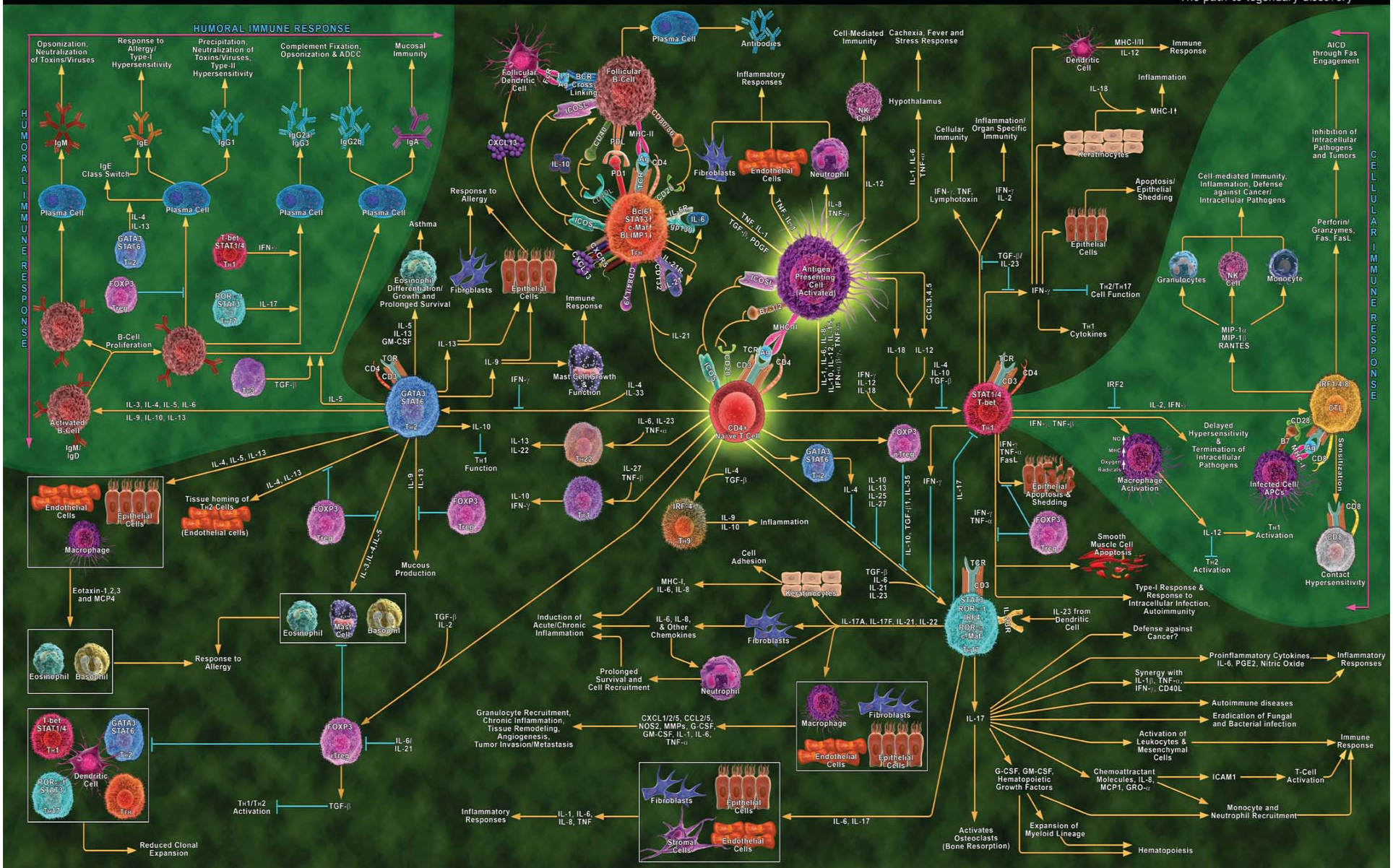
Valence? 10

Davey 1990 p 51

Immunologic Networks

http://pinterest.com/pin/509470395063175 36/

BioLegend
The path to legendary discovery™



www.biolegend.com

Interactive Poster: biolegend.com/immunologicnetworks

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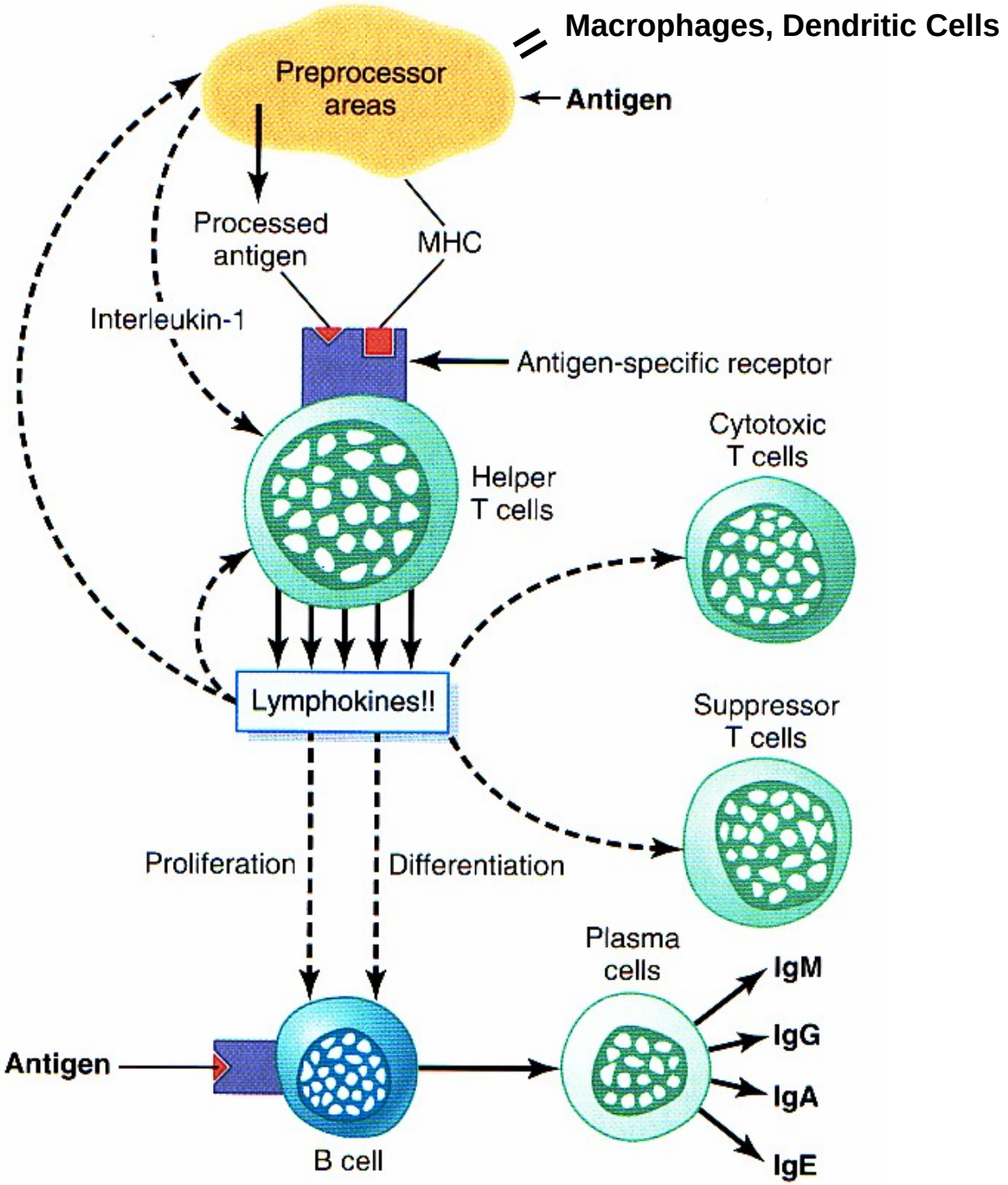
Phone: (858) 455-9588 Fax: (877) 455-9587
Email: customerserv@biolegend.com, techserv@biolegend.com

We would like to thank *Dr. Vijay K. Kuchroo* of Harvard Medical School for his contributions to this poster.

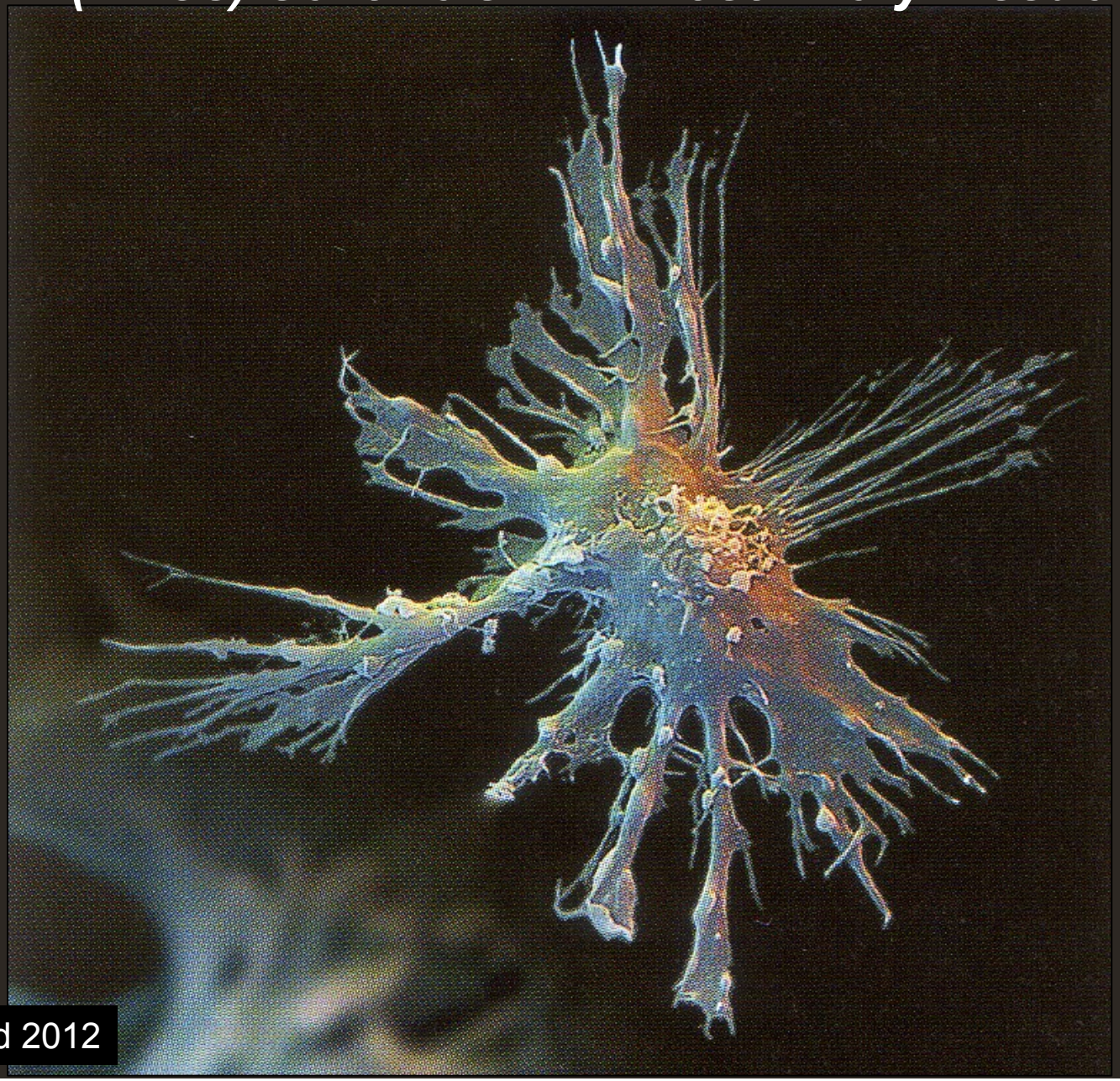
04-0018-00

Created by ProteinLounge.com in Sep 2011

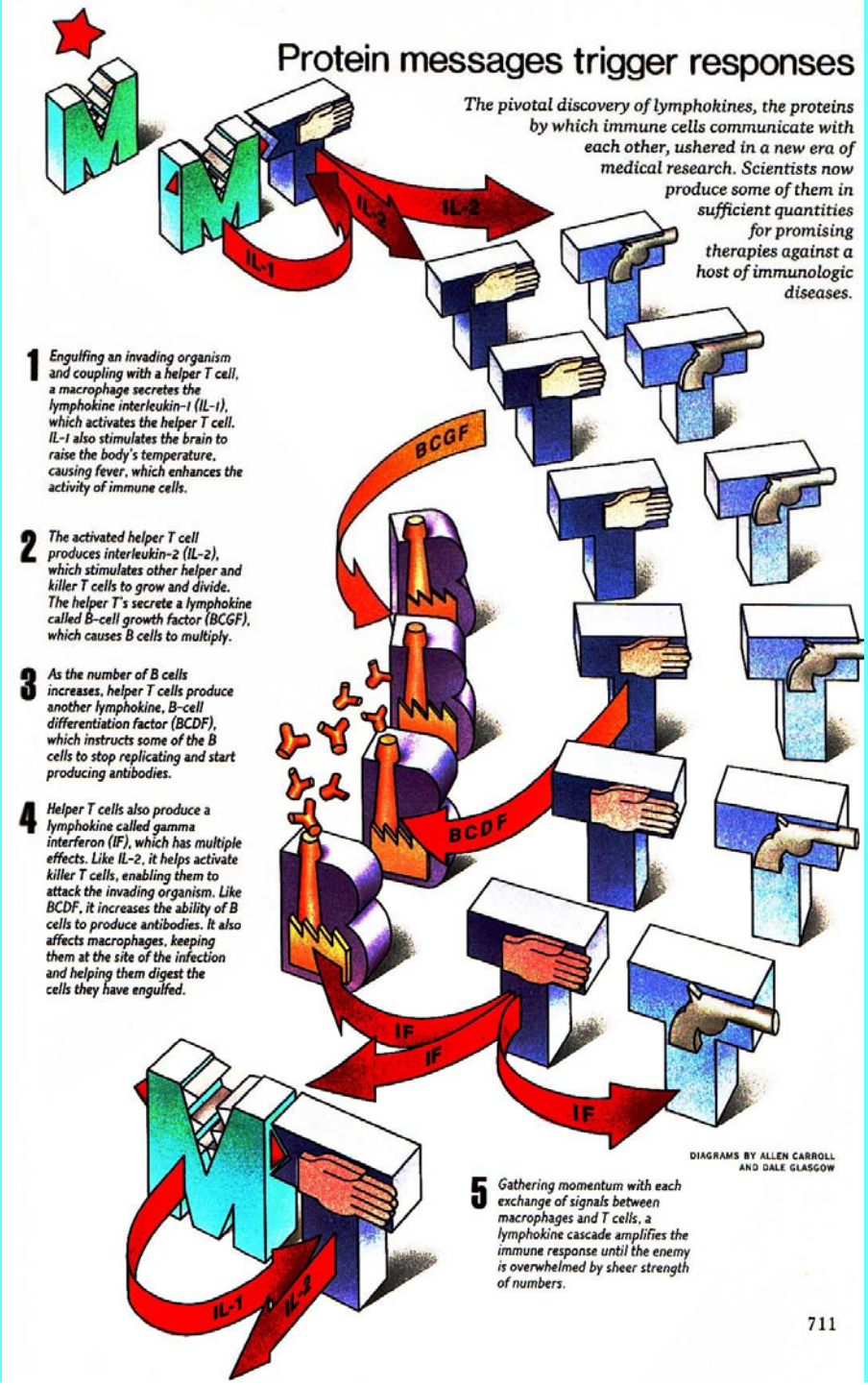


G&H fig 34-8 2011

Dendritic Cells: Specialized Antigen-Presenting Cells (APCs) Sentinels in Almost Every Tissue!



L Sherwood 2012



Nat Geog 1986

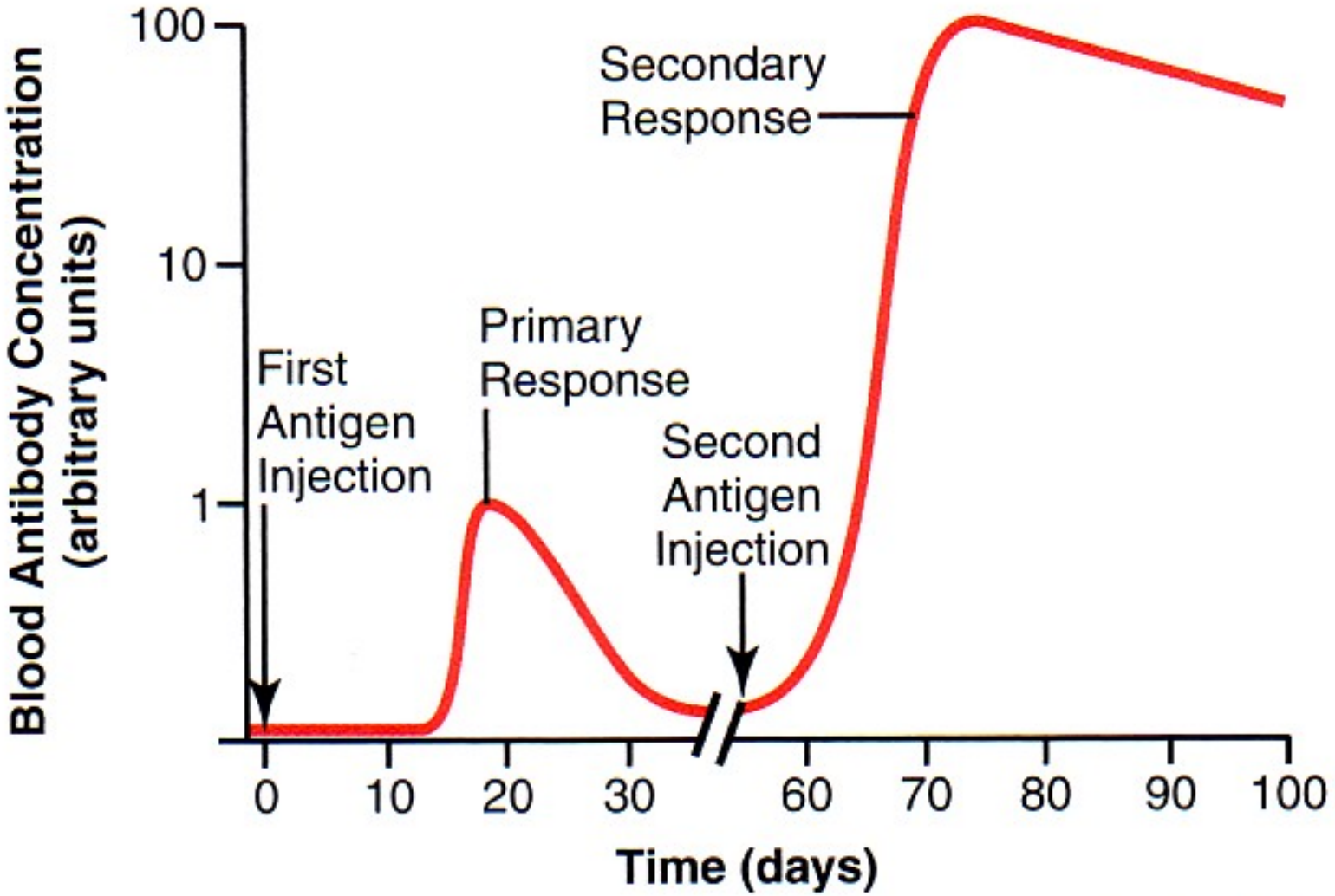


Figure 34-3 Time course of the antibody response in the circulating blood to a primary injection of antigen and to a secondary injection several weeks later.

G&H 2011

Go Red for women
love your heart
American Heart Association

Wear Red next Friday (Feb 6th!)
Help raise awareness about
Women & ♥ disease

http://www.goredforwomen.org/

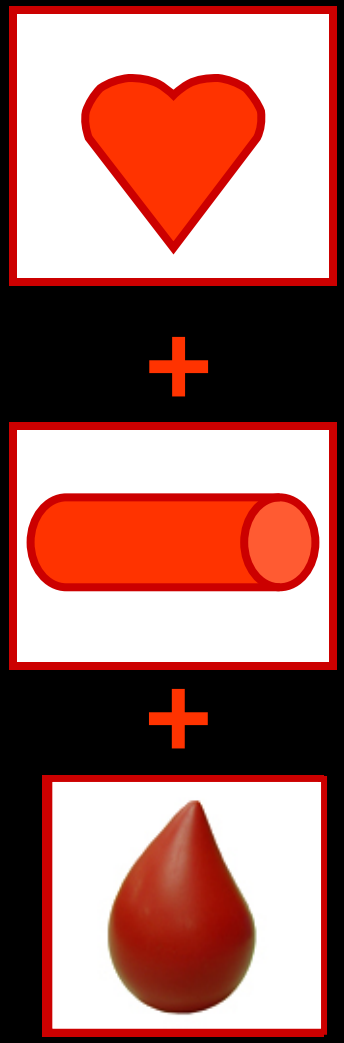
https://www.goredforwomen.org/about-heart-disease/facts_about_heart_disease_in_women-sub-category/statistics-at-a-glance/

7 Resolutions to Improve ♥ Health in 2014

- **Quit smoking**
- **Avoid 2nd –hand smoke**
- **Know your numbers**
- **Process out processed foods**
- **Get moving**
- **Get your friends & family on board**
- **Spread awareness**

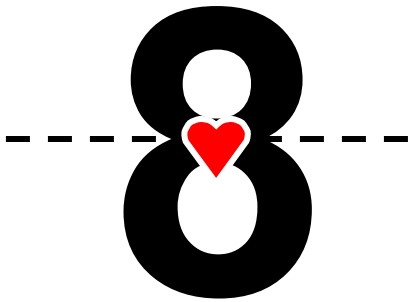
http://www.goredforwomen.org/about-heart-disease/symptoms_of_heart_disease_in_women/just-a-little-heart-attack/

Cardiovascular (CV) = Heart + Vessels + Blood!

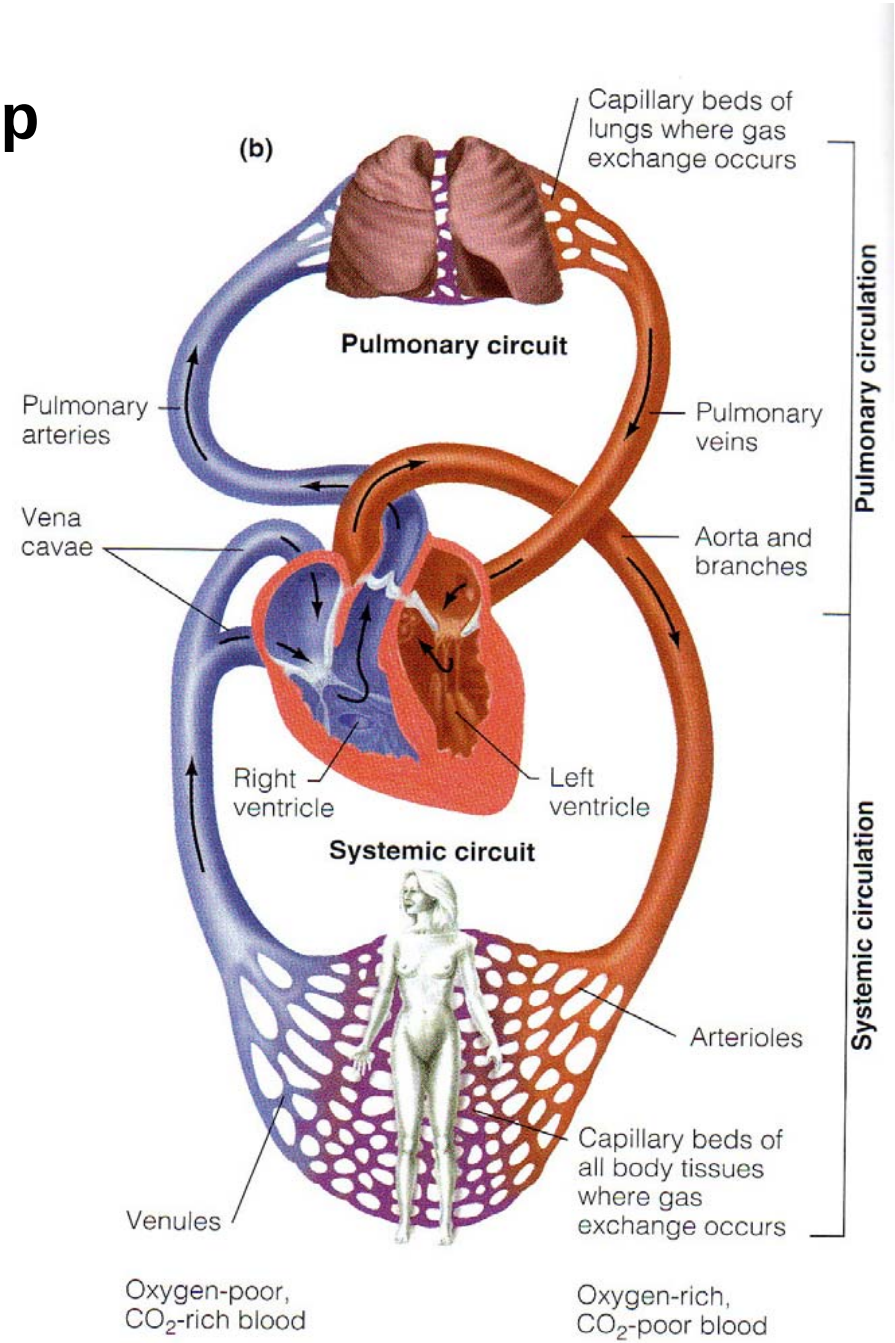


NB: Figure-8 loop

Pulmonary

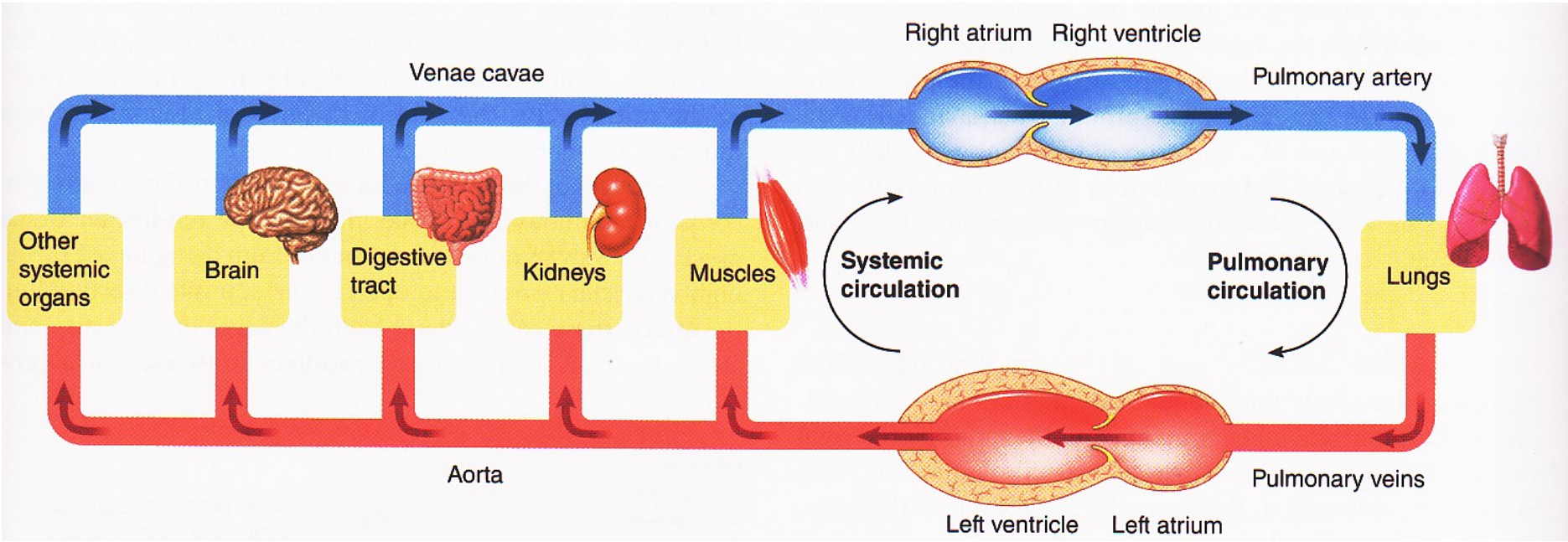


Systemic

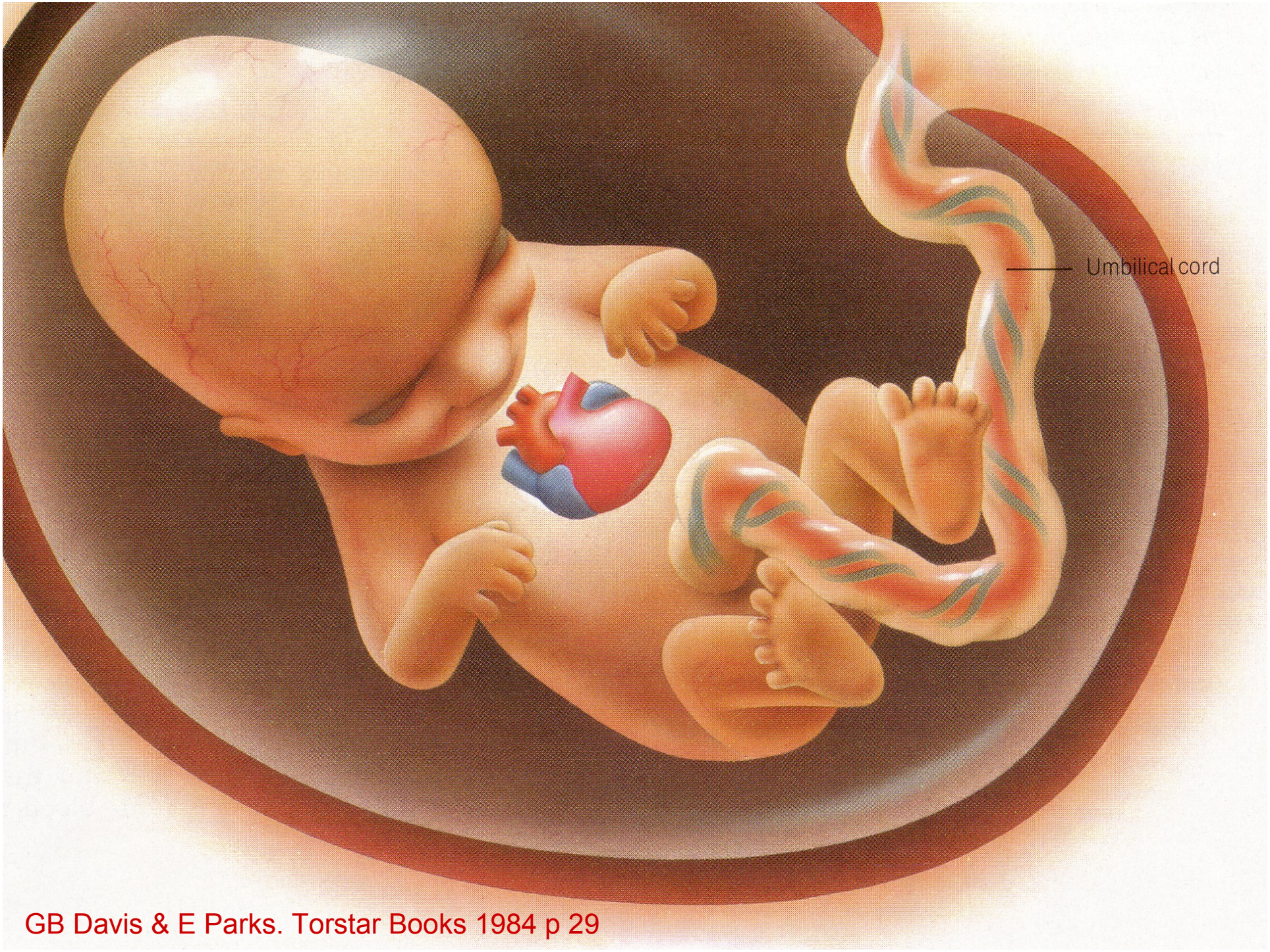


D Chiras 2013 fig 4-1b

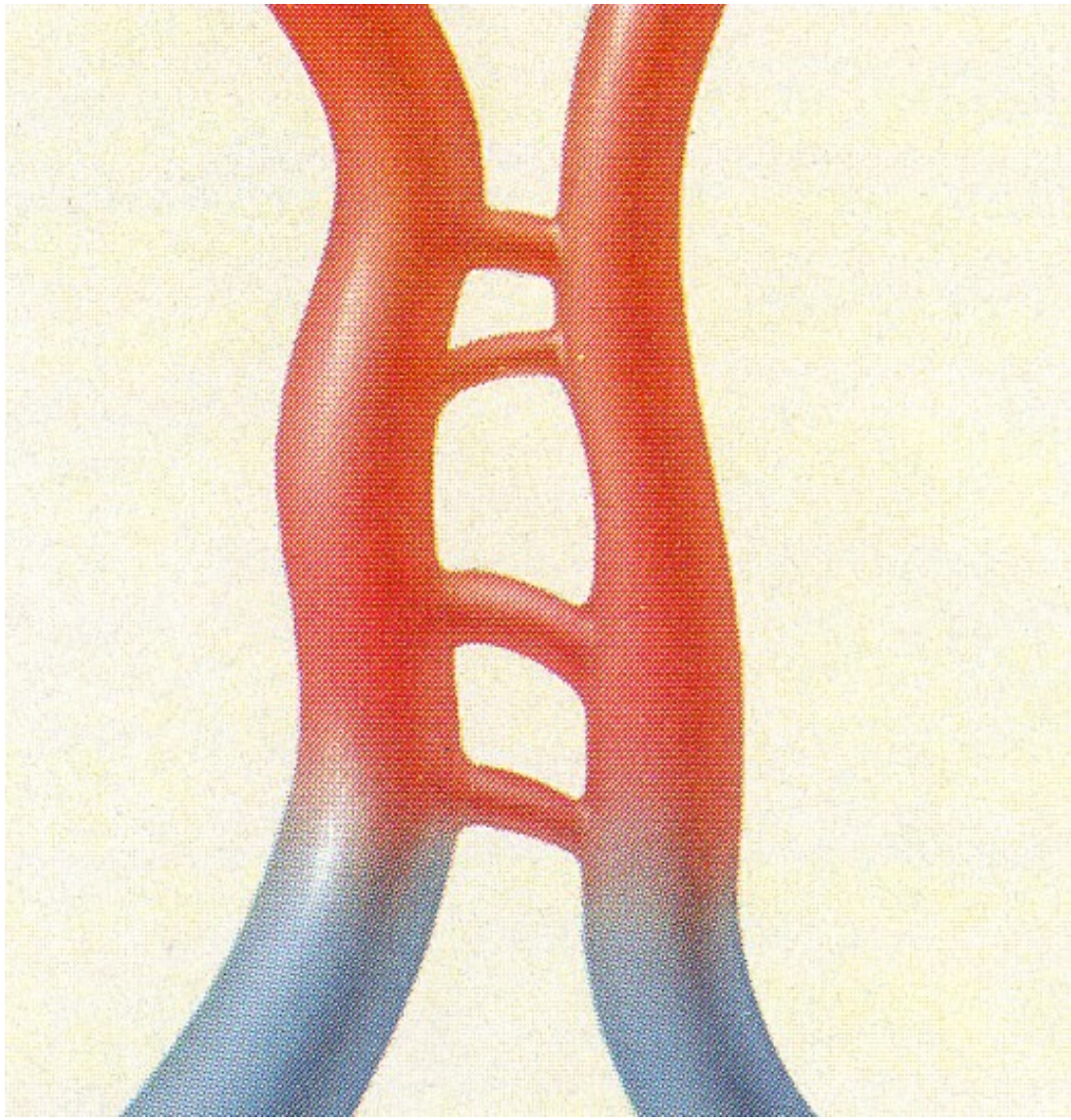
Dual Pump Action & Parallel Circulation

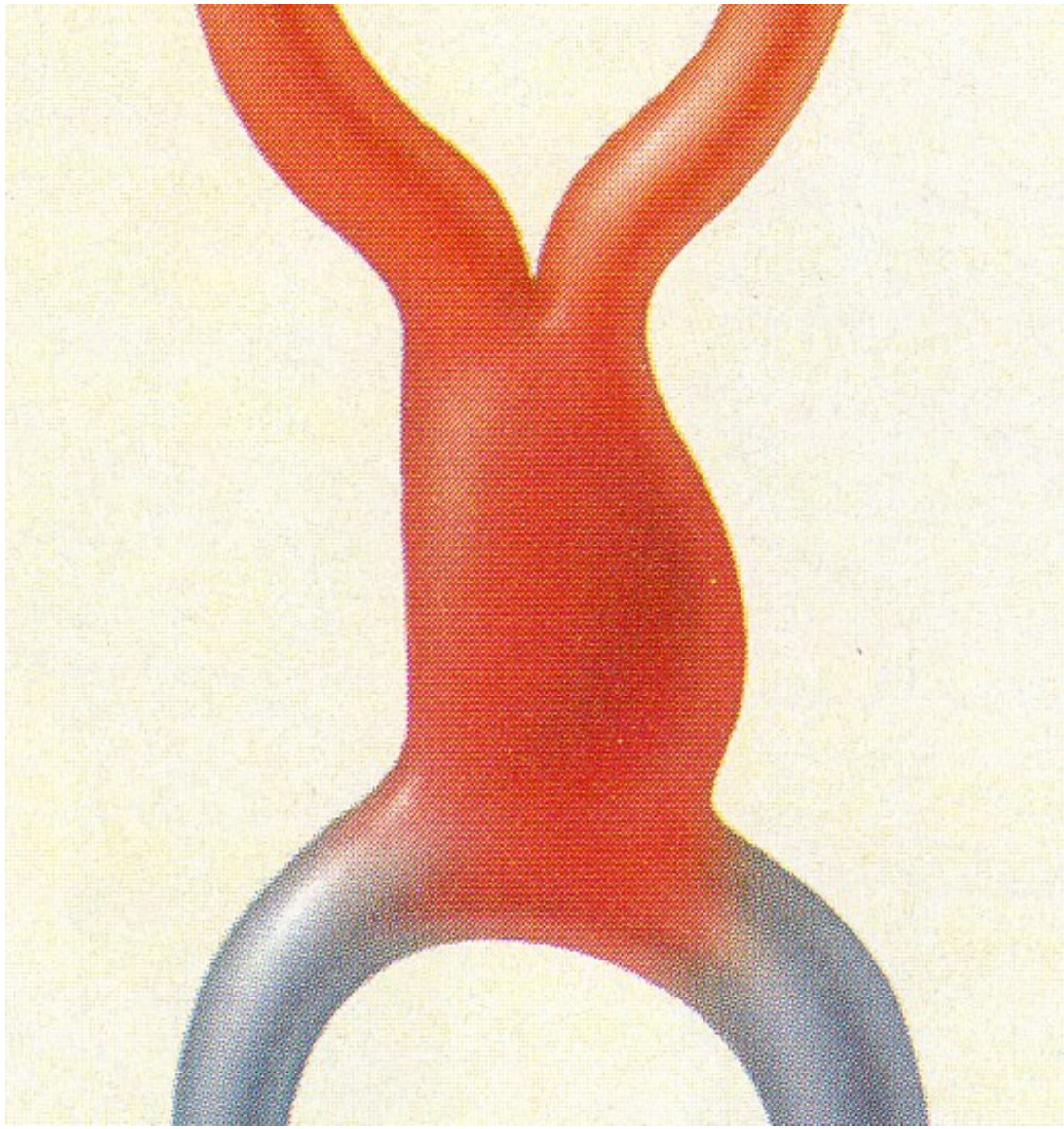


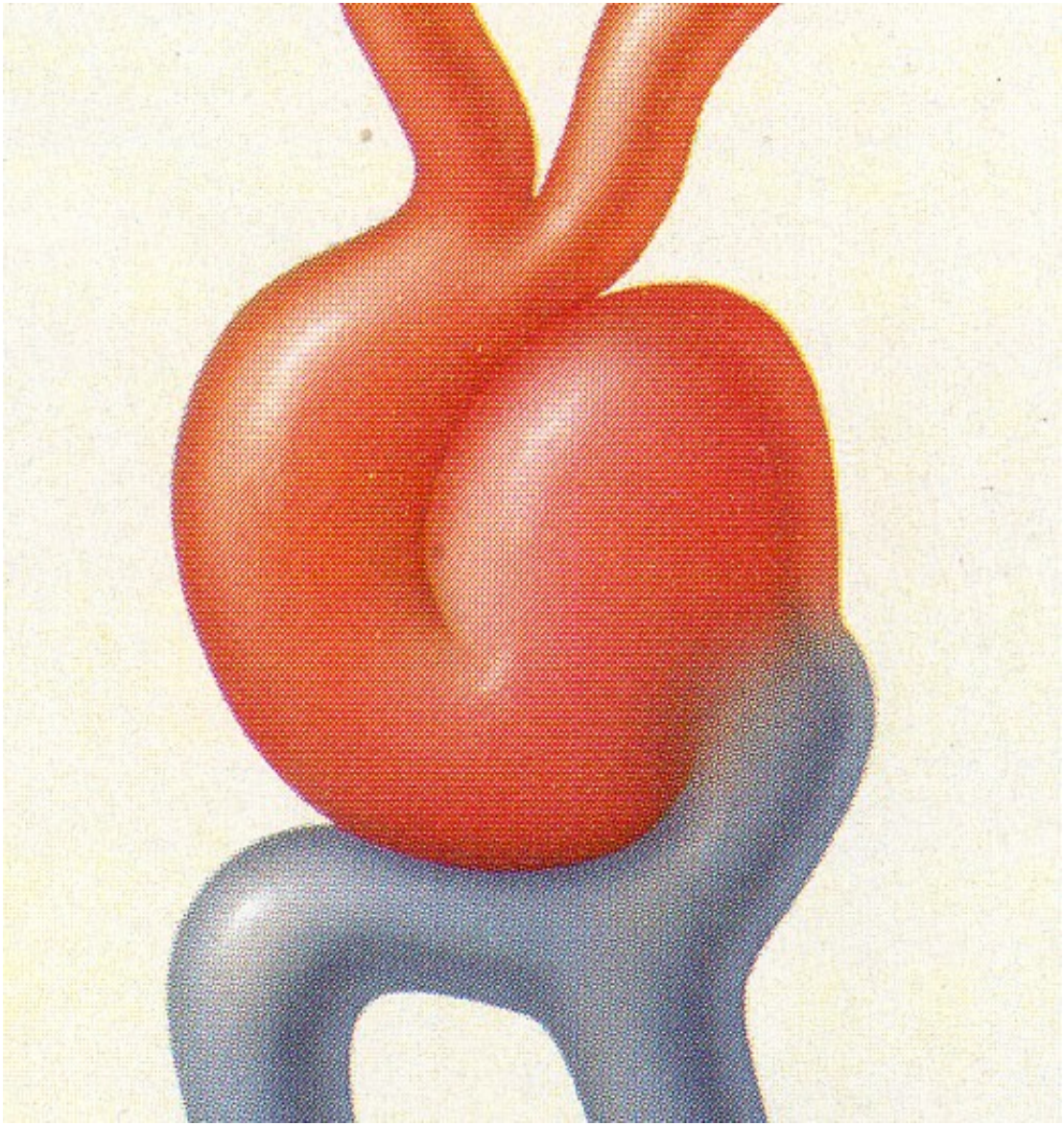
LS 2012 fig 9-2b p 231



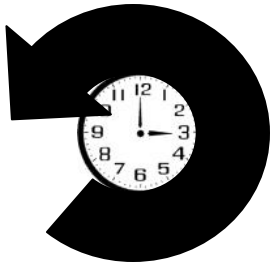
GB Davis & E Parks. Torstar Books 1984 p 29

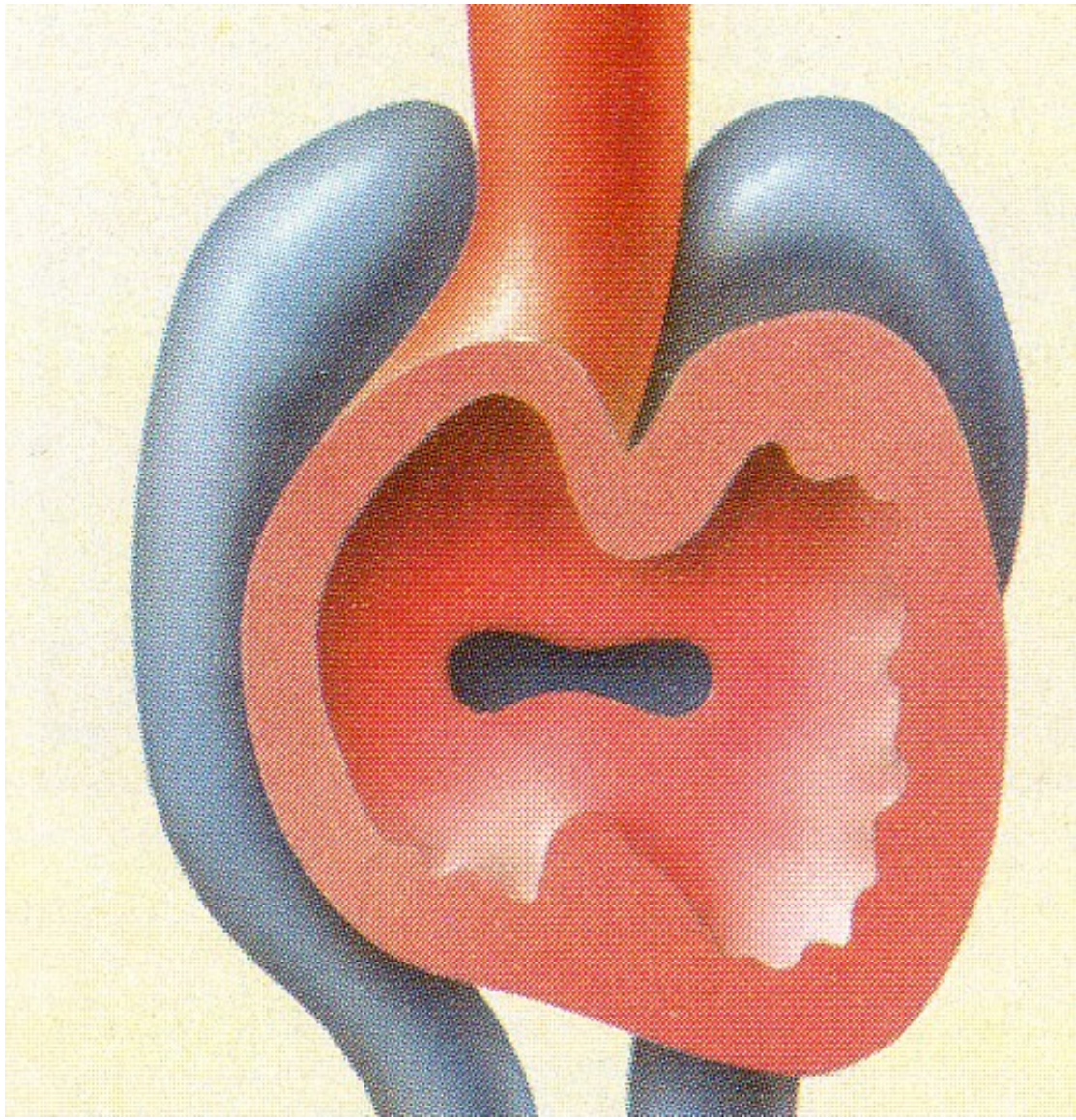


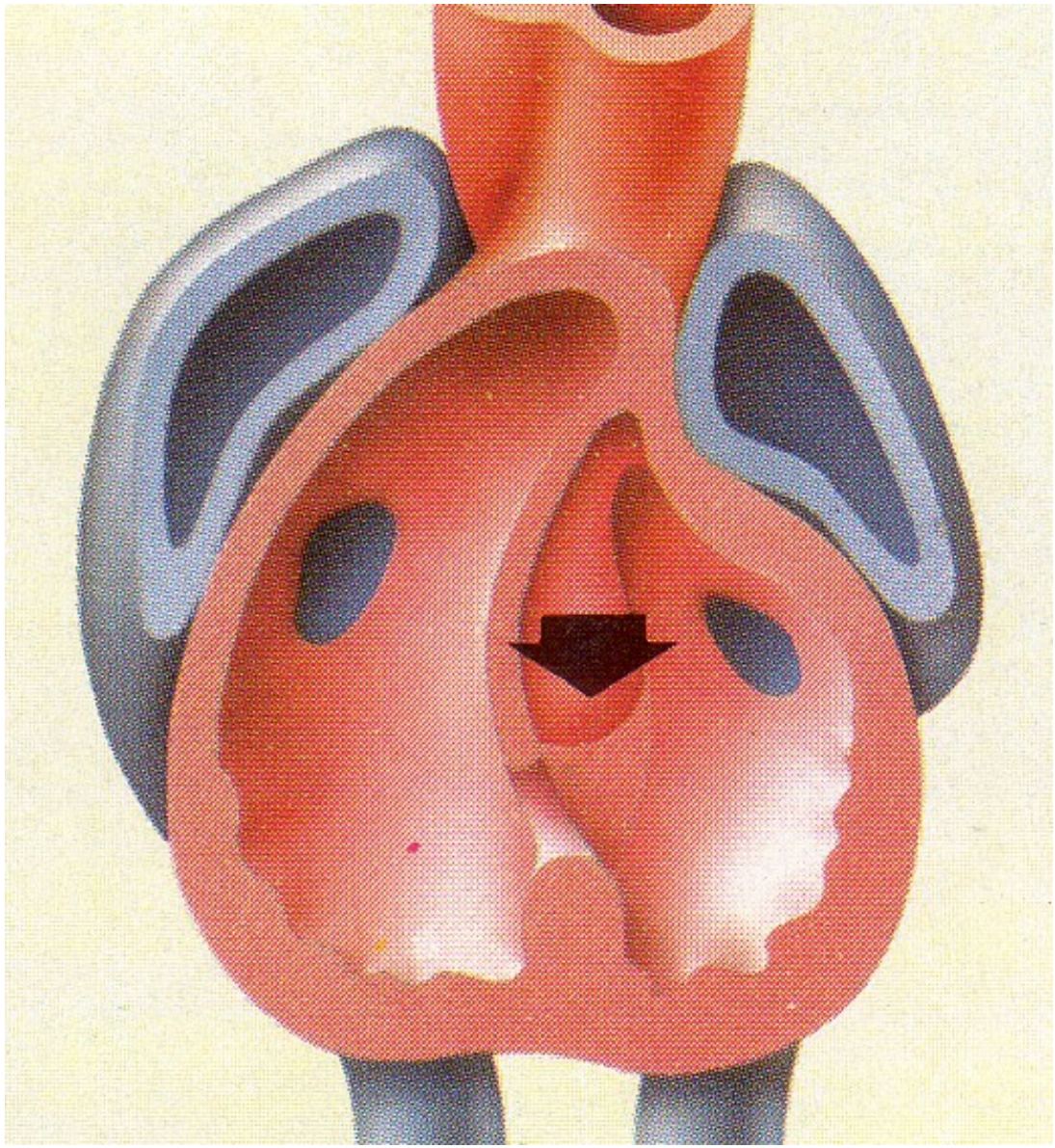




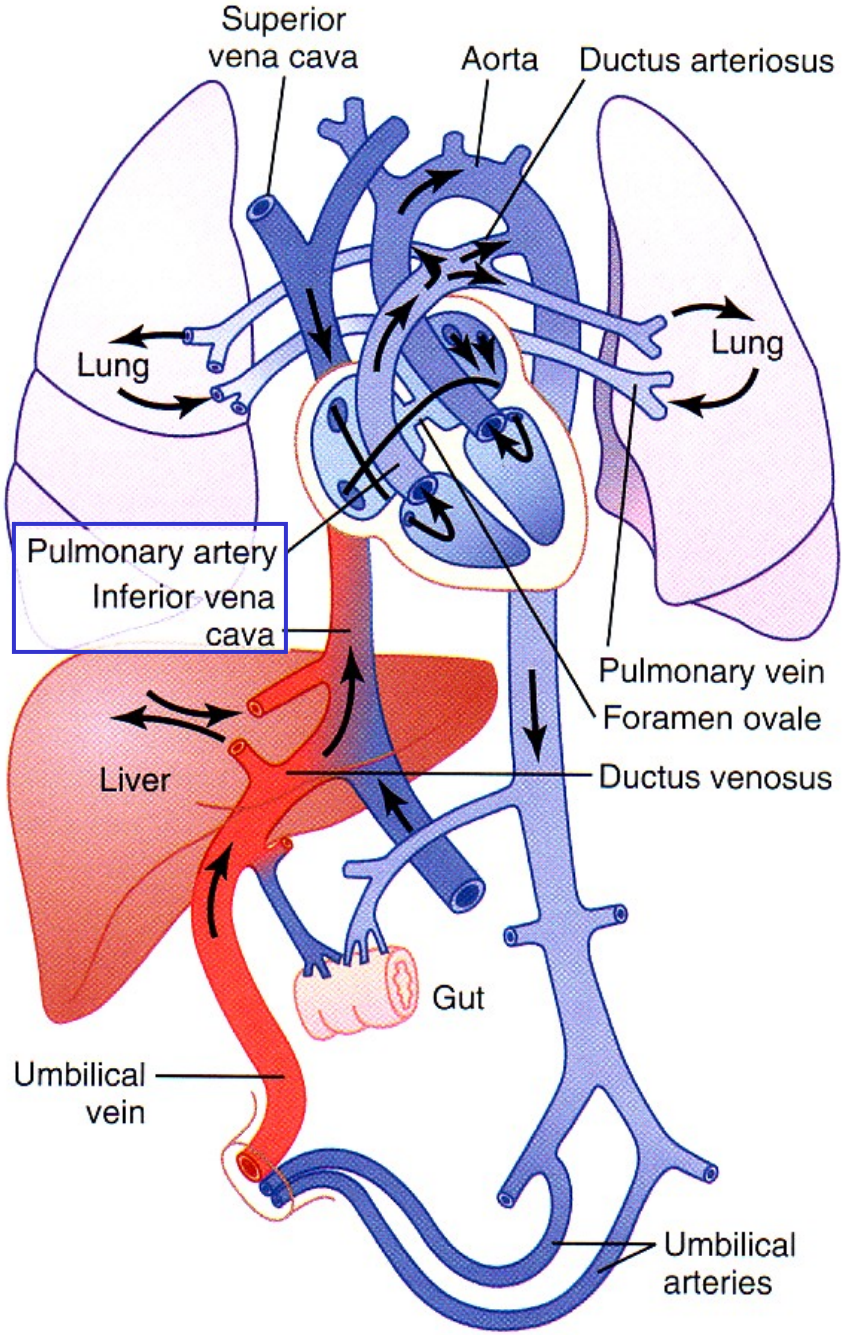
Counter-clockwise



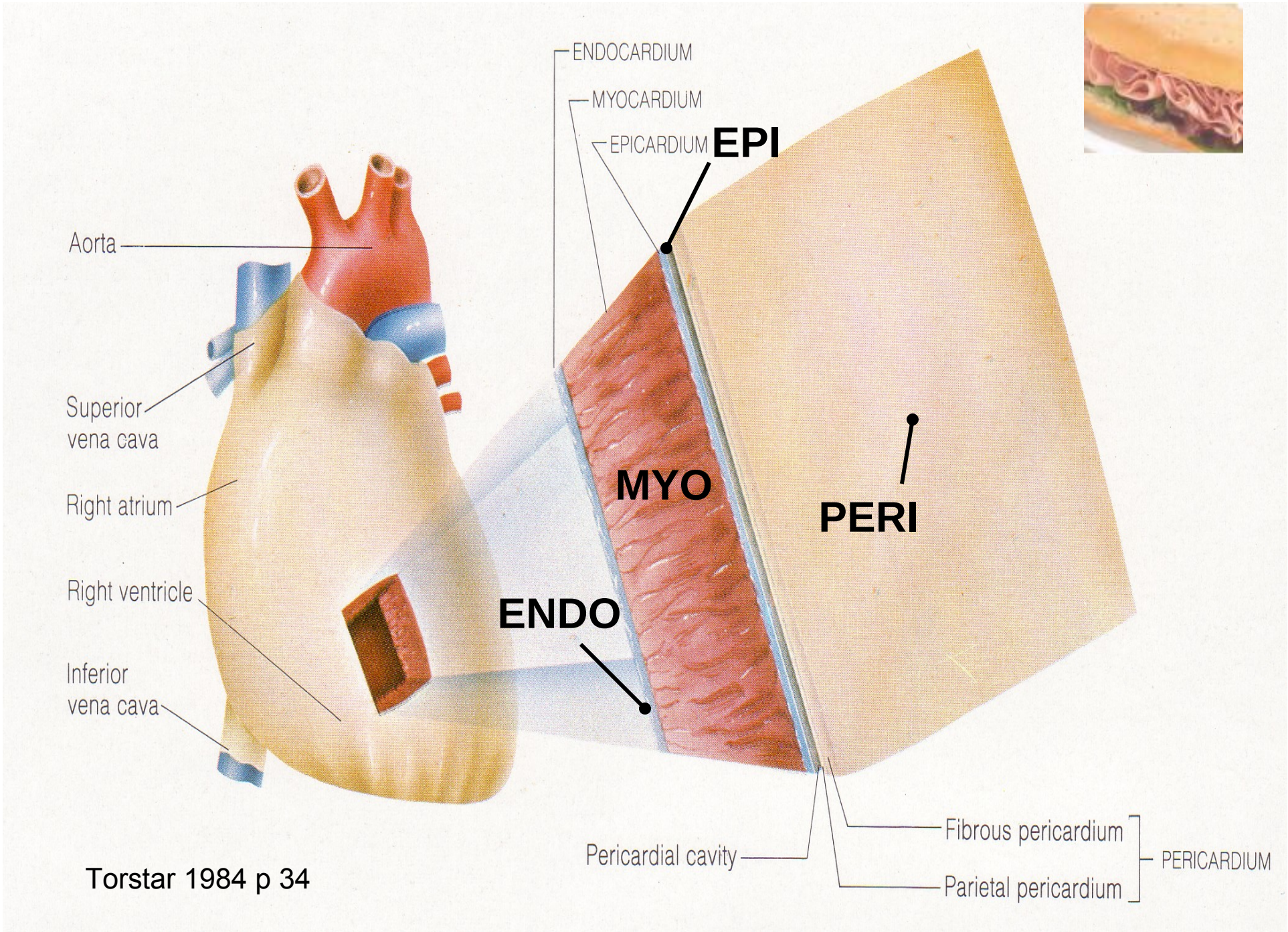




Fetal Circulation
≡ Aqua Animal
Bypass Lungs
R → L ♥ Shunt

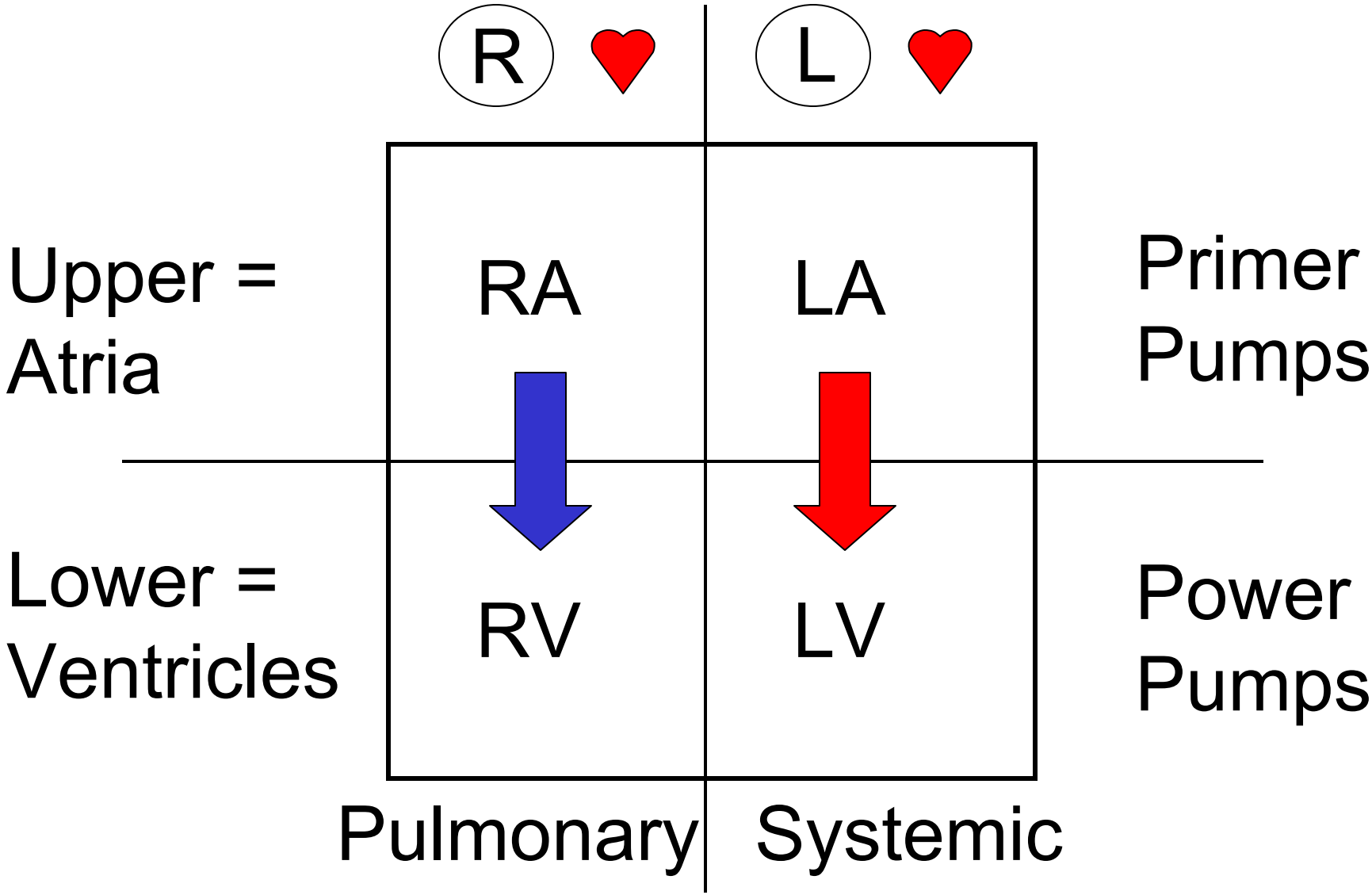


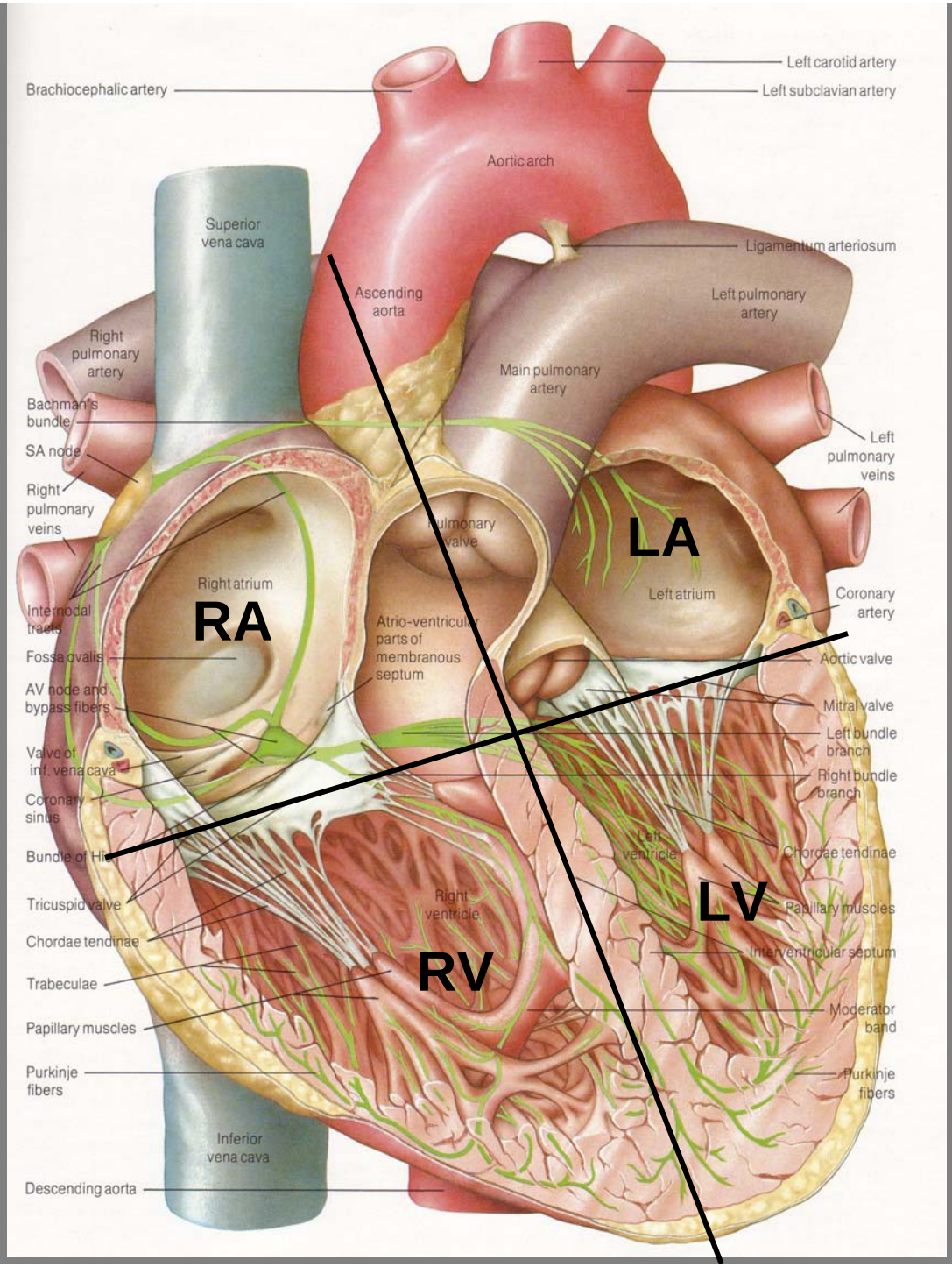
G&H 2011 fig 83-4



Torstar 1984 p 34

Human ♥ = 4-chambered box?
2 separate pumps?





Torstar 1984 p 53

Human ♥ = 4 unique valves?
2 valve sets?

More rigid

Semilunar = *Half-moon shaped*

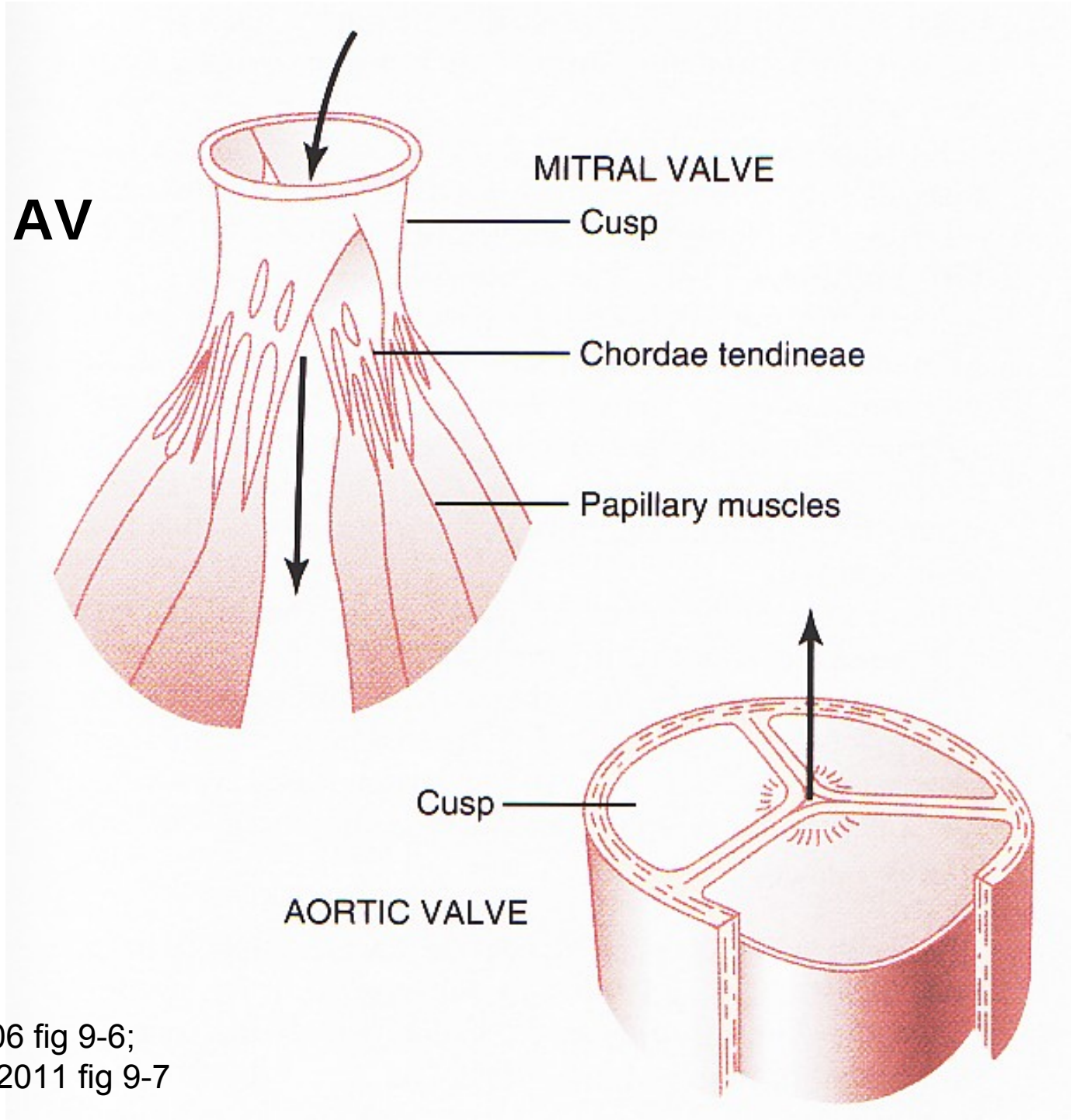
1. Pulmonic/Pulmonary
2. Aortic

More flimsy

AV = *Atrioventricular*

3. (R) AV = Tricuspid
4. (L) AV = Mitral/Bicuspid

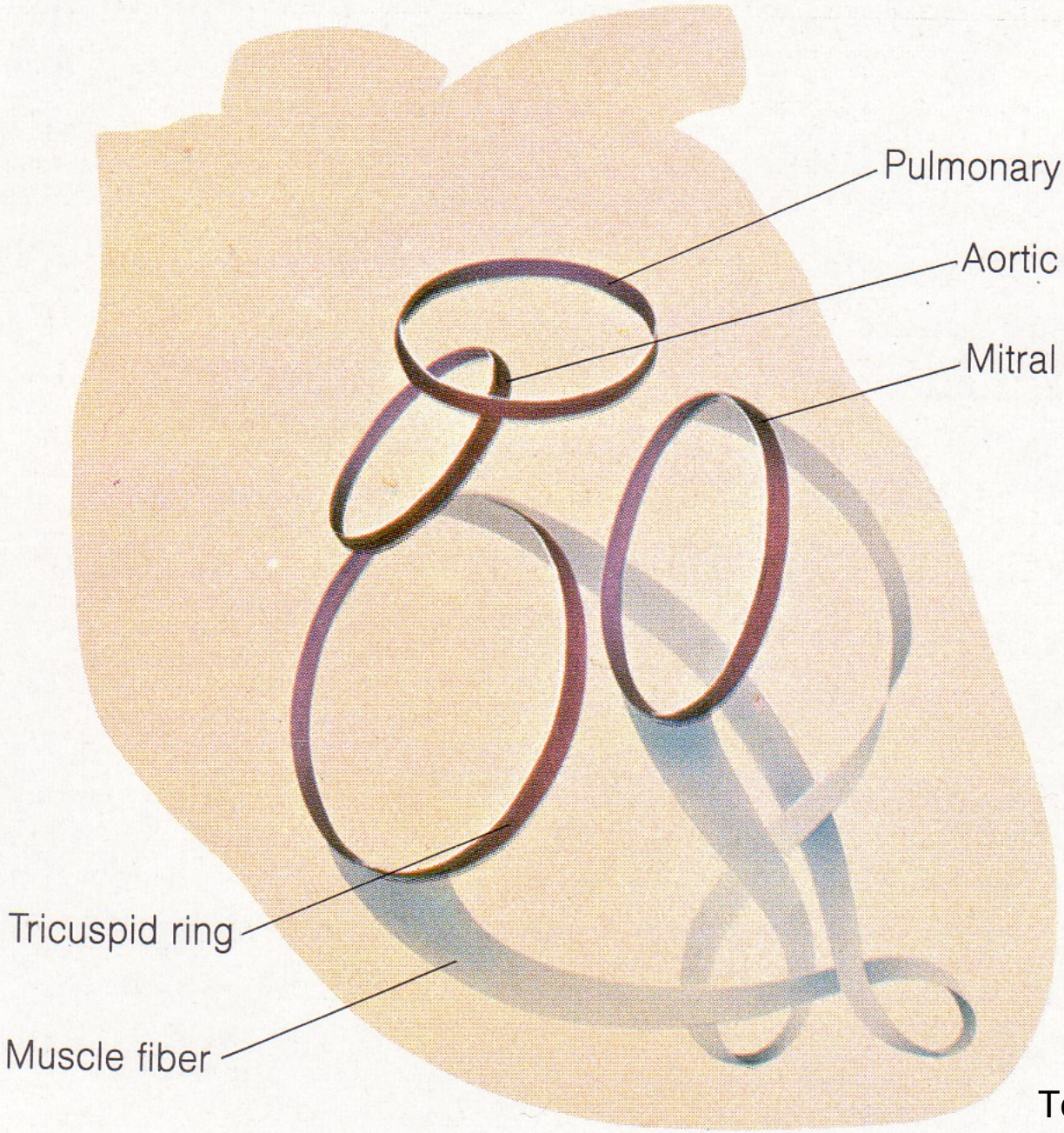
Ⓛ AV



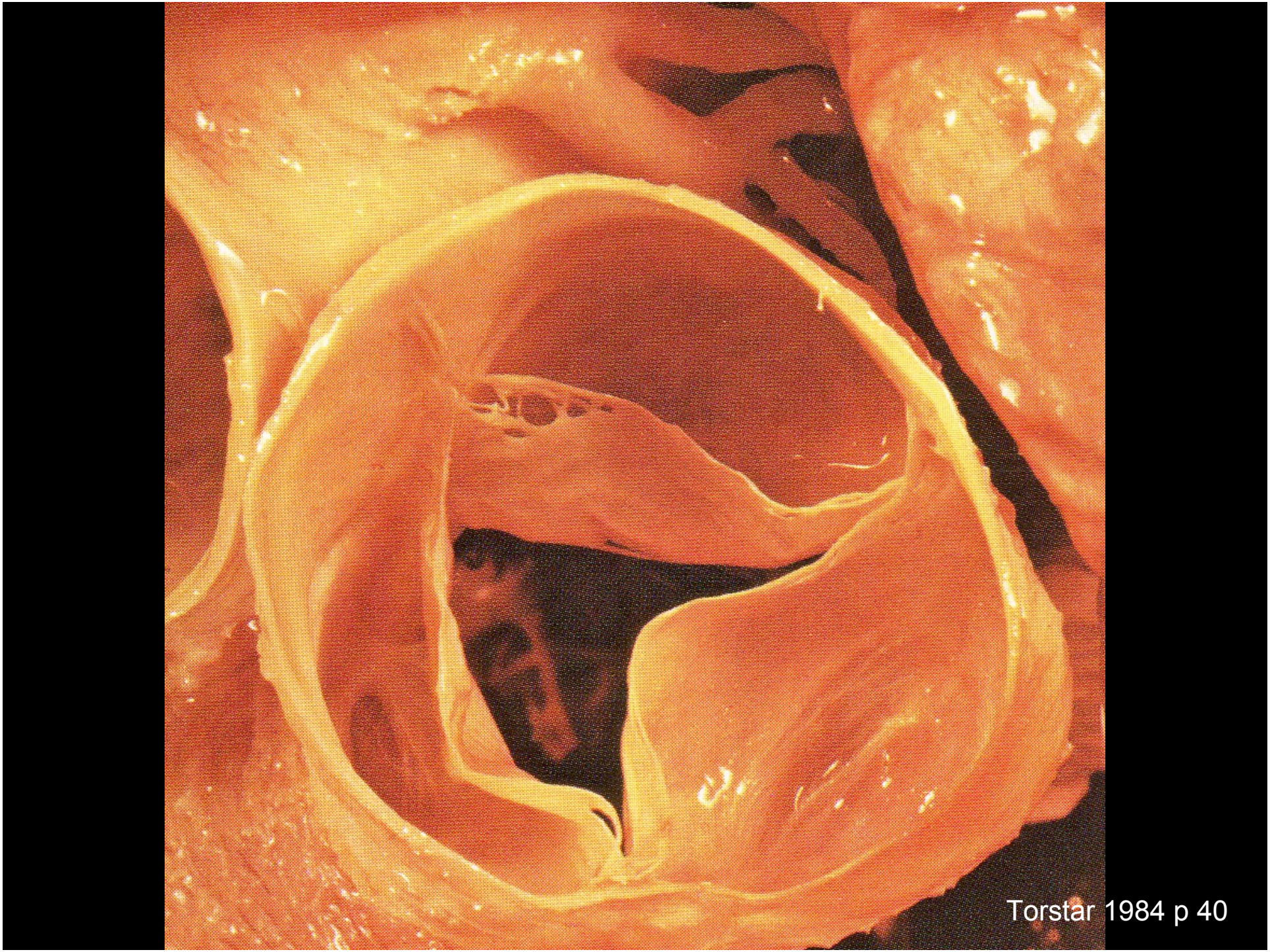
SL

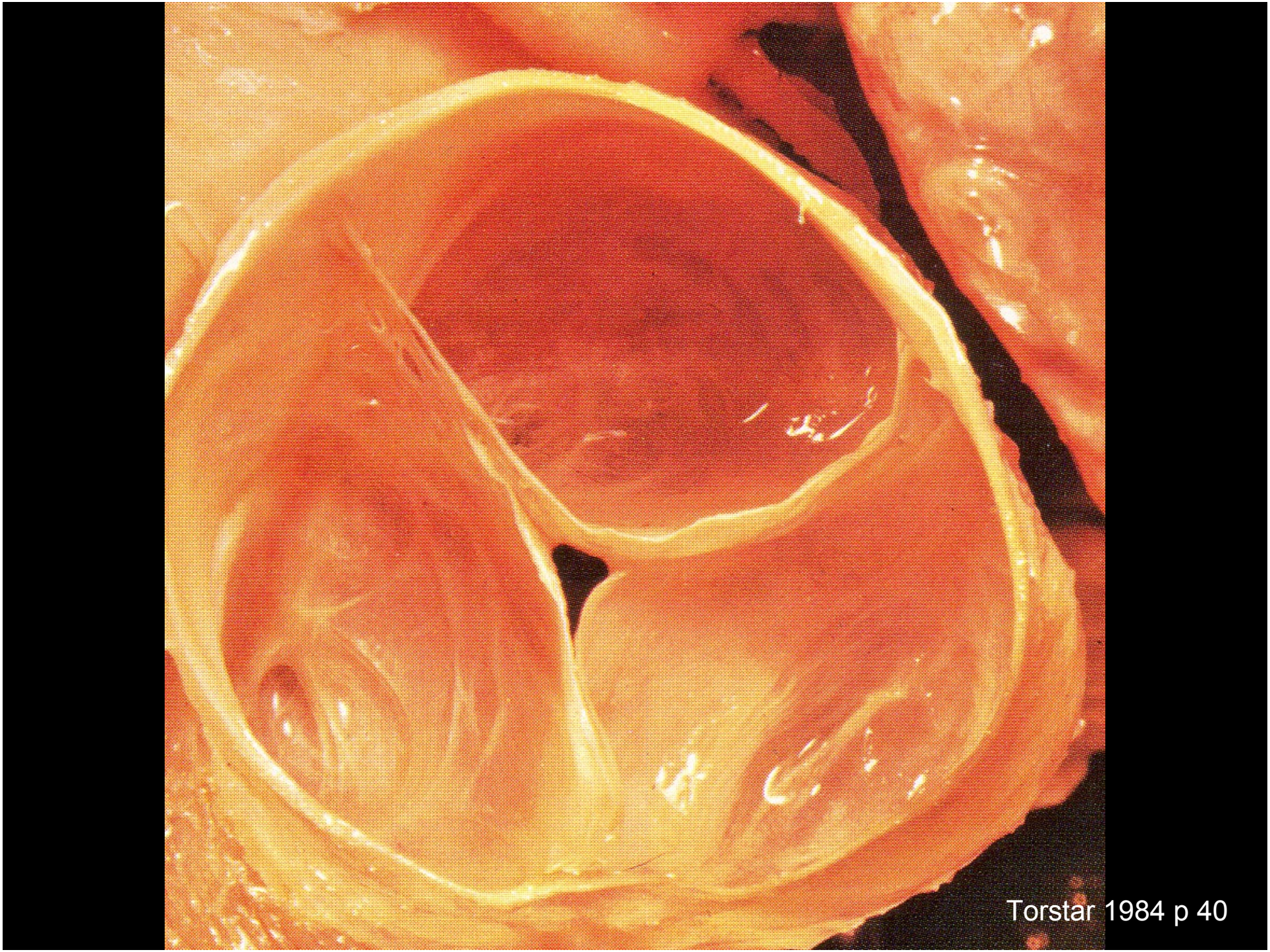
G&H 2006 fig 9-6;
cf: G&H 2011 fig 9-7

Heart Valve Orientation & Scaffolding

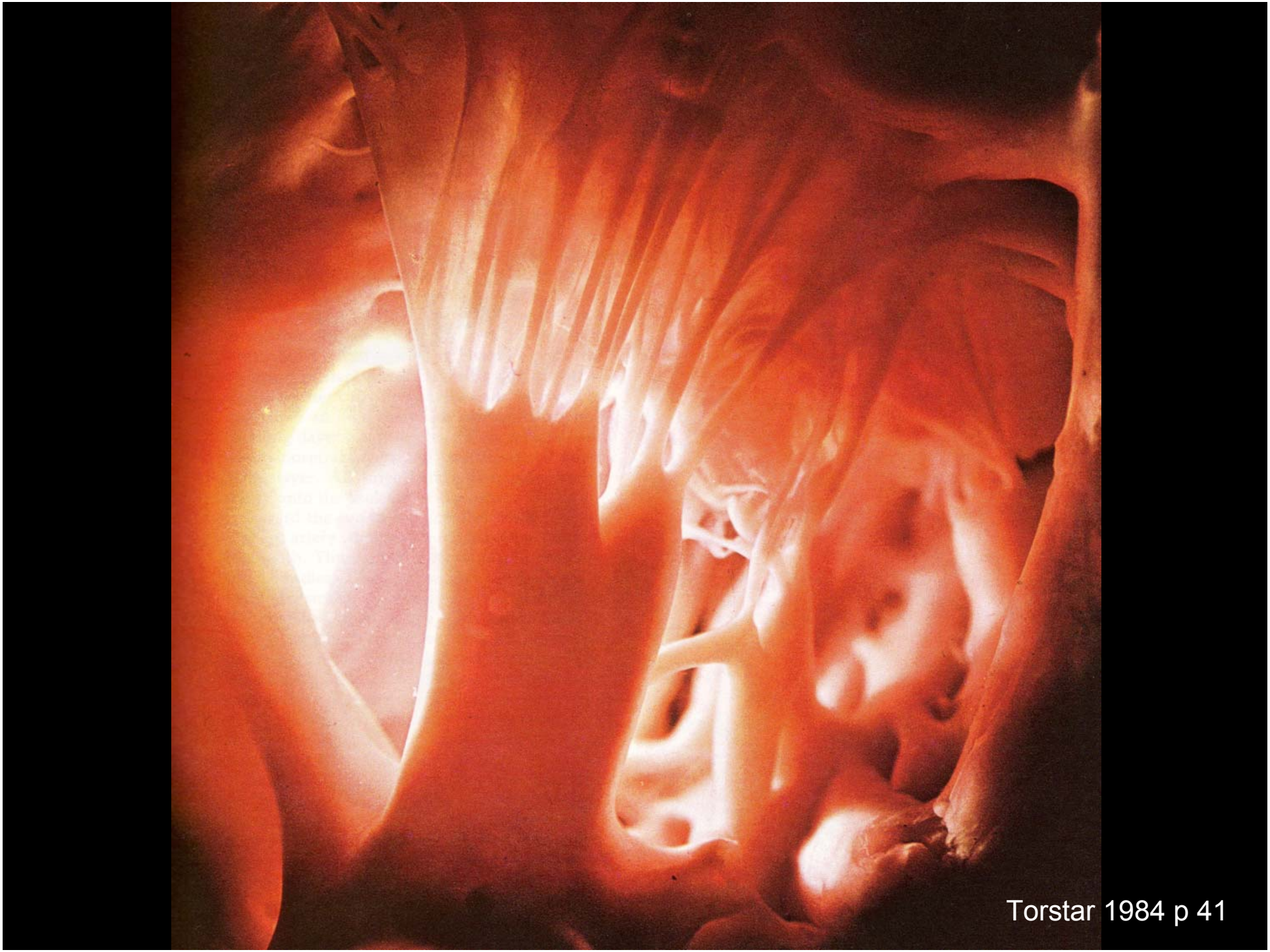


Torstar Books 1984


Torstar 1984 p 40



Torstar 1984 p 40



Torstar 1984 p 41

What the heck's a *bruit?* (brwe, brōōt) [Fr.] sound ≥ 25 subclassifications!

Aneurysmal b. **a blowing sound over an aneurysm.**

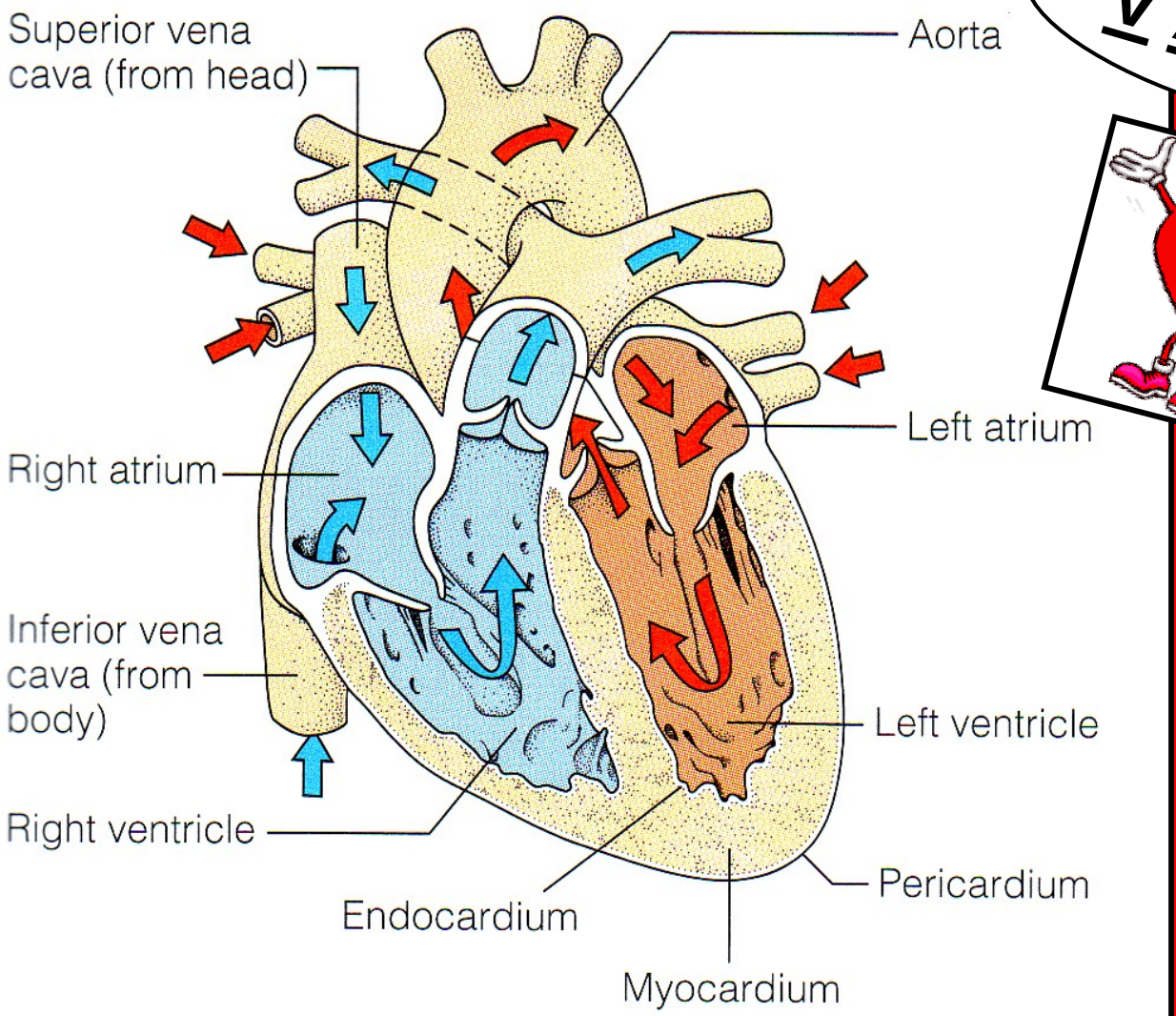
b. de canon **[Fr. sound of cannon] abnormally loud 1st heart sound heard in complete heart block.**

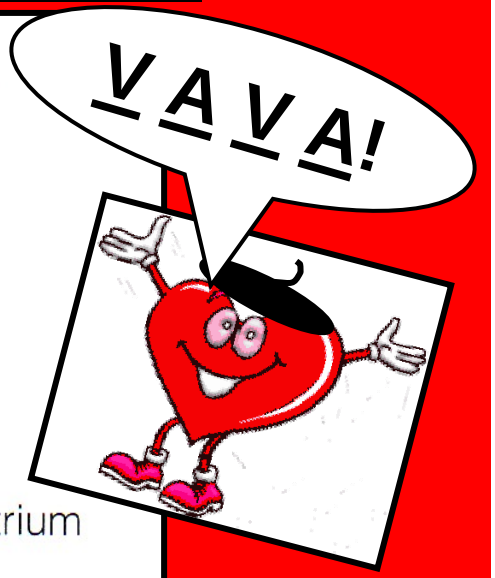
b. de craquement **[Fr. sound of crackling] a crackling pericardial or pleural bruit.**

False b. **artifact caused by pressure of the stethoscope or derived from circulation of the ear.**

b. de lime **[Fr. sound of a file] cardiac sound resembling filing.**

Veins → Atria → Ventricles → Arteries

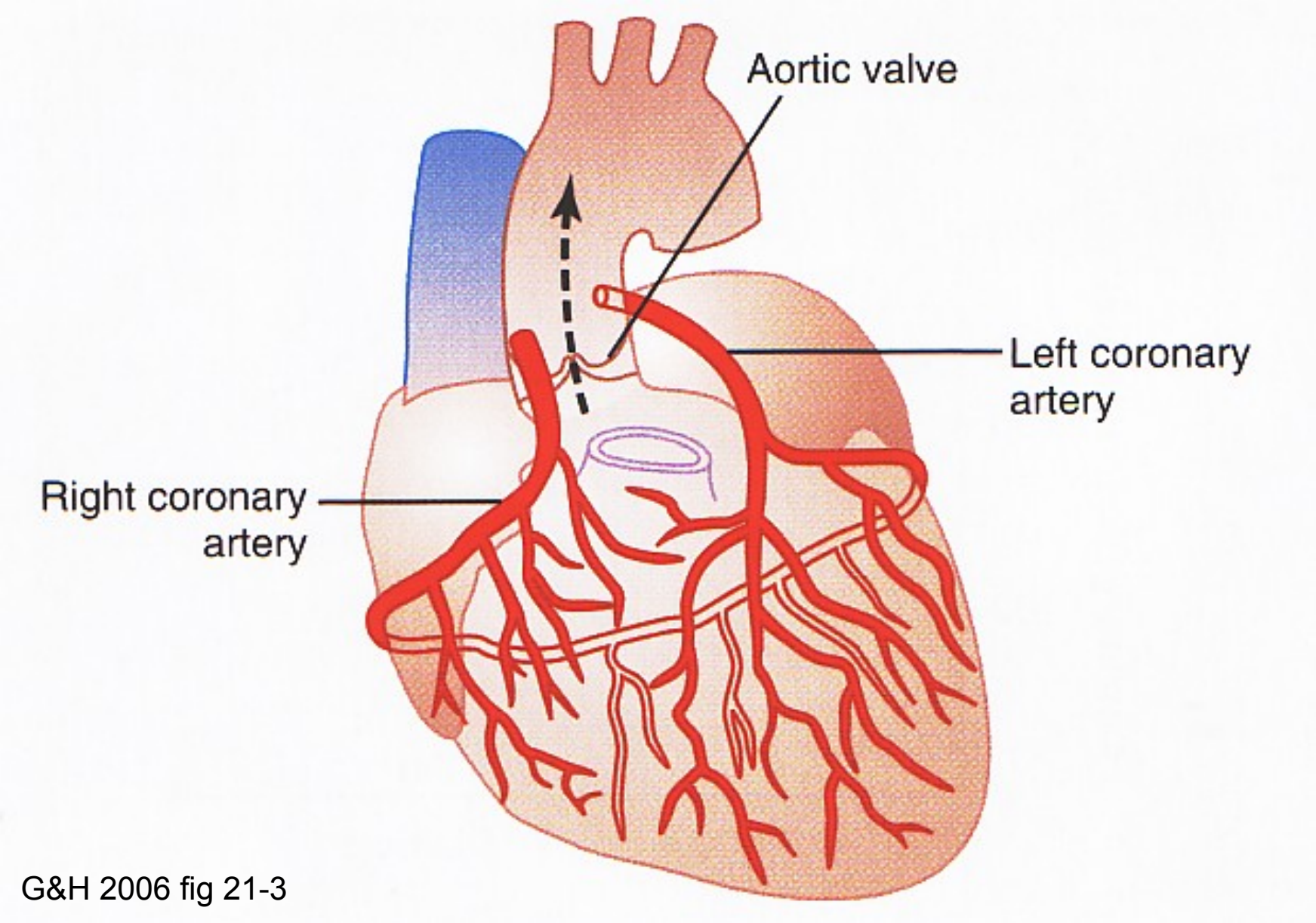




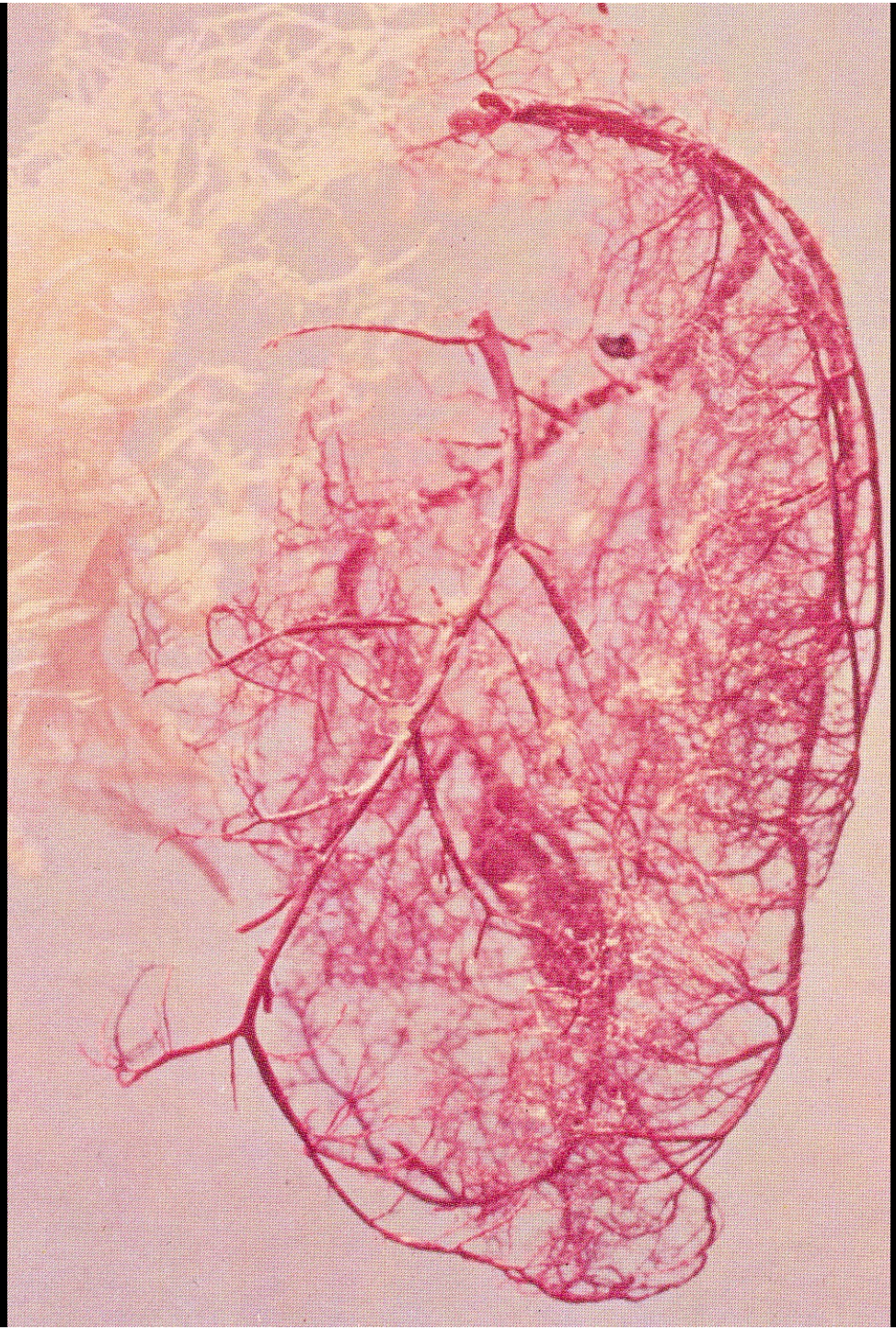
http://www.nhlbi.nih.gov/health/health-topics/topics/hhw/contraction.html

LS2007

Coronary Circulation ≡ Crowns the Heart!



G&H 2006 fig 21-3



Torstar 1984 p 47

Heart Dominance May Influence Survival

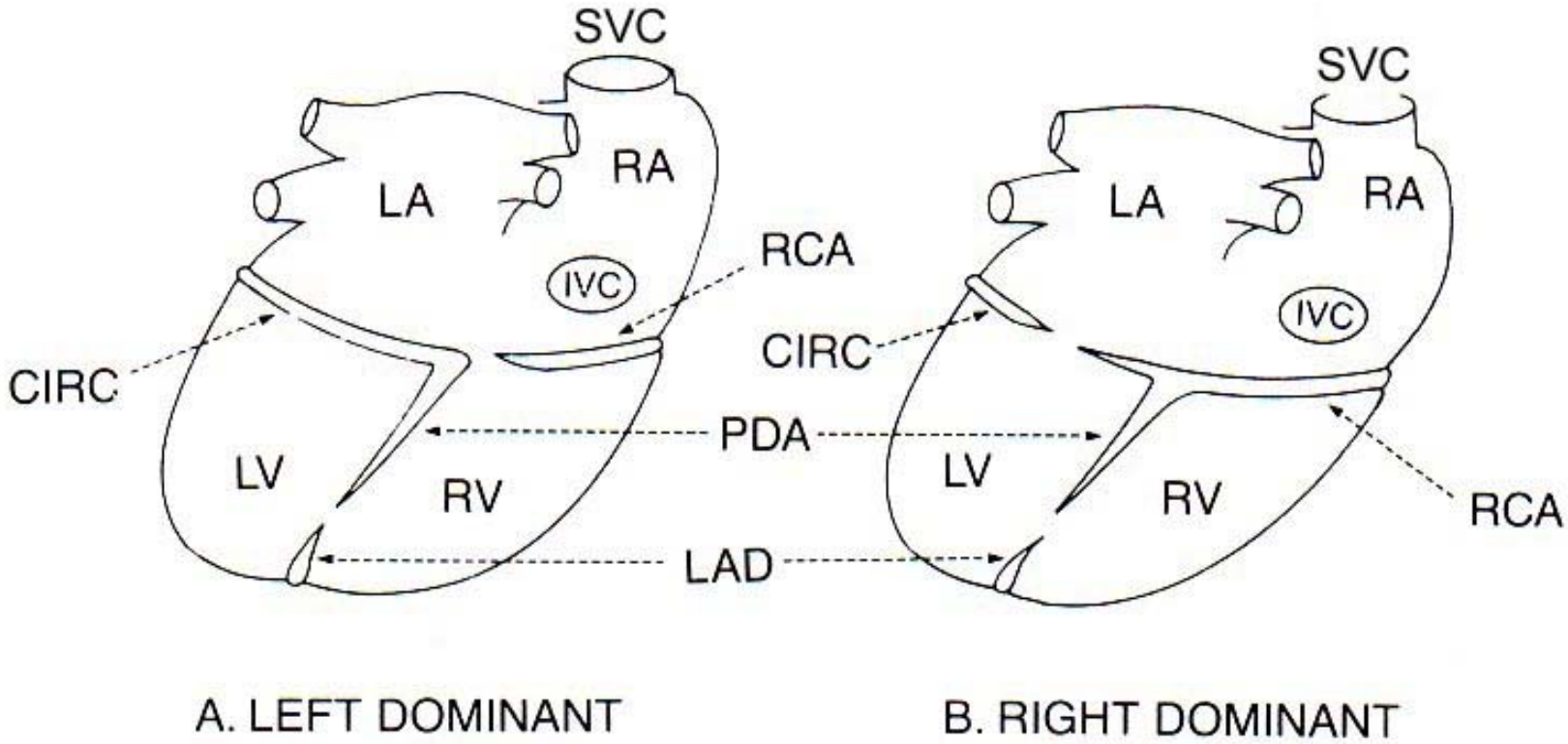
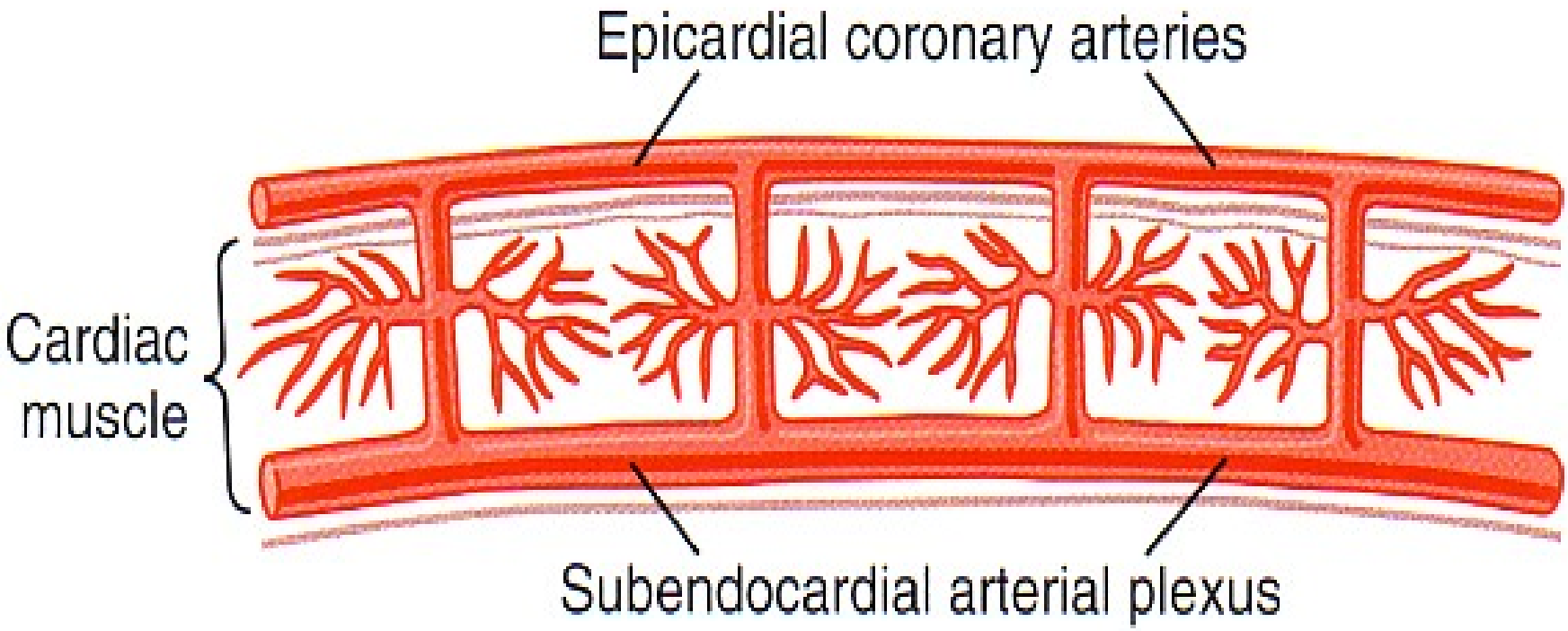


FIG. 1.9. Diagrammatic views of the posterior surfaces of the human heart showing left (A) and right dominant (B) patterns of coronary artery supply. In the left dominant pattern, the posterior descending artery (PDA) is supplied by the circumflex branch of the left coronary artery (CIRC). In the right dominant pattern, the posterior descending artery is supplied by the right coronary artery (RCA). Other abbreviations: LAD, left anterior descending coronary artery; LA, left atrium; RA, right atrium; LV, left ventricle; RV, right ventricle; SVC, superior vena cava; IVC, inferior vena cava.

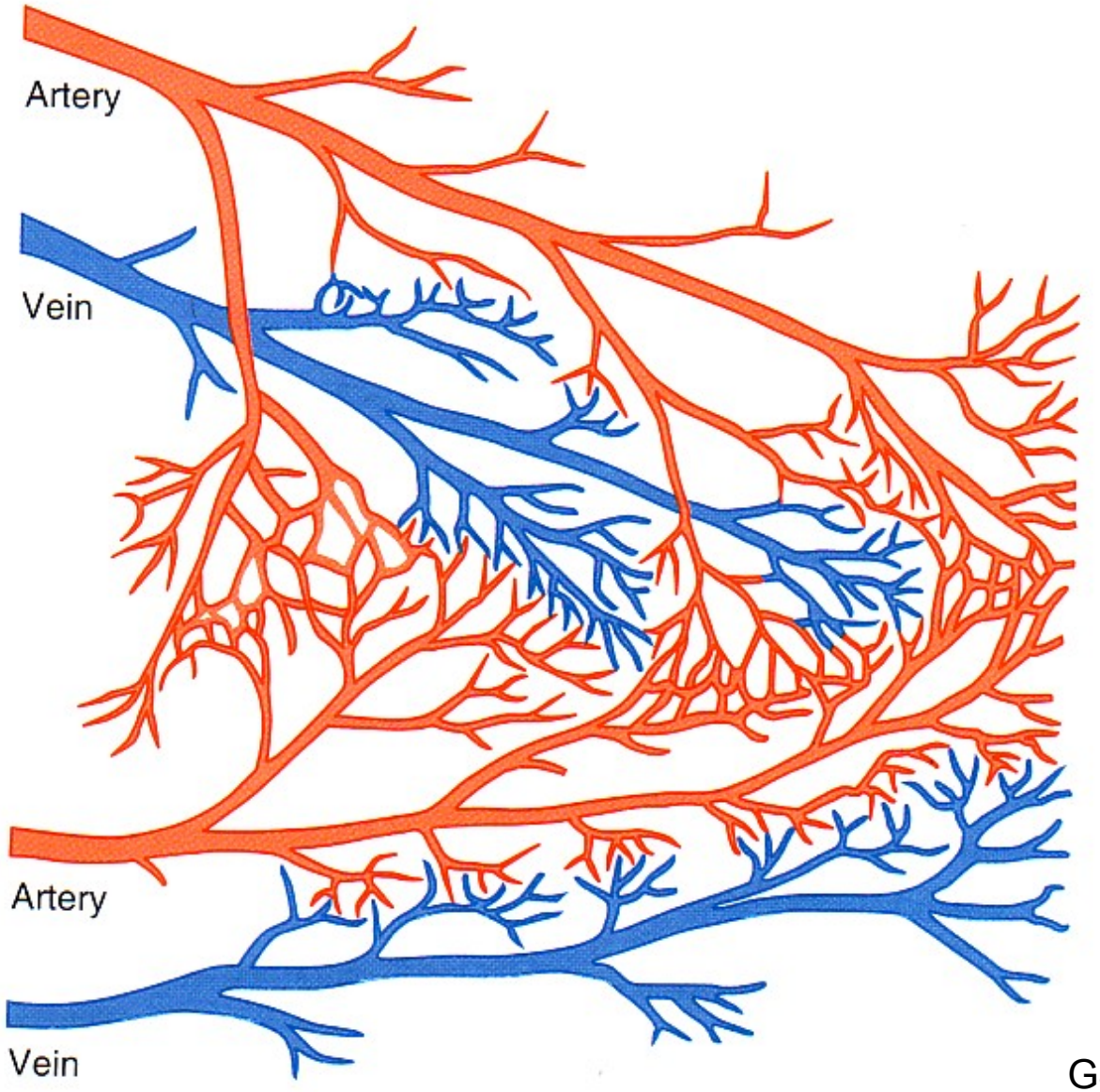
AM Katz 1992 p 12

Coronary Arteries Pierce the Heart from Epi to Endo



G&H 2011 fig 21-5

Anastomoses May Provide Lifesaving Collateral Circulation!!



G&H 2011 fig 21-6

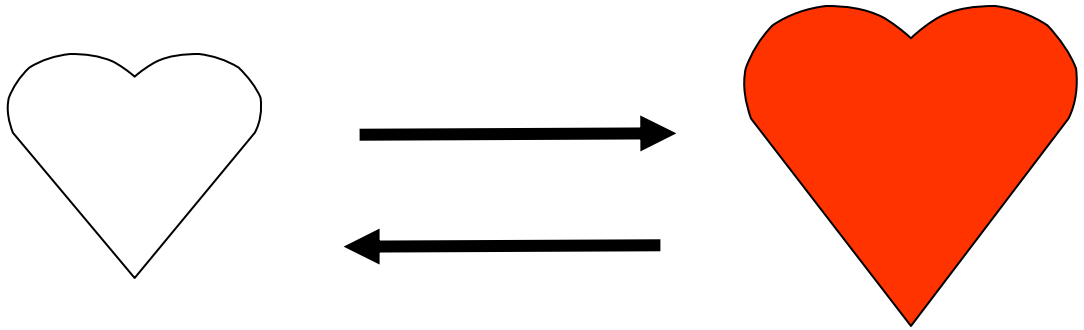
Cardiac Cycle

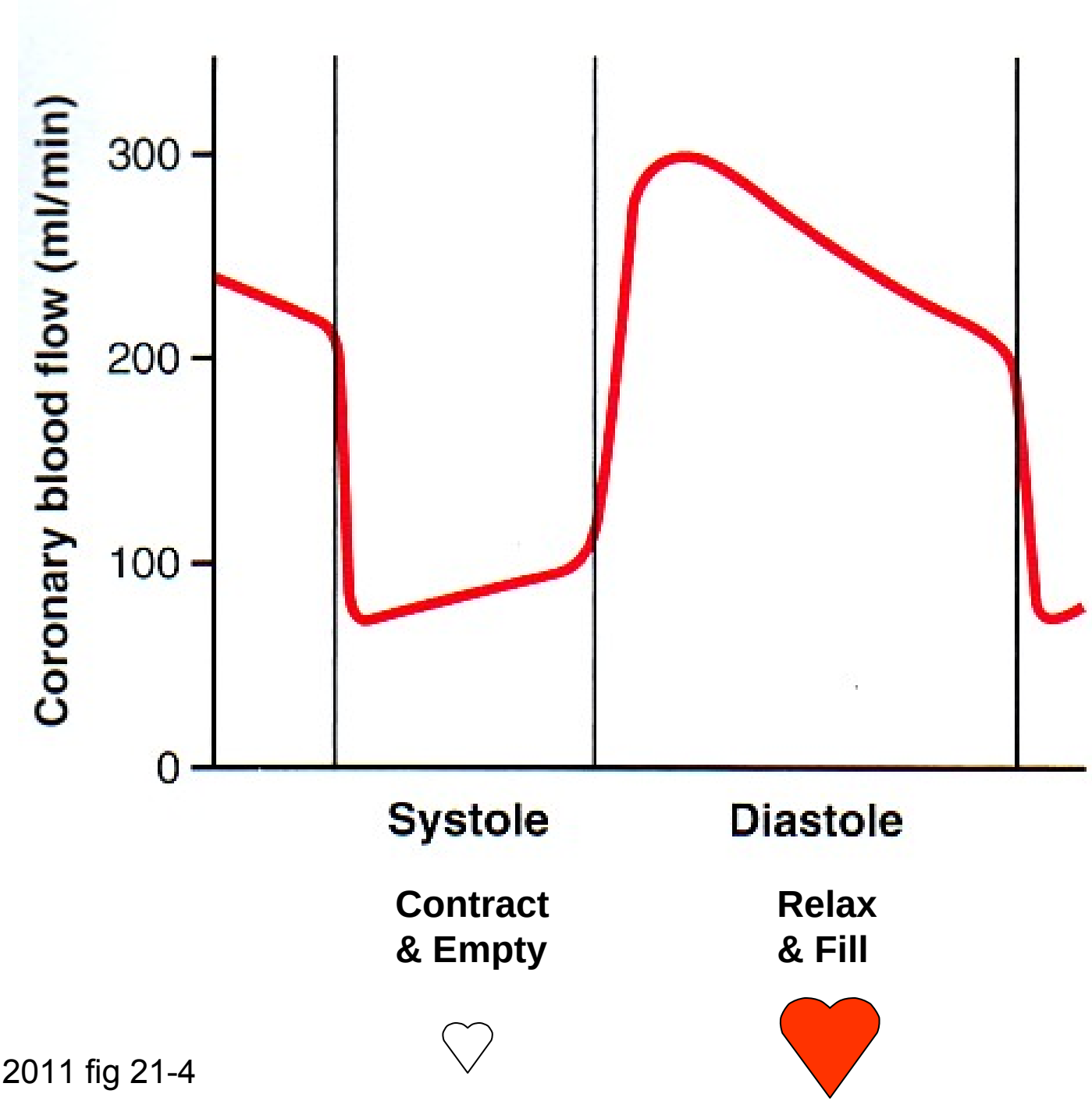
Systole

Contract
& Empty

Diastole

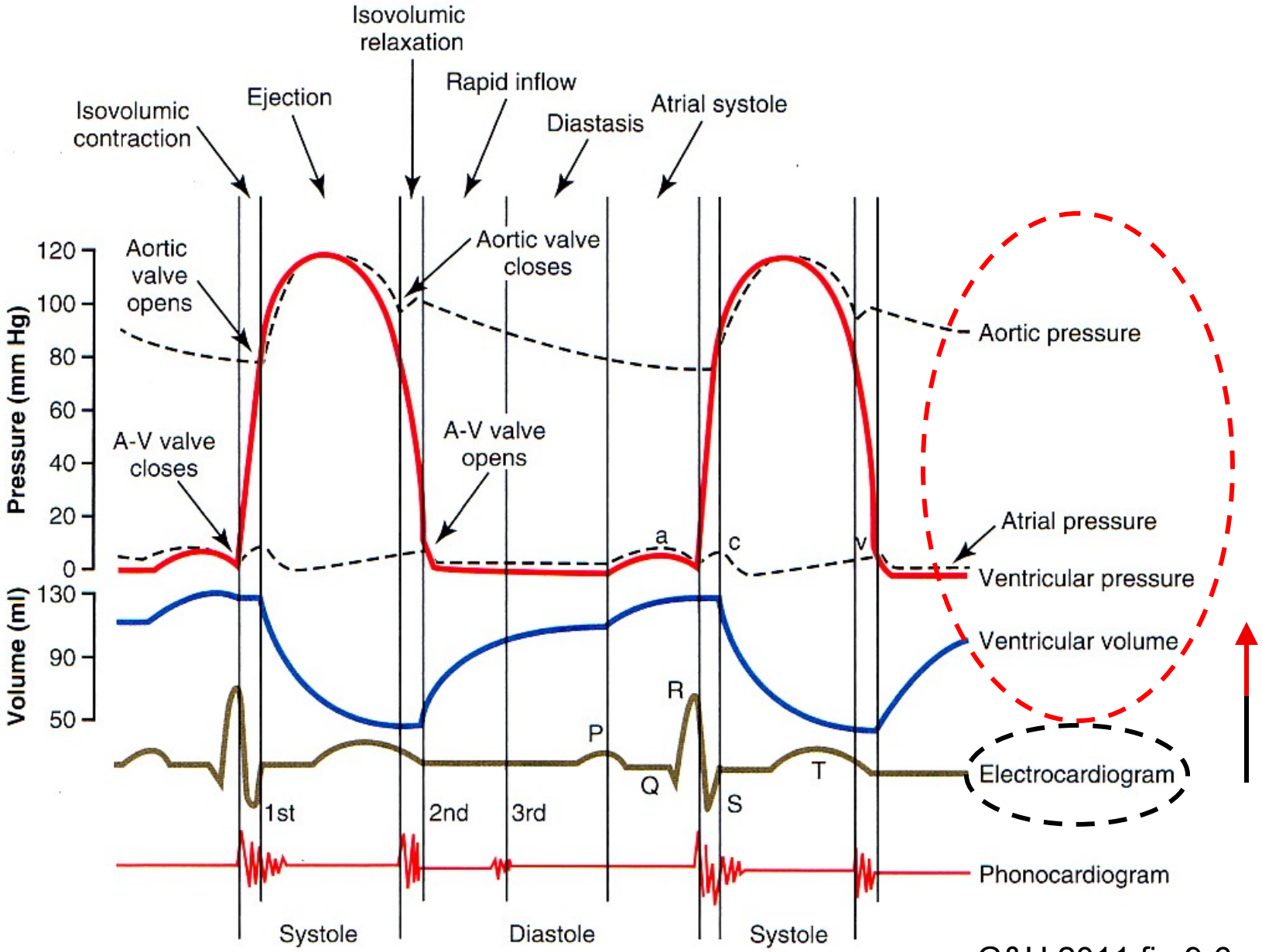
Relax
& Fill



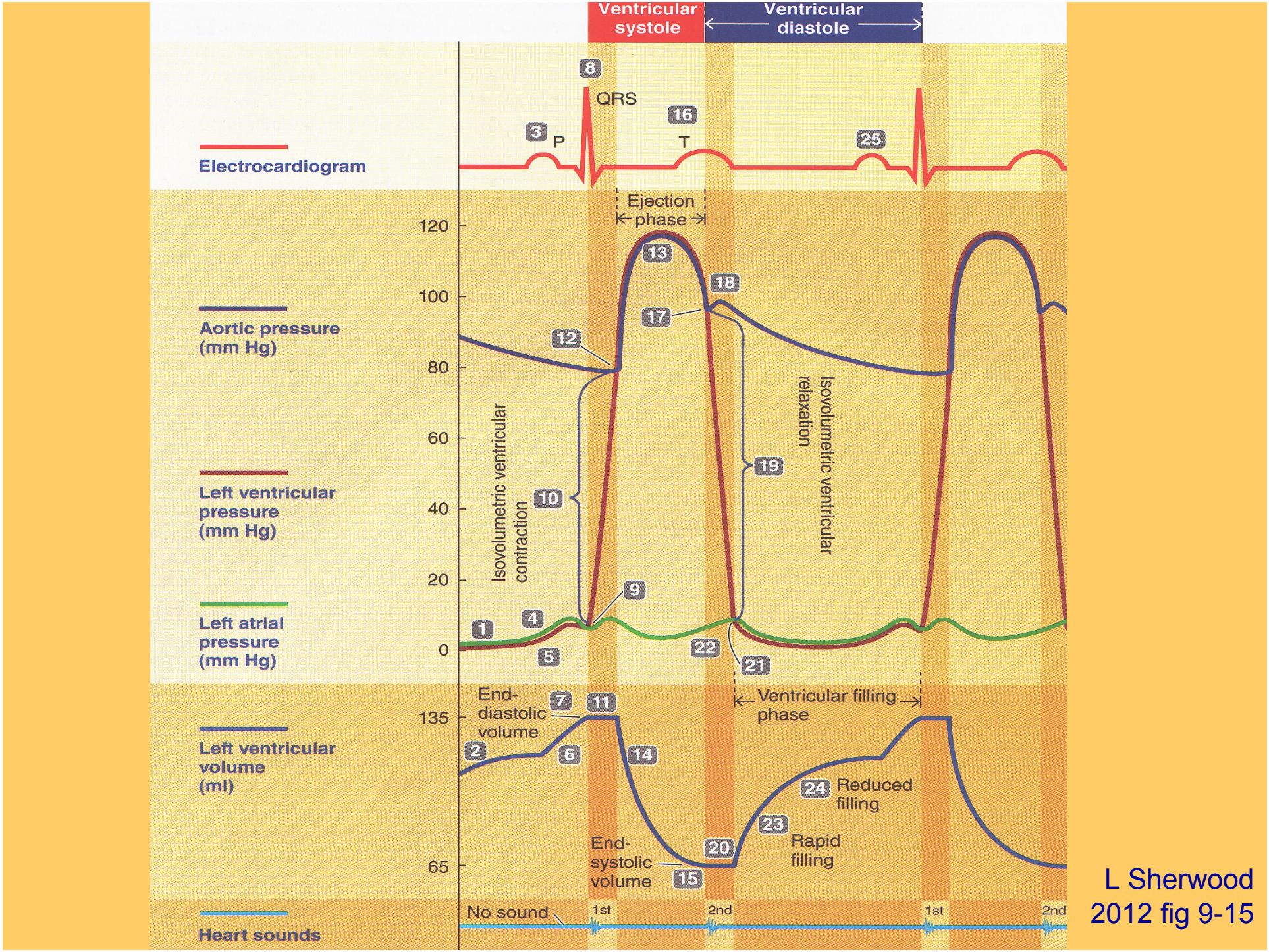


G&H 2011 fig 21-4

Electrical Events Precede Mechanical Events!

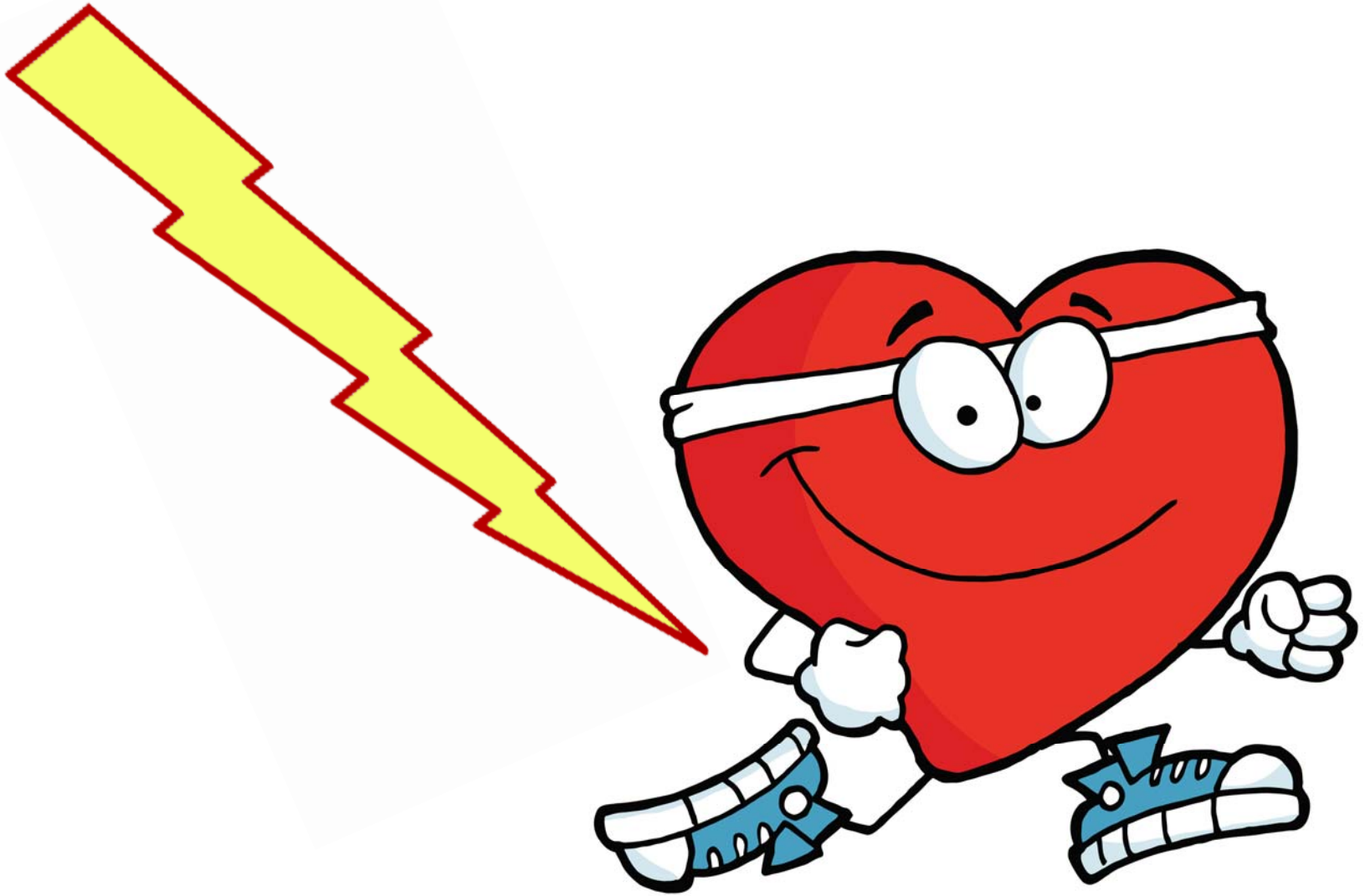


G&H 2011 fig 9-6

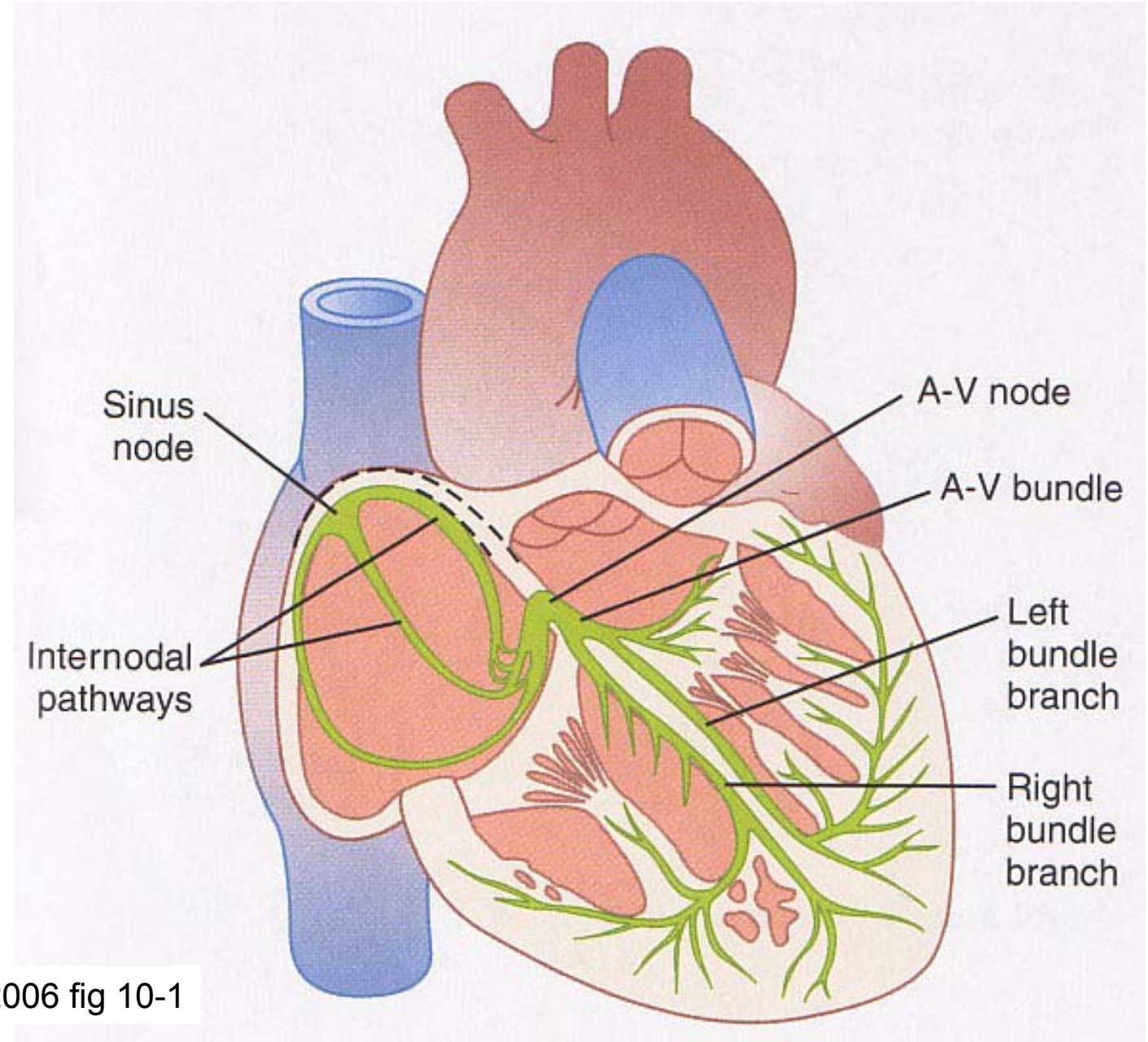


L Sherwood
2012 fig 9-15

(Automatically) Shock the Heart then it Contracts!

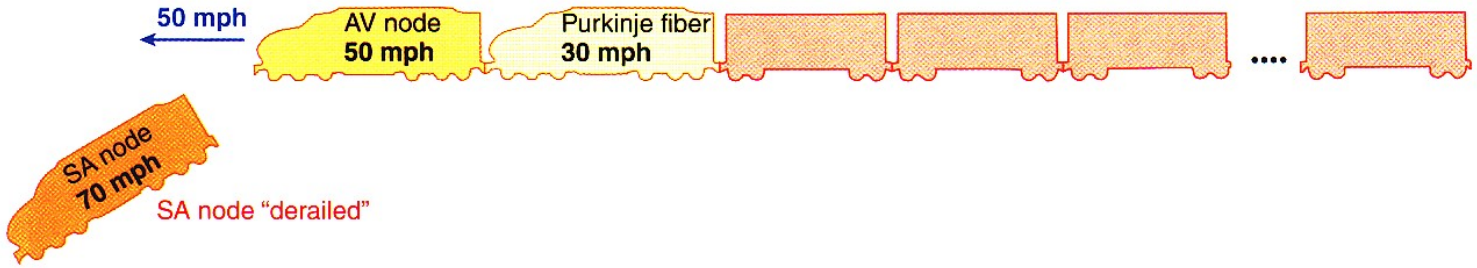


Intrinsic Regulation: Autorhythmic

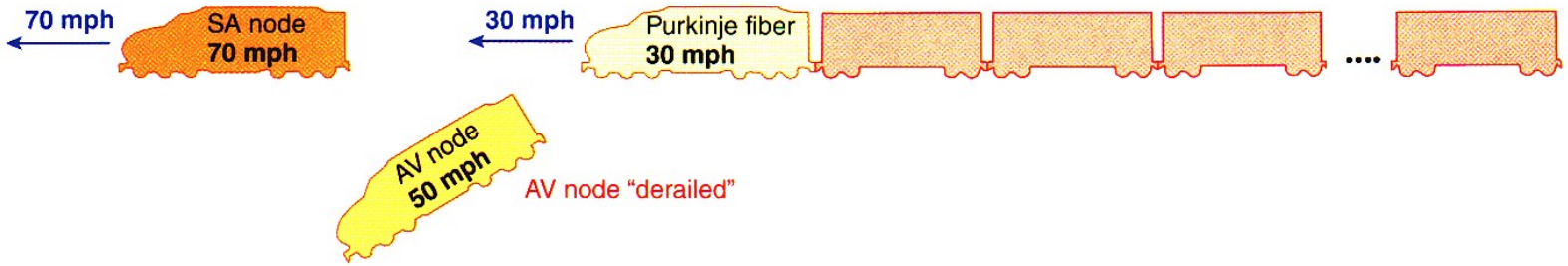


G&H 2006 fig 10-1

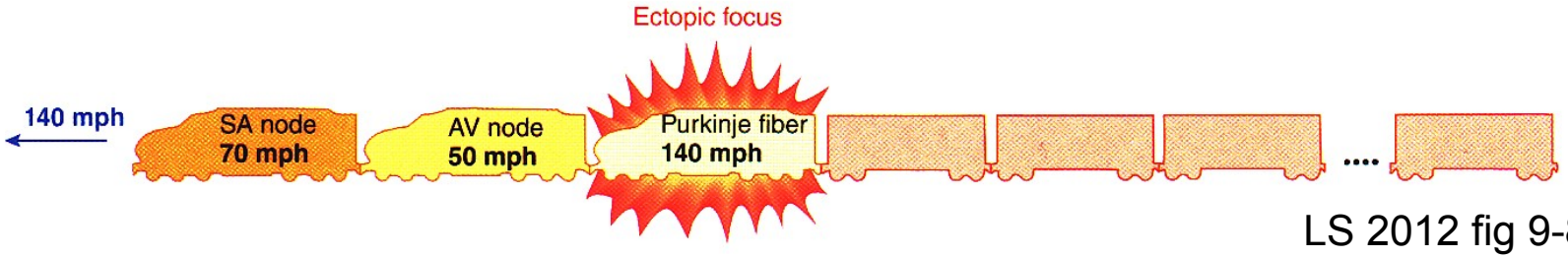
(a) Normal pacemaker activity: Whole train will go **70 mph** (heart rate set by SA node, the fastest autorhythmic tissue).



(b) Takeover of pacemaker activity by AV node when the SA node is nonfunctional: Train will go **50 mph** (the next fastest autorhythmic tissue, the AV node, will set the heart rate).

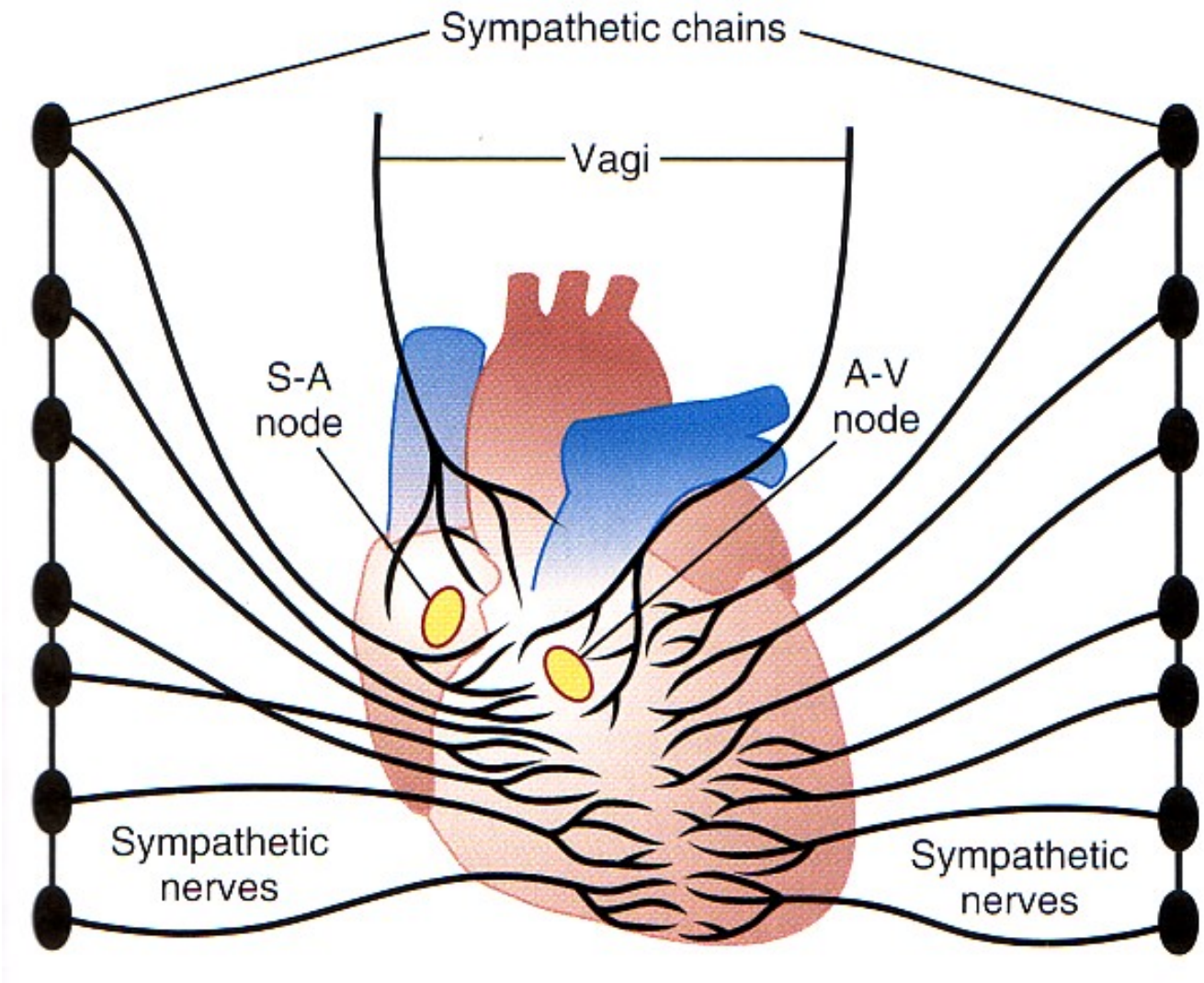


(c) Takeover of ventricular rate by the slower ventricular autorhythmic tissue in complete heart block: First part of train will go **70 mph**; last part will go **30 mph** (atria will be driven by SA node; ventricles will assume own, much slower rhythm).



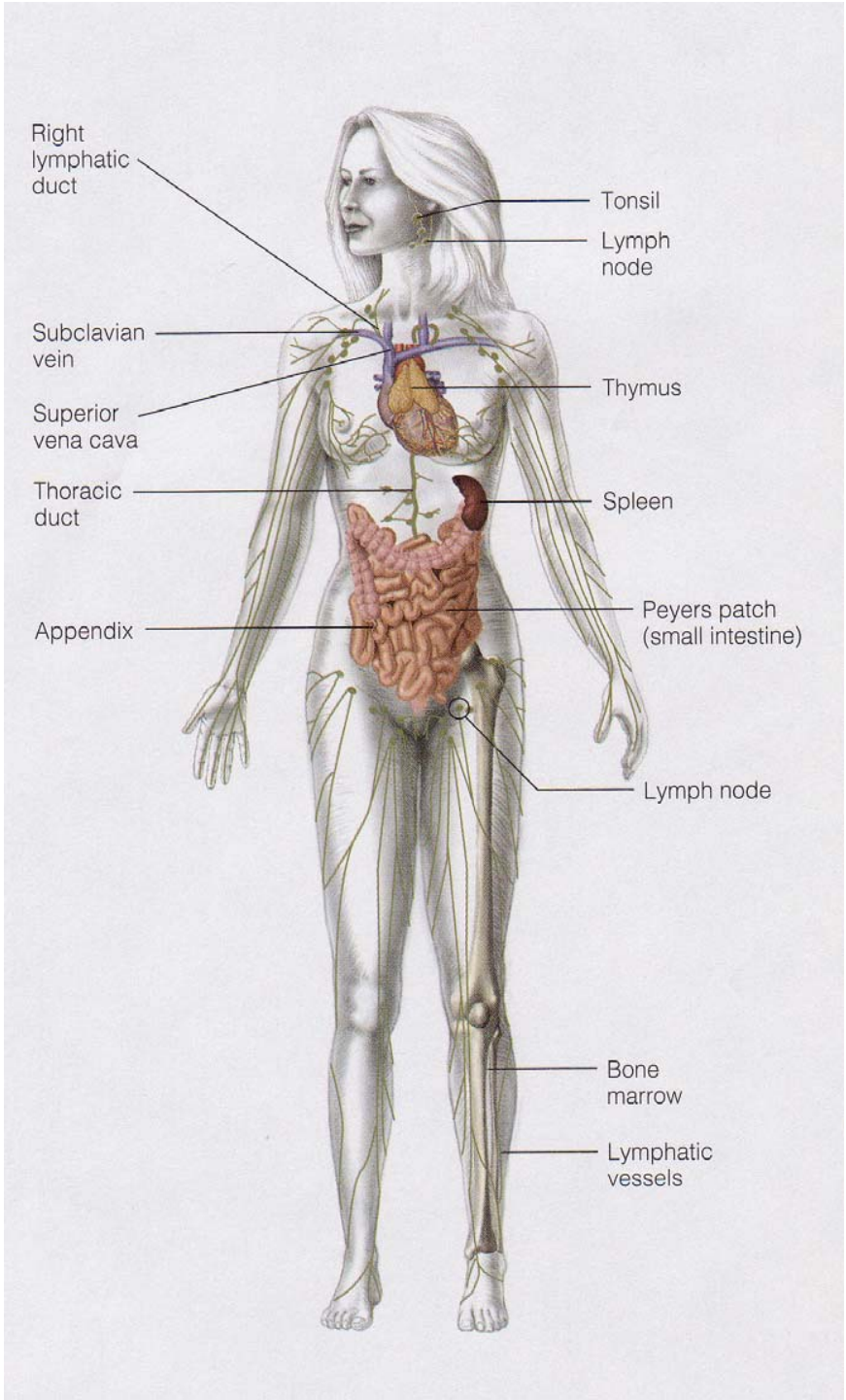
LS 2012 fig 9-8 p 237

Extrinsic Regulation: Nervous



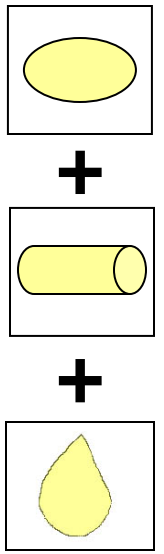
NB: + Extrinsic Hormonal
e.g. Adrenal Epi + NE

G&H 2006 fig 9-12



Lymphatic System

1. **Lymph Nodes**
2. **Vessels**
3. **Lymph**



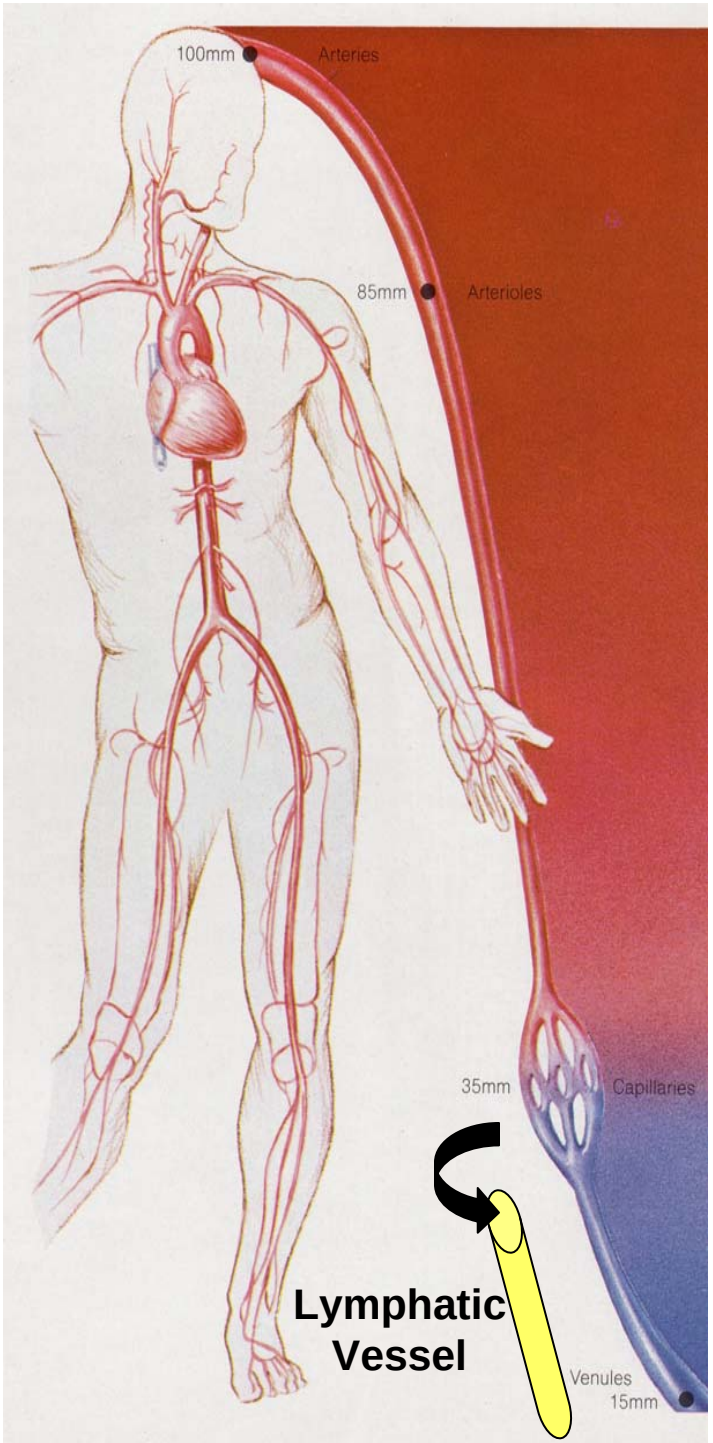
No pump!

D Chiras 2003

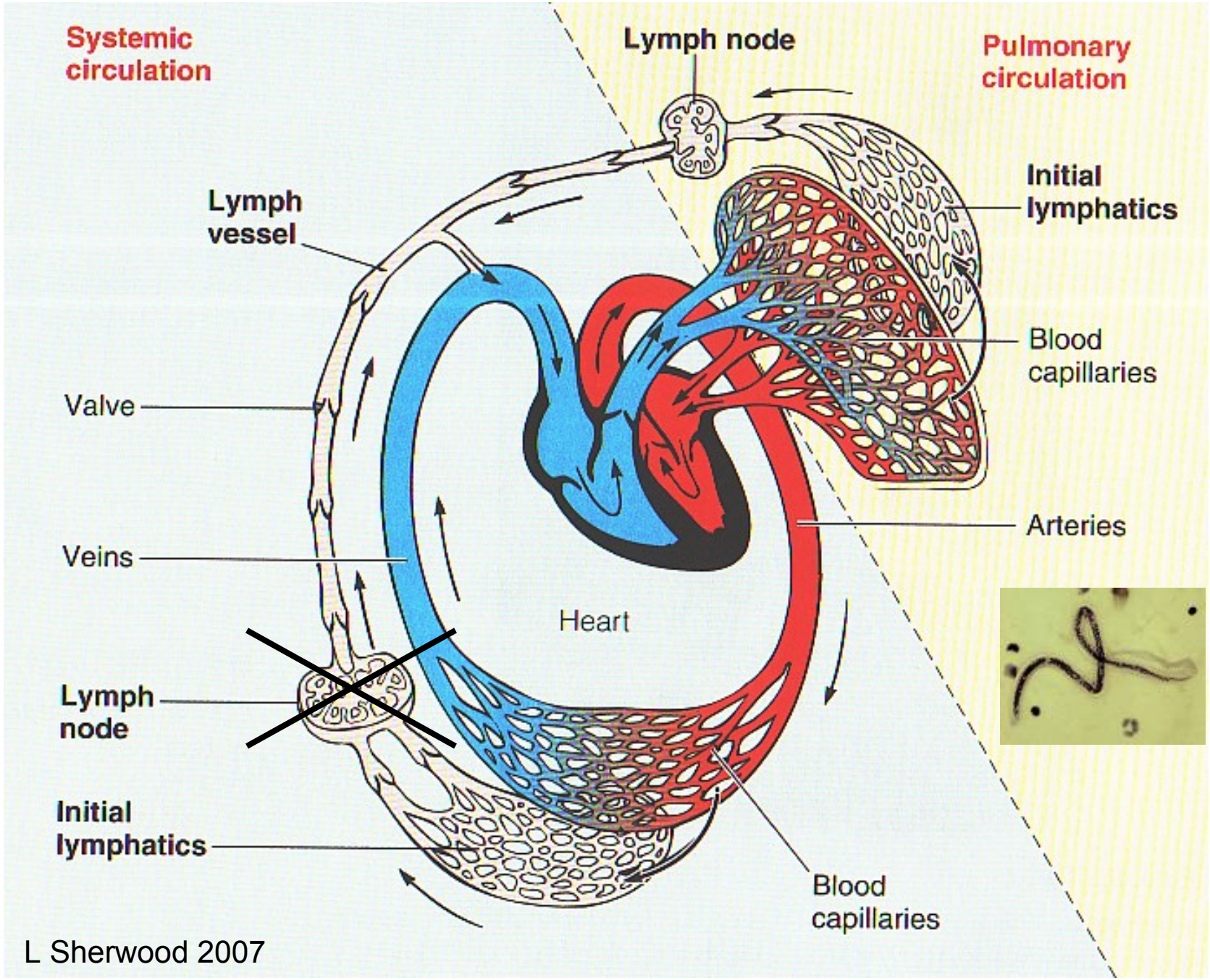
Lymphatic System

Alternative System of Circulation
or
Drainage System

Lymph Vessels || ***Veins***



Torstar Books 1984


Systemic circulation
Lymph node
Pulmonary circulation
Lymph vessel
Initial lymphatics
Blood capillaries
Valve
Arteries
Veins
Heart
Lymph node
Initial lymphatics
Blood capillaries
L Sherwood 2007

Elephantiasis: Lymphatic Blockage Due to Mosquito-Borne Parasitic Worm

L Sherwood 2007