

# BI 358 Lecture 8

Dr. Kraig is... I g GGGGREAT!!



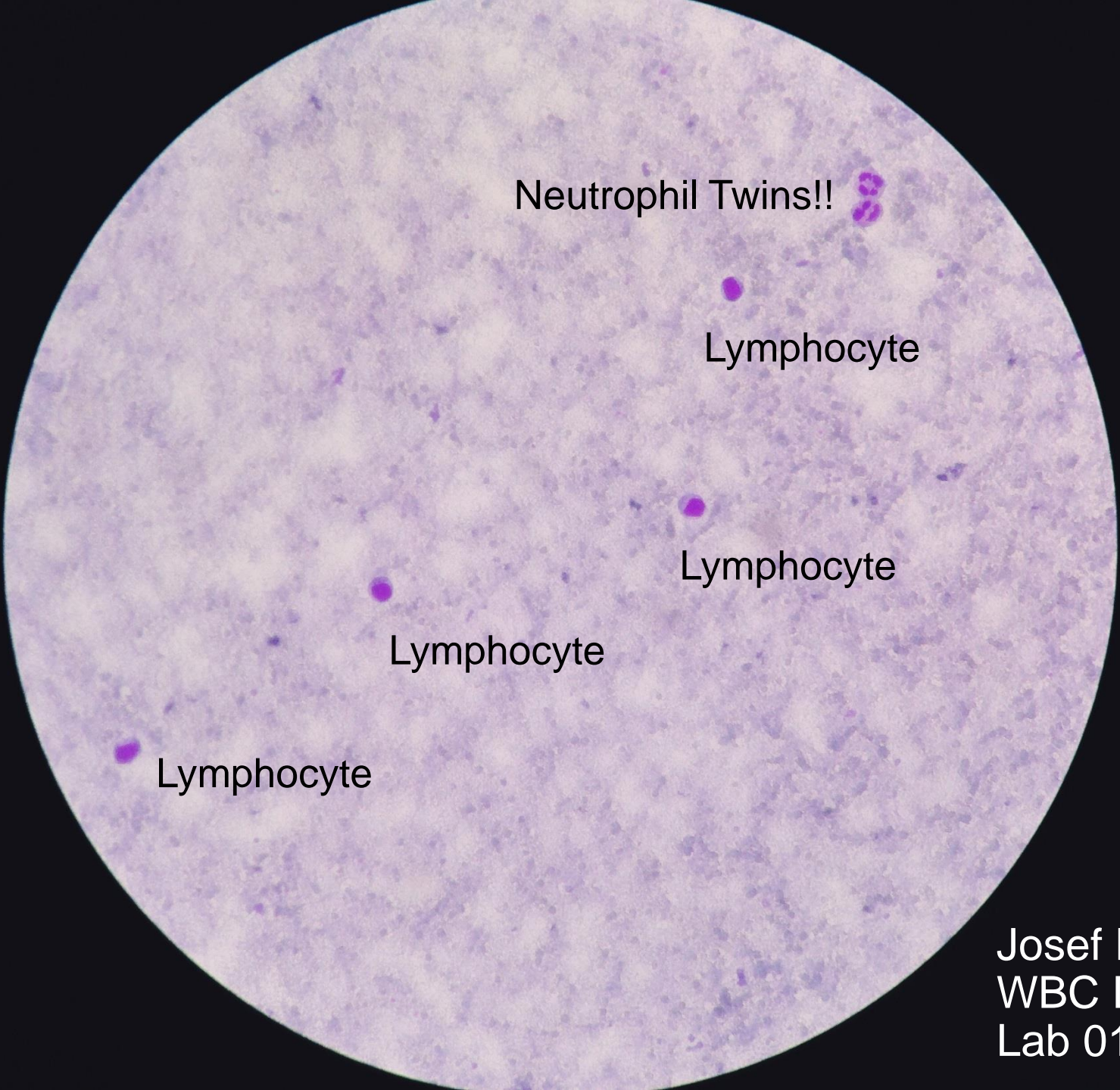
**I. Announcements** Kraig Jacobson MD, Allergy & Asthma Research Associates, Oak Street Medical, Thurs Feb 9<sup>th</sup>! Update on outlines and paper drafts. WBC lab photo! Q?

**II. Immunology II** G&H 2016 ch 35, G&H 2011 ch 34

- A. Recap cf: Innate vs. adaptive immunity G&H, LS +...  
Innate immunity eg inflammation, interferon, complement
- B. Antibody (Ab=Ig) structure, subclasses, mechanisms  
G&H + LS + Davey fig 2.4 p 19, fig 4.2 p 42, tab 4.1 p 49
- C. Mom's milk *Scientific American*
- D. Immune Regulation + Allergy: G&H

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

- A. Cardiovascular system? Figure-8 loop D Chiras (DC), LS
- B. Fetal development & circulation Torstar Books, G&H
- C. Layers: peri-, epi-, myo- & endocardium Torstar Books
- D. ♥ structure & function G&H fig 9-7, LS...
- 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



Neutrophil Twins!!

Lymphocyte

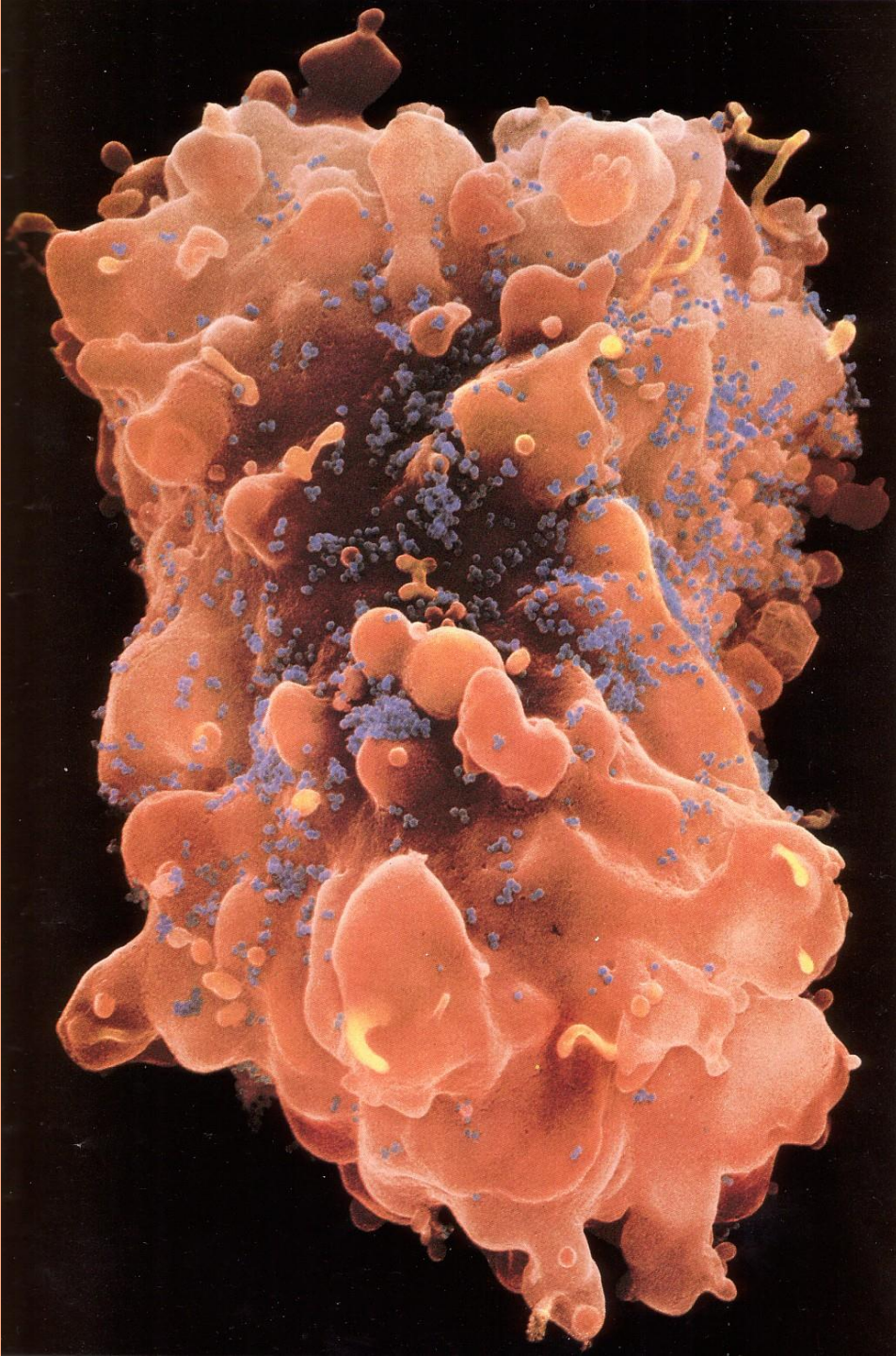
Lymphocyte

Lymphocyte

Lymphocyte

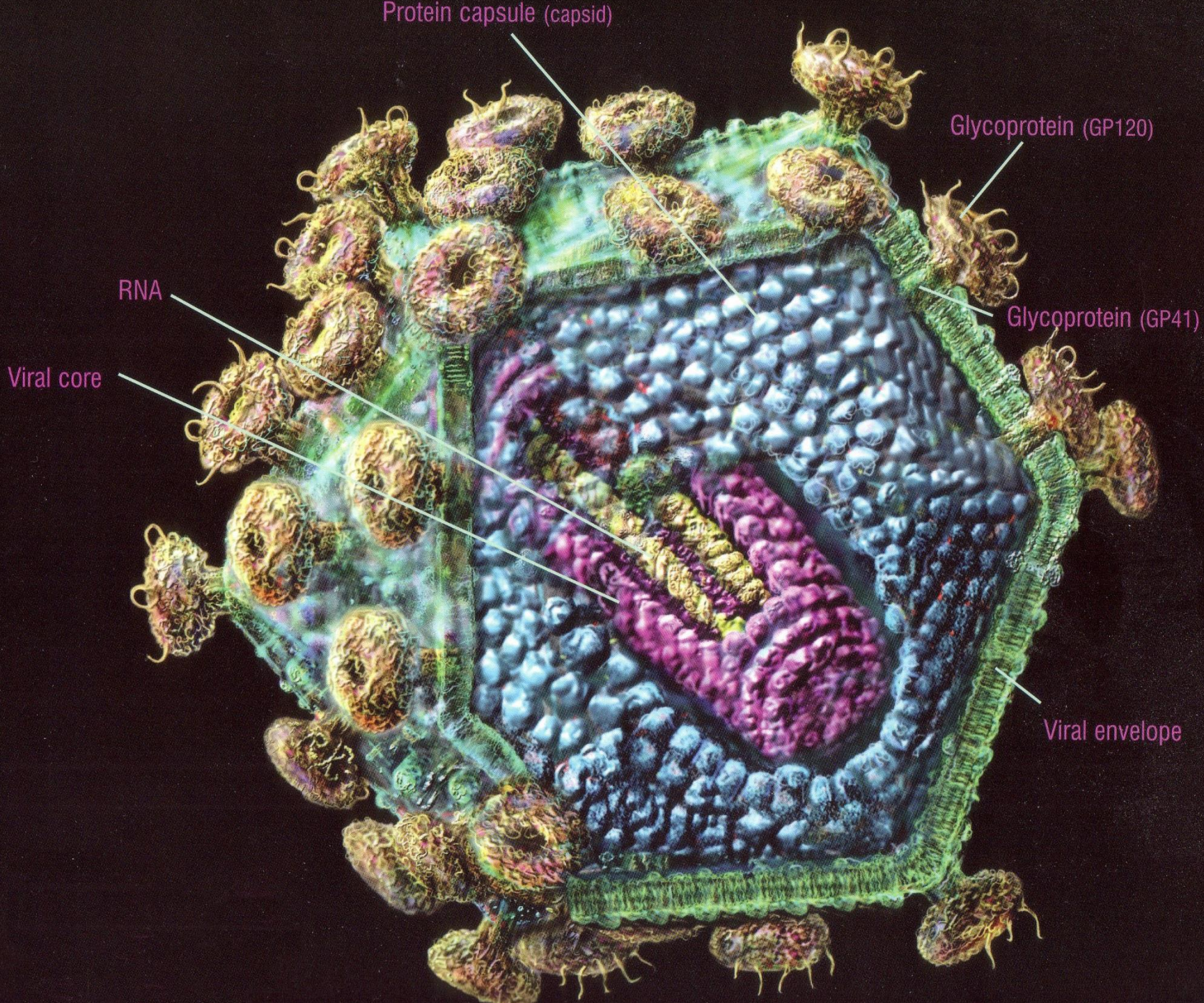
Josef Khalifeh  
WBC Differential  
Lab 012715





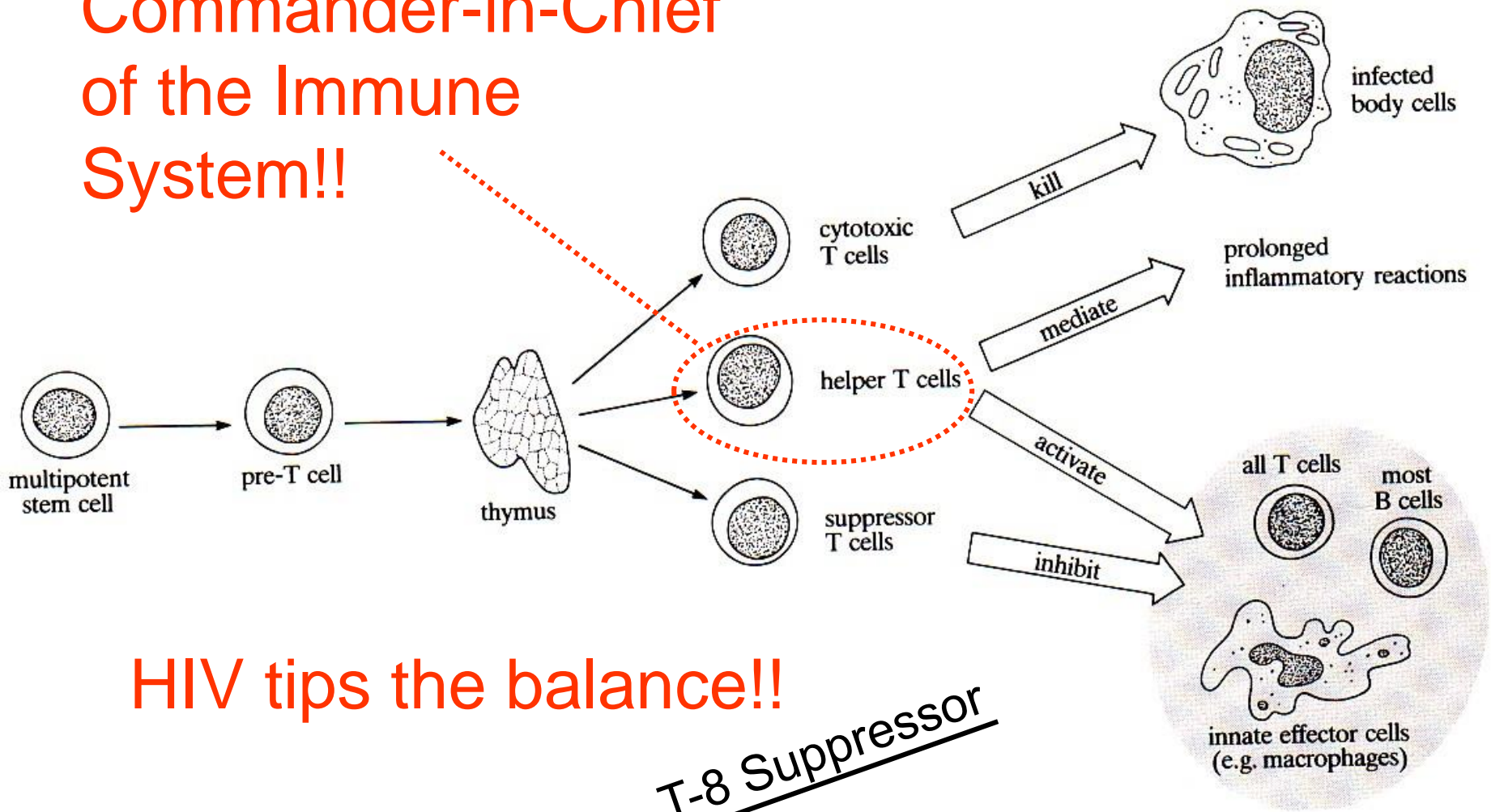
30,000 x GMBH  
Nat Geog 1986



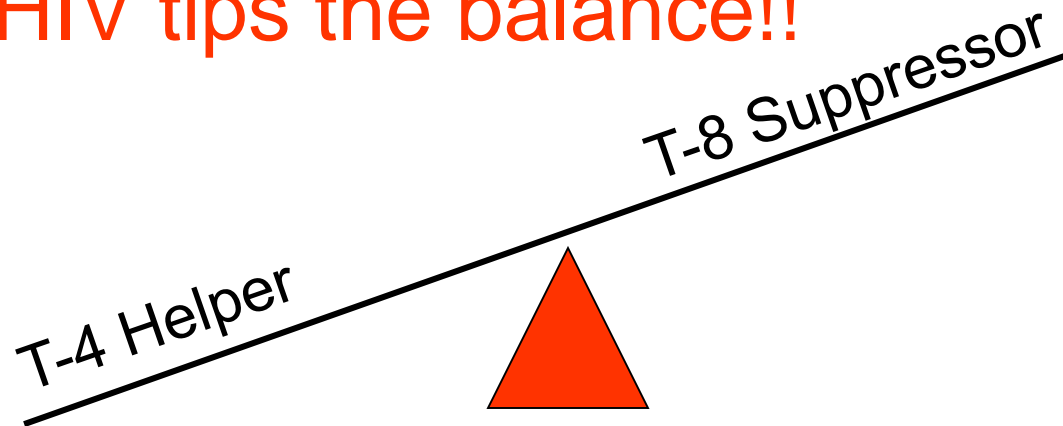




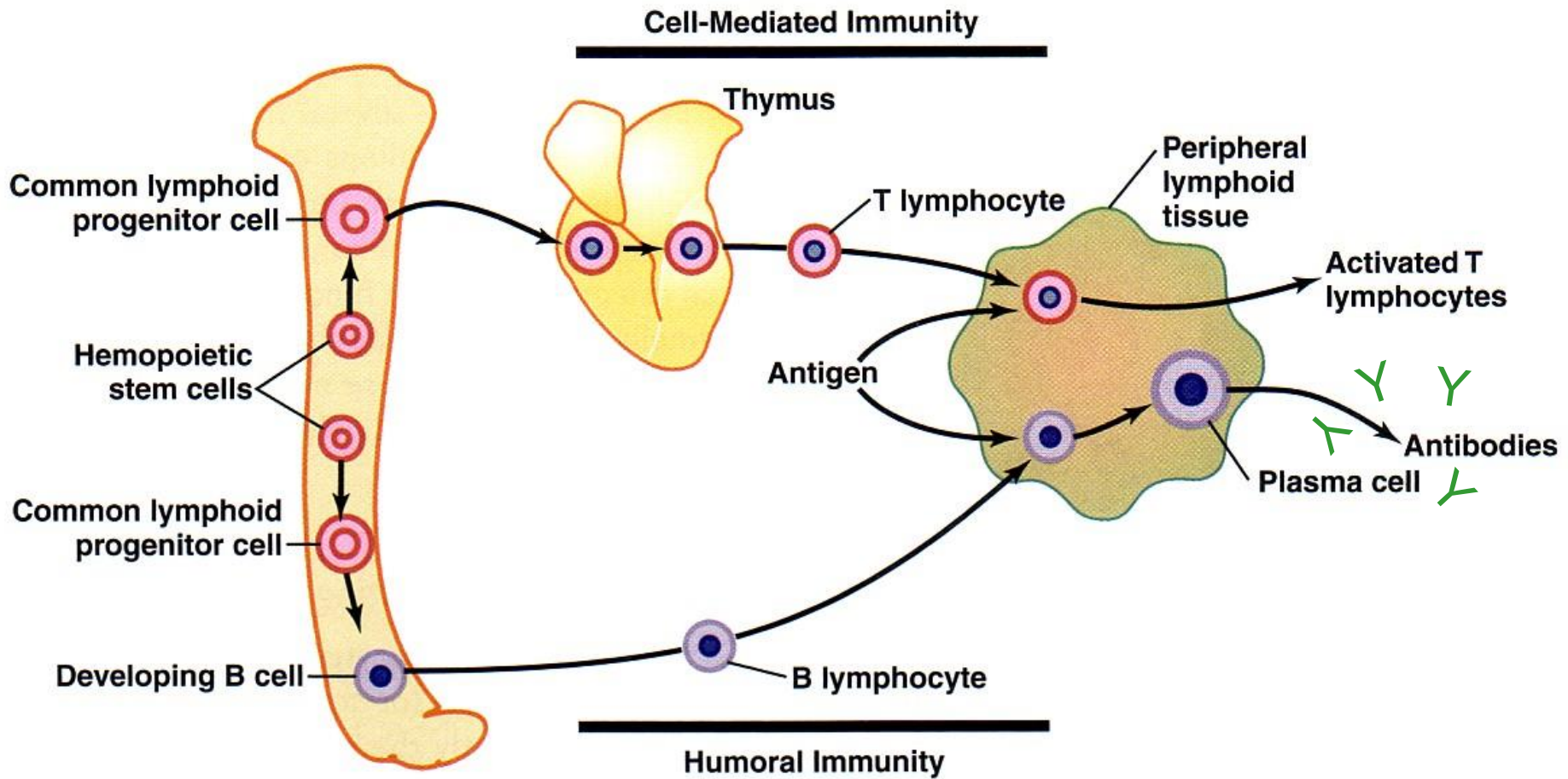
# Commander-in-Chief of the Immune System!!



HIV tips the balance!!

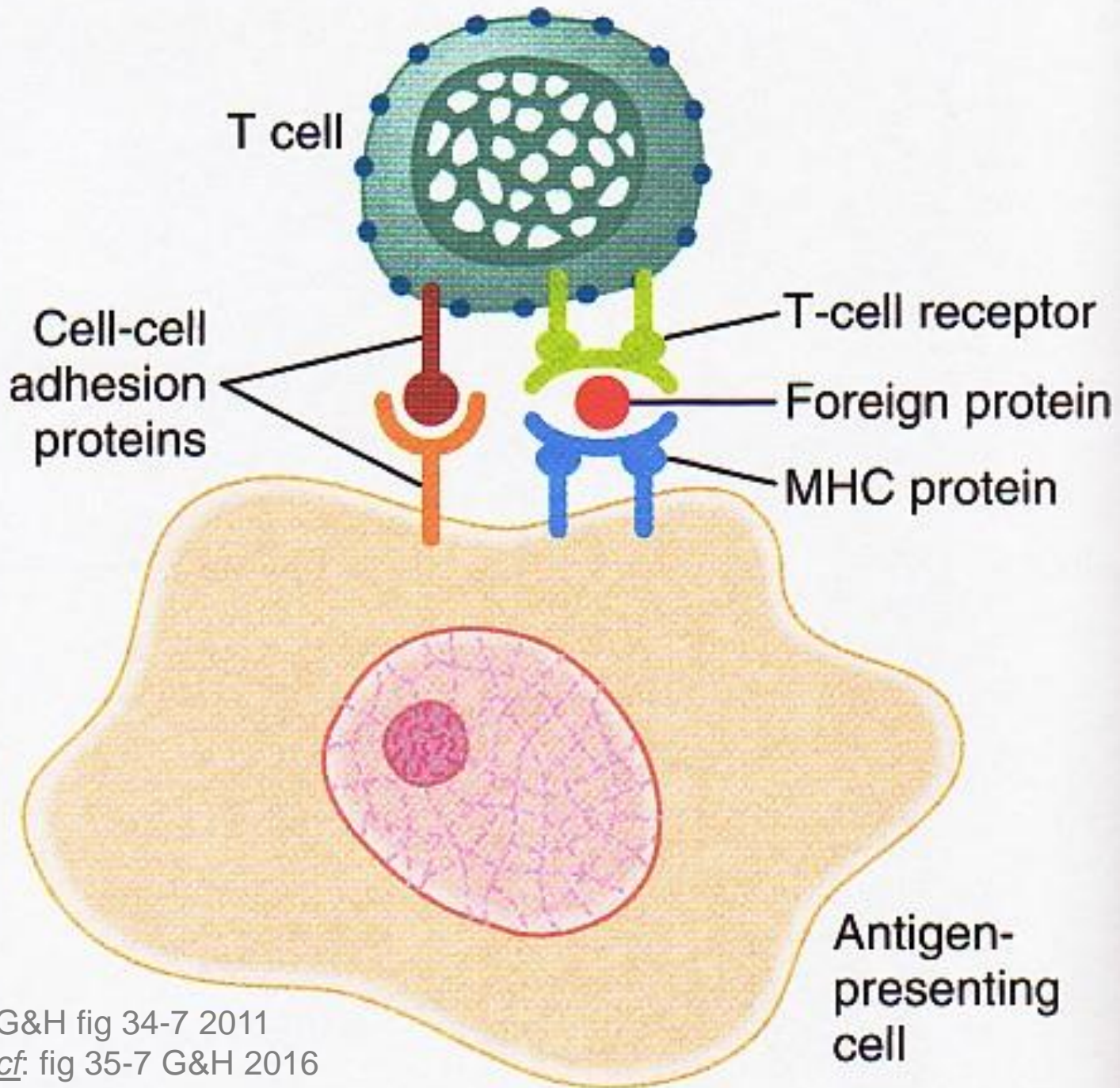






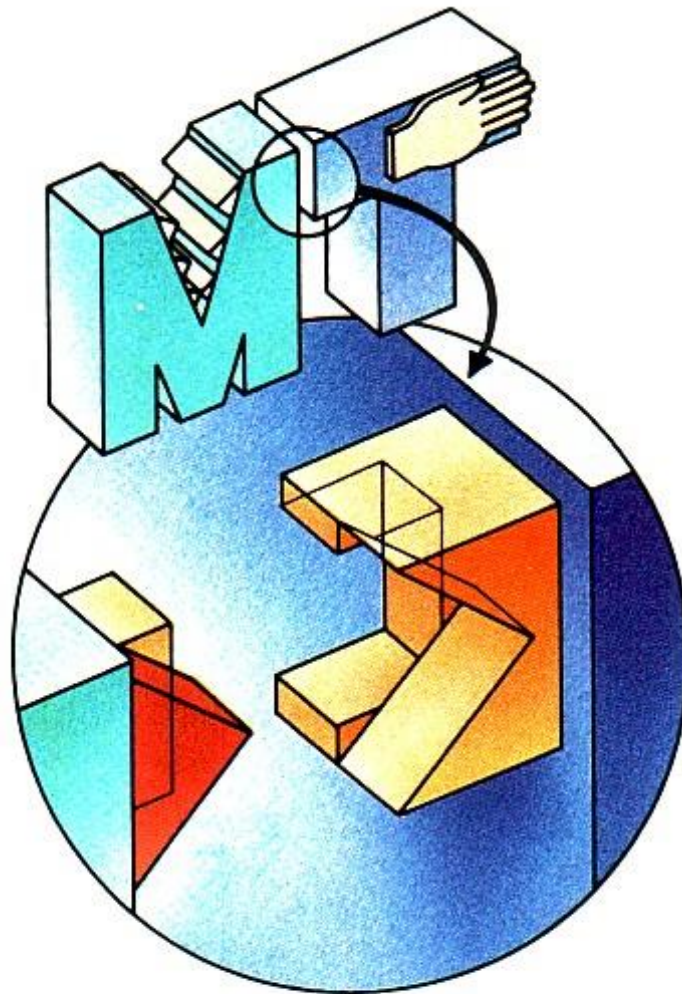
G&H fig 34-1 2011  
 cf: fig 35-1 G&H 2016





G&H fig 34-7 2011  
*cf.* fig 35-7 G&H 2016

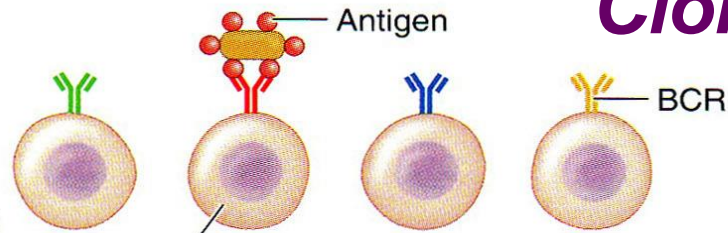




*The vital union that activates a helper T cell takes place only when the T cell recognizes both a “self” marker (rectangle) and a “nonself” antigen (triangle) on a macrophage.*

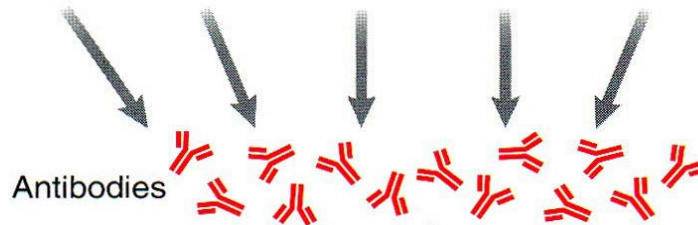
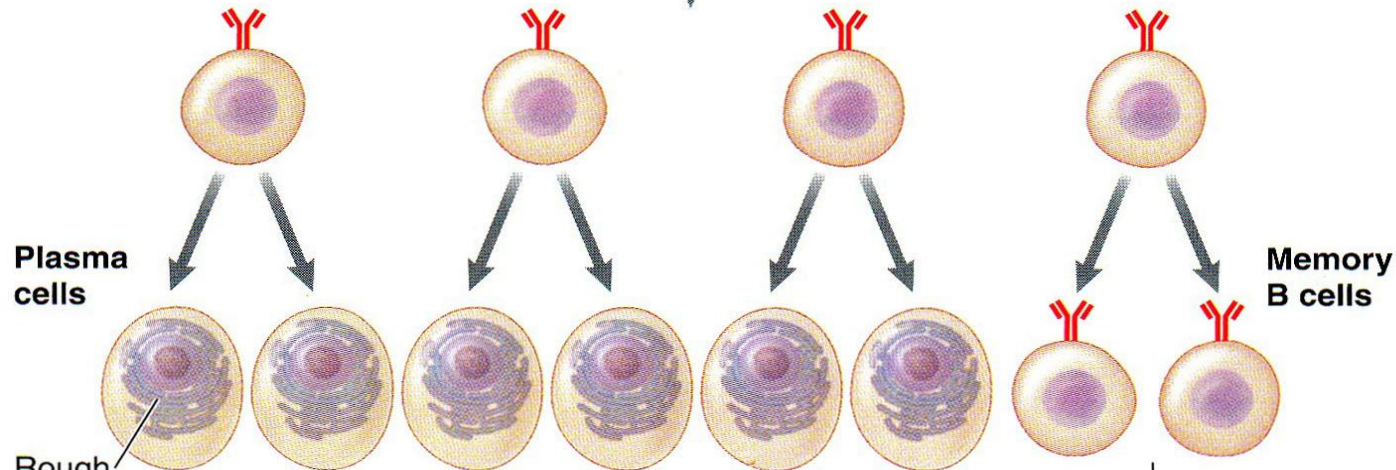
# Clonal Selection

Population of unactivated B cells, each a member of a different B-cell clone that makes a specific receptor, which is displayed on the membrane surface as a BCR



B cell specific to antigen

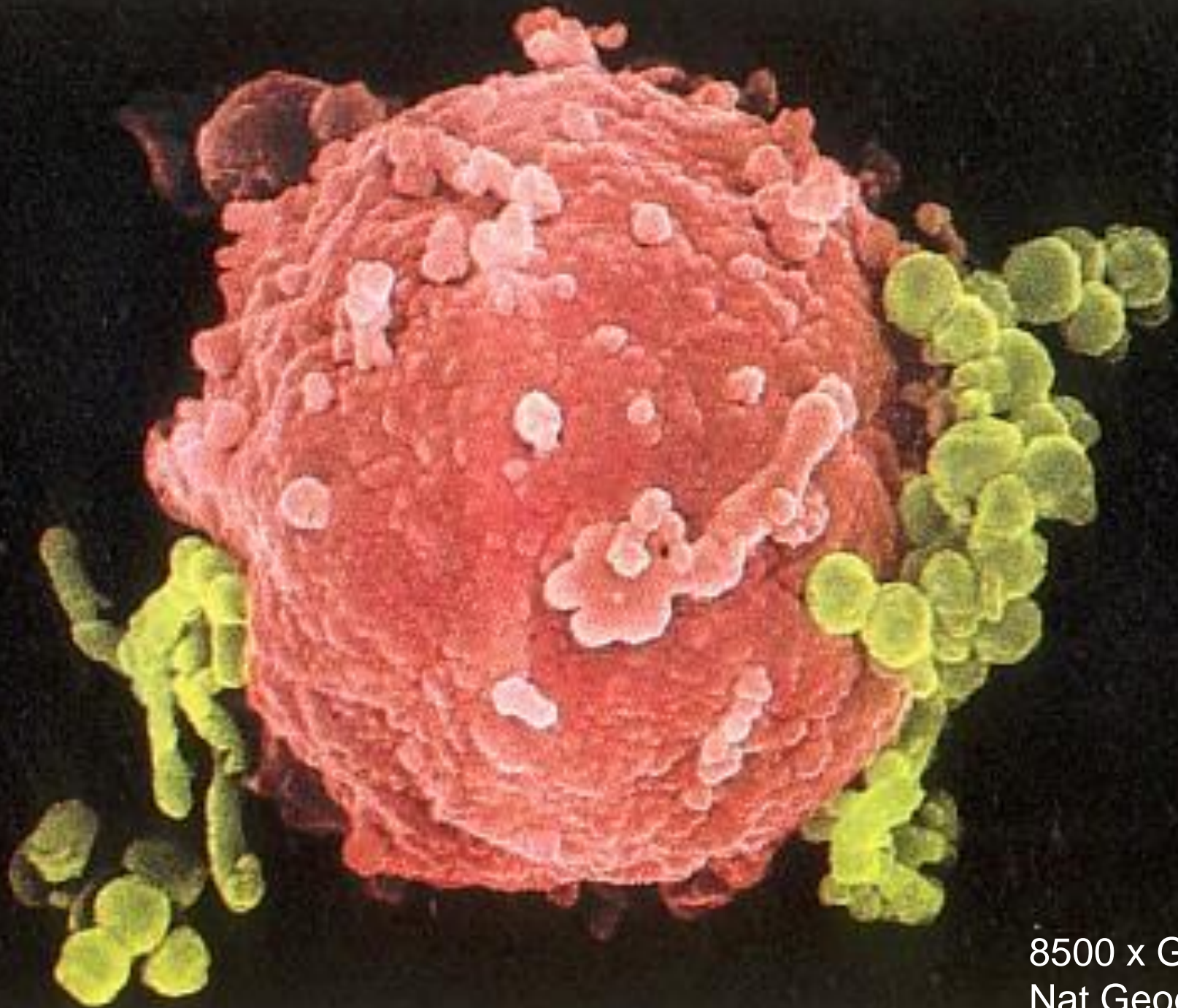
Binding of antigen and interaction with helper T cell stimulates the matching B cells to divide and expand the clone of selected cells.



Most of the new B cells differentiate into plasma cells, which secrete antibodies.

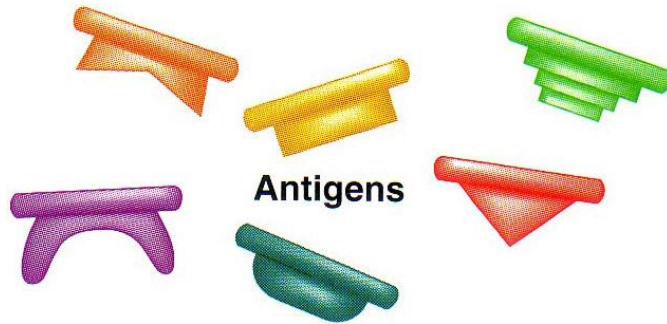
A few of the new B cells differentiate into memory B cells, which respond to a later encounter with the same antigen.



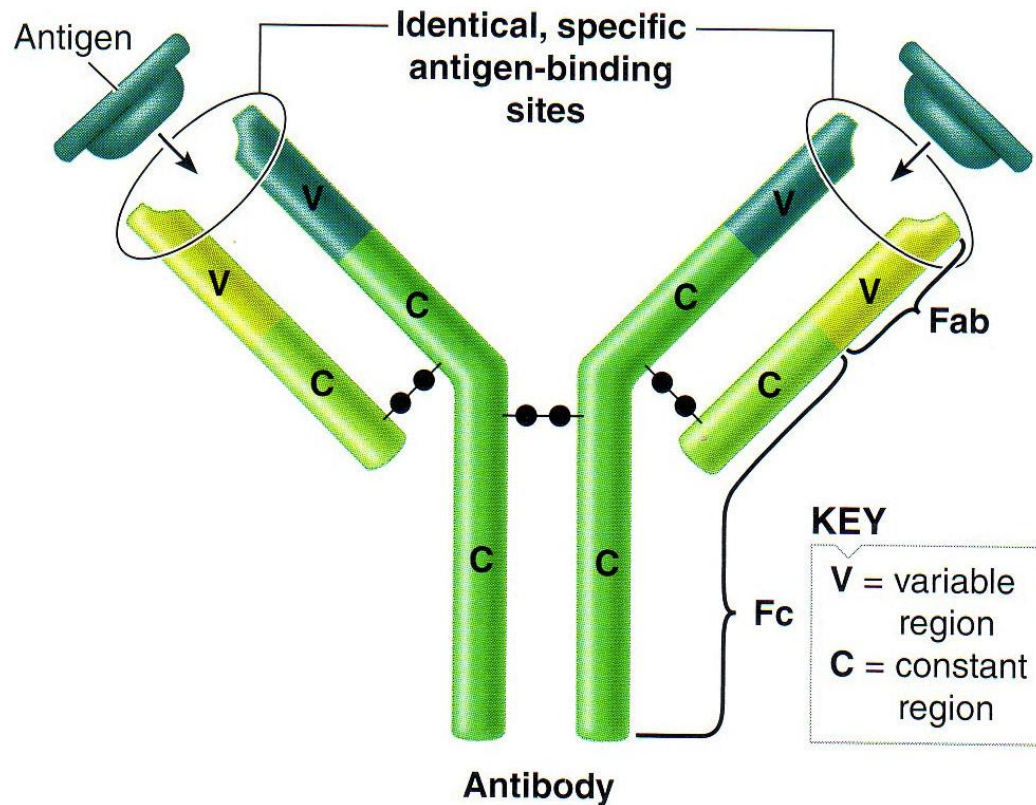


8500 x GMBH  
Nat Geog 1986

# Typical IgG Antibody Structure

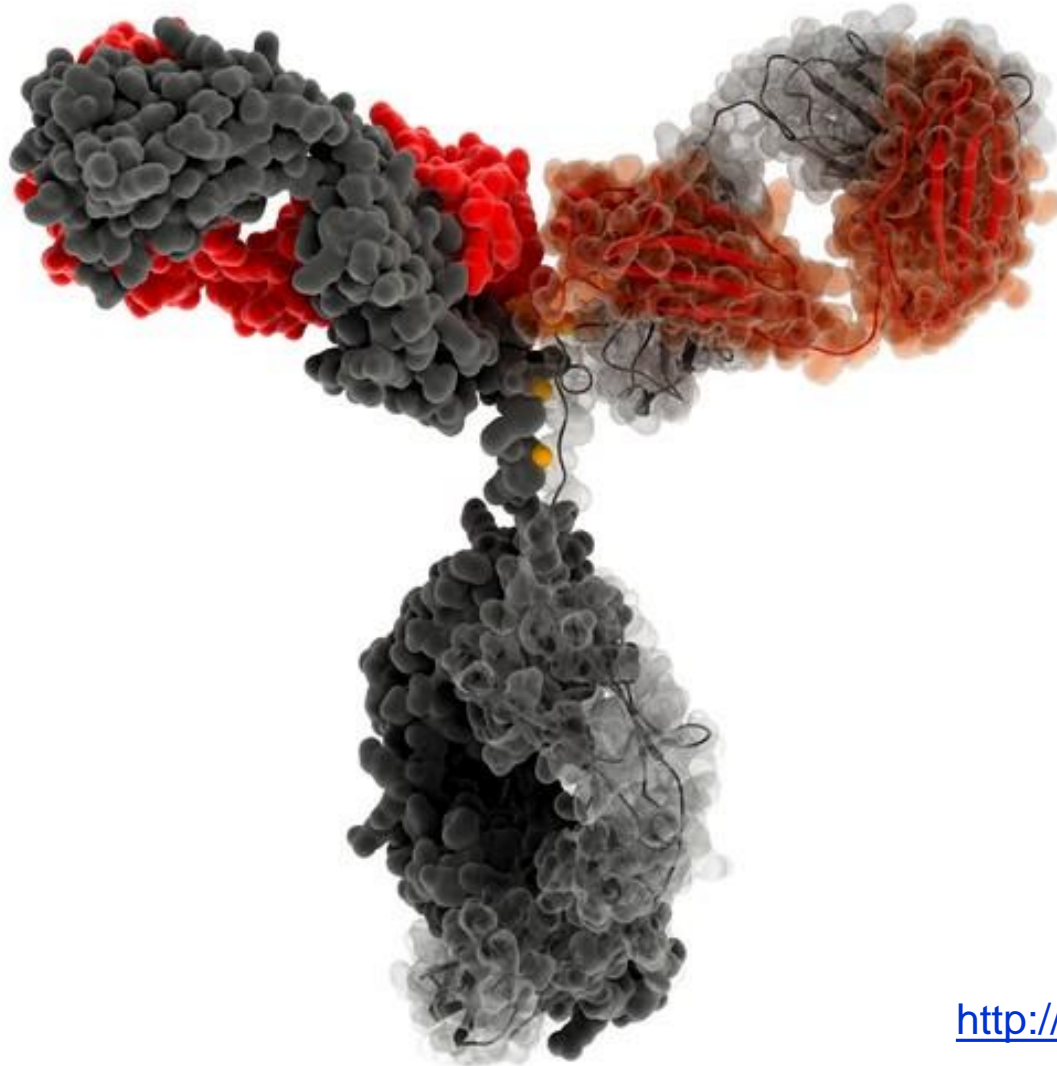


*How do antibodies work?*



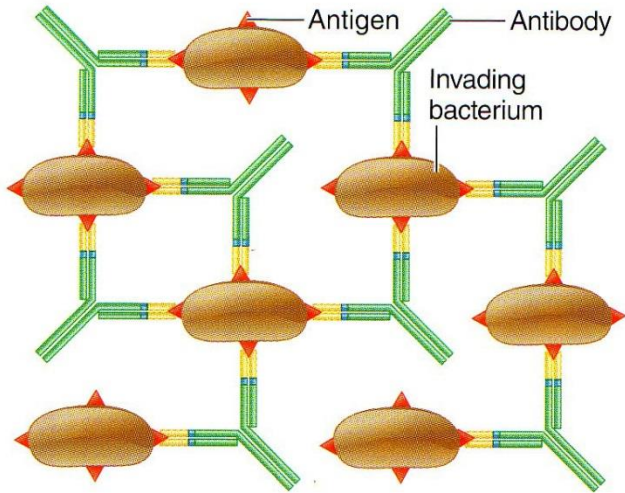


# Immunoglobulin G

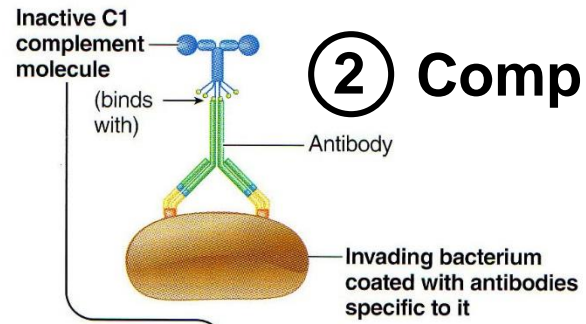


**Source:**  
Visual Science  
<http://visualscience.ru/en/>

# ① Agglutination



# ② Complement

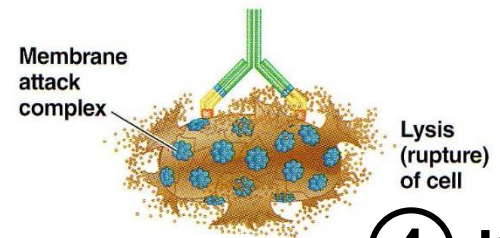


Activated by binding with antigen-attached antibody

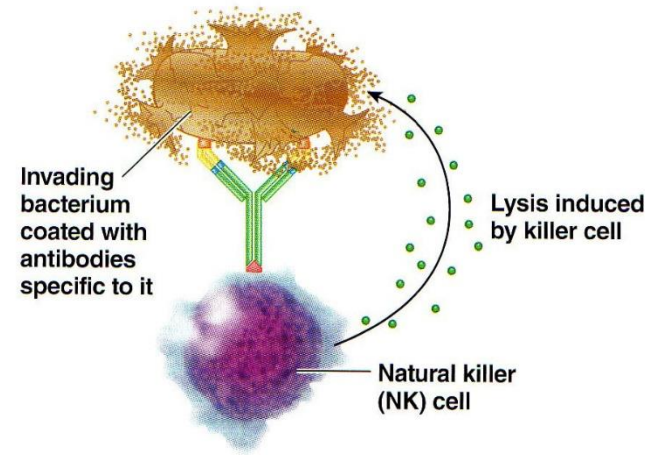
(leads to)

Formation of C5-C9, the membrane attack complex

(forms holes in foreign cell)



# ④ Killer Cells



# ③ Opsonization

Invading bacterium coated with antibodies specific to it

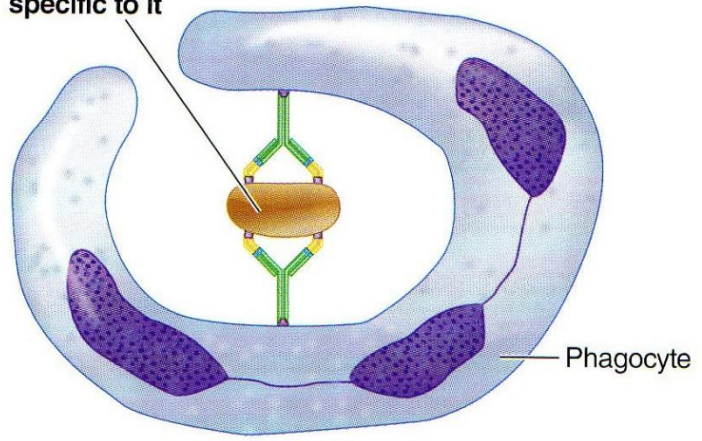




TABLE 4.1 Characteristics and functions of the human immunoglobulin classes

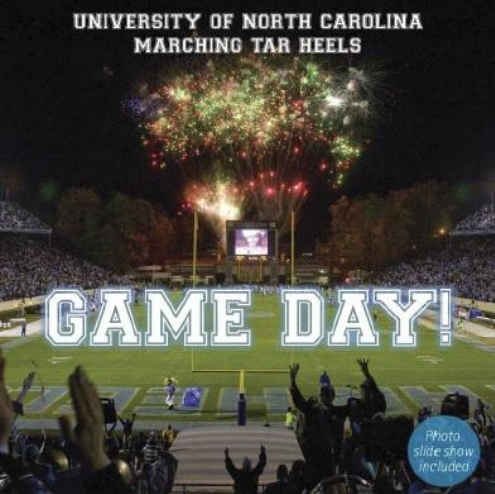
	G	A	M	D	← E
immunoglobulin class	IgG	IgA	IgM	IgD	IgE
heavy-chain type	$\gamma$	$\alpha$	$\mu$	$\delta$	$\epsilon$
number of constant domains in each heavy chain	3	3	4	3	4
relative molecular mass ( $M_r$ ) of monomer	150 000	160 000	180 000	185 000	200 000
normally found as polymer?	no	dimer	pentamer	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.



UNIVERSITY OF NORTH CAROLINA  
MARCHING TAR HEELS



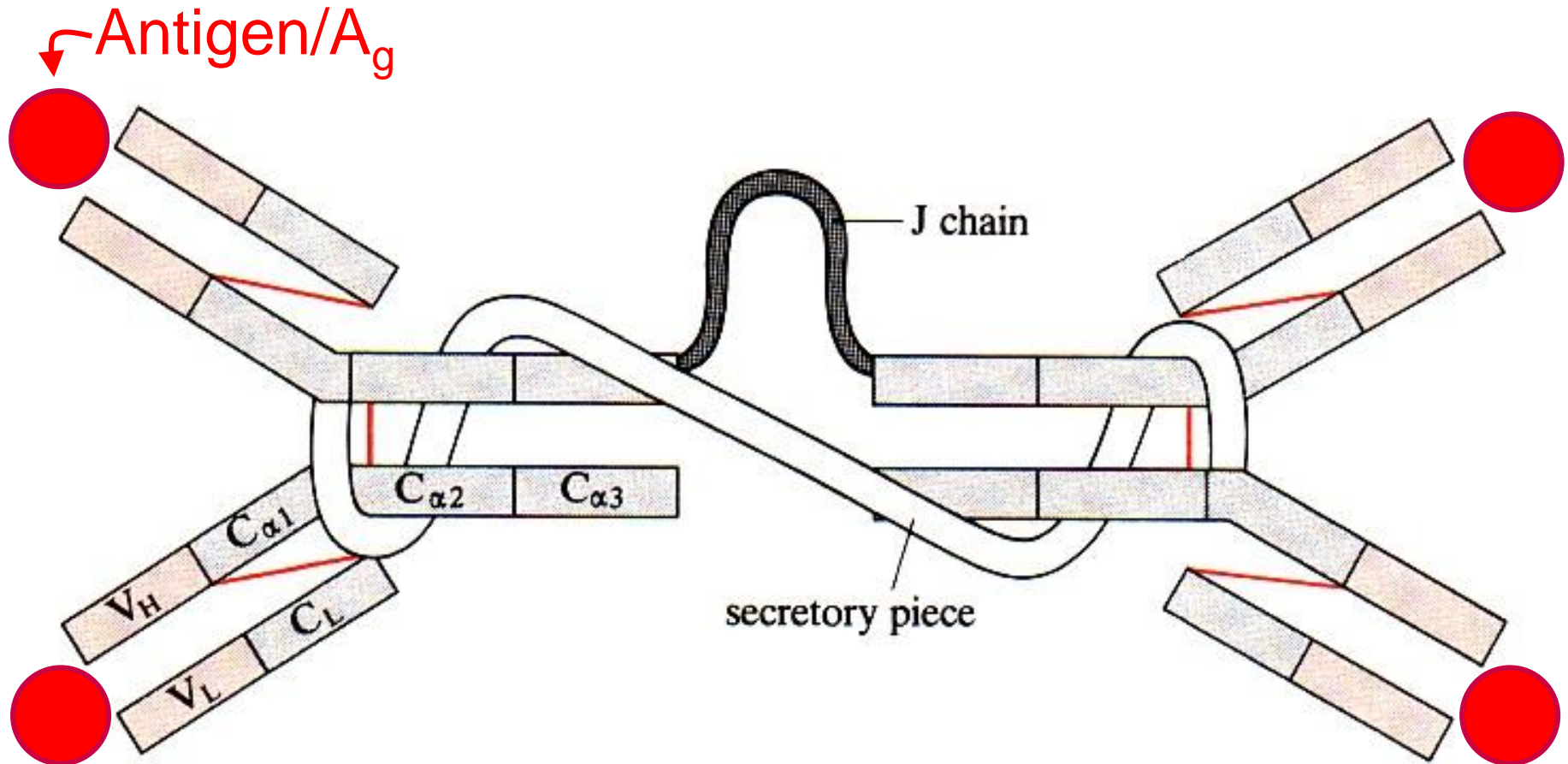
# GAMED!



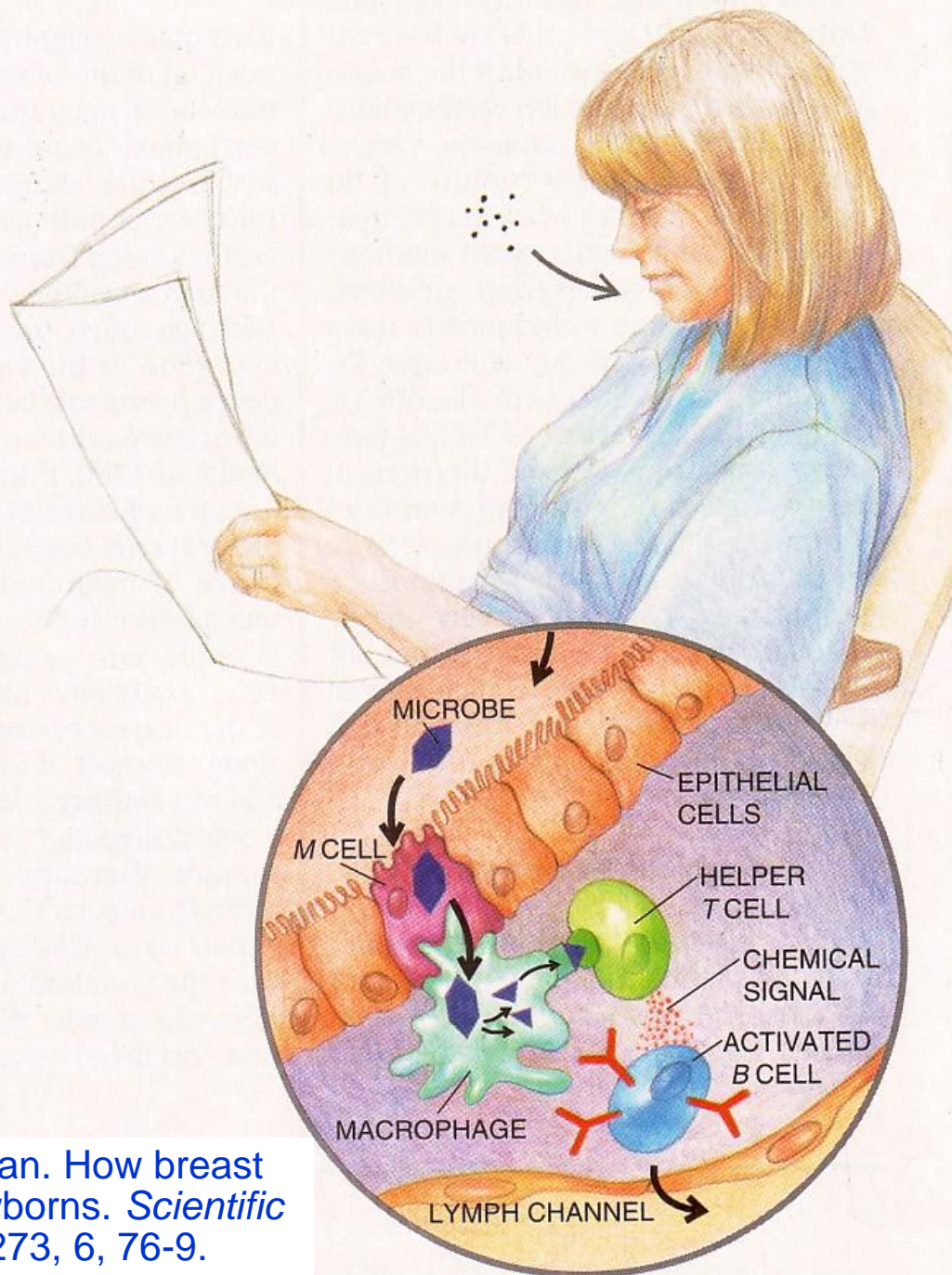


IgA = Secretory A<sub>b</sub>

Dimer!!



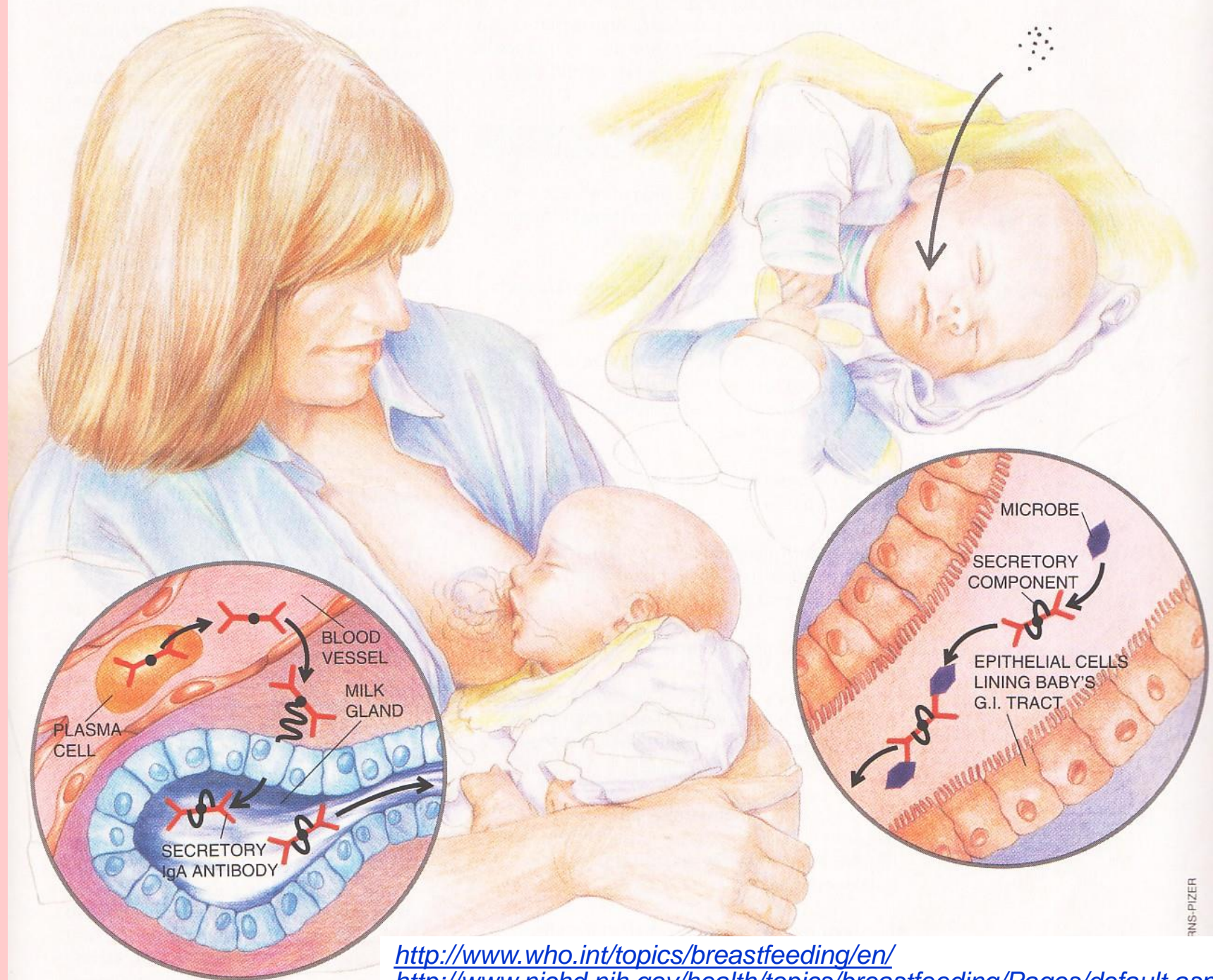
Valence? 4



**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, ingesting 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 <sub>12</sub> binding protein	Reduces amount of vitamin B <sub>12</sub> , which bacteria need in order to grow.
Bifidus factor	Promotes growth of <i>Lactobacillus bifidus</i> , 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.

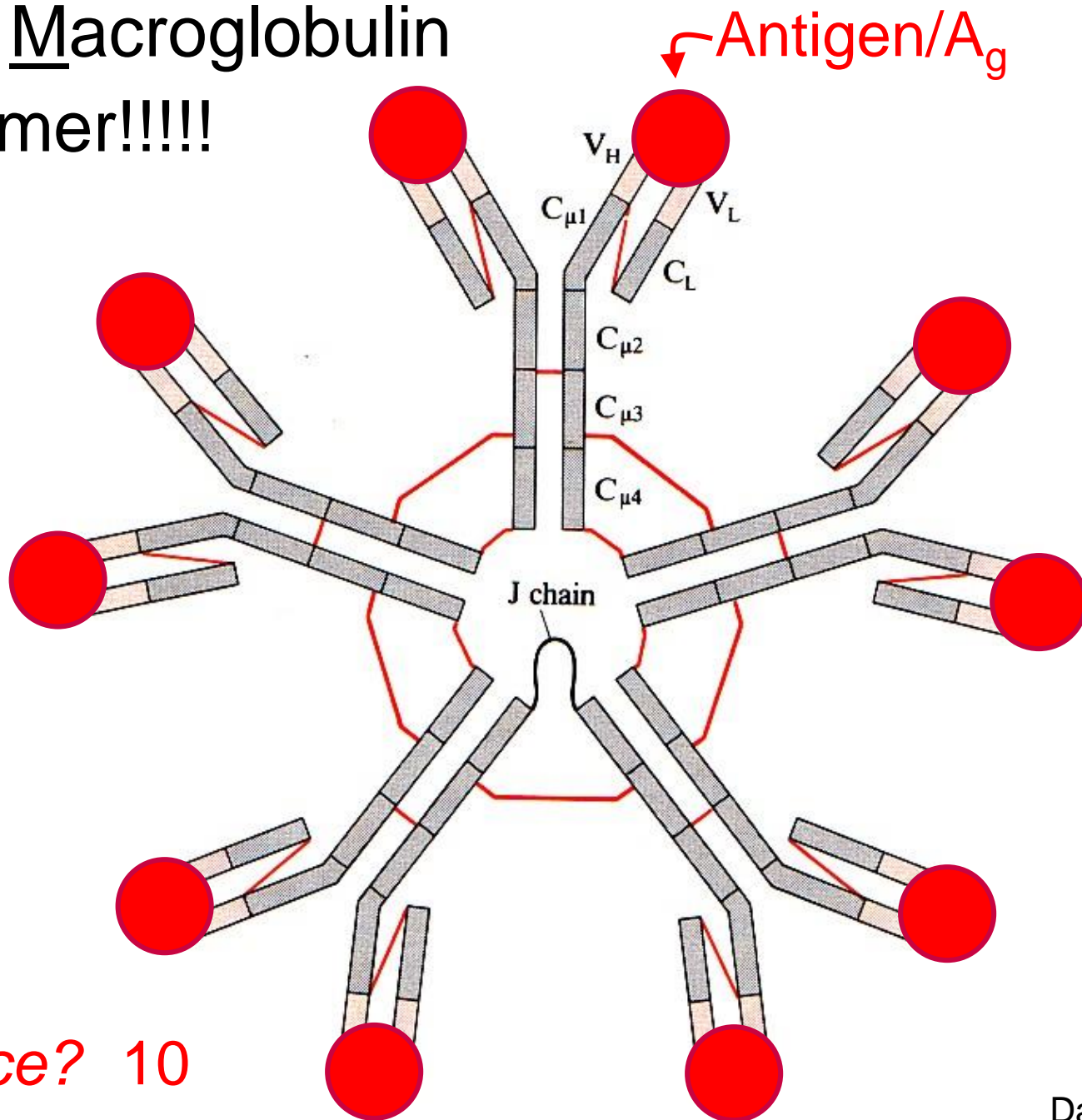
Oligosaccharides

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>

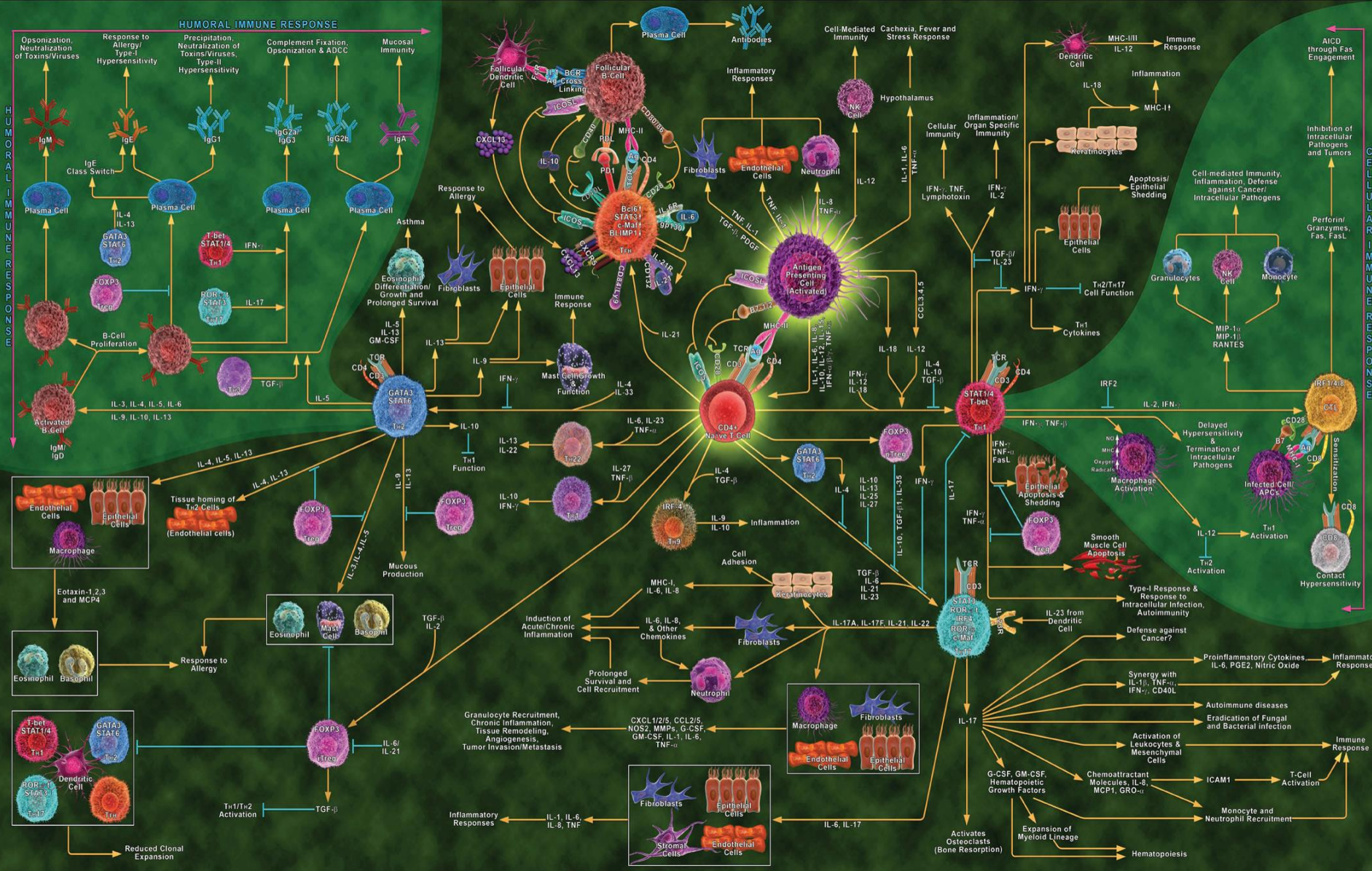


IgM = Macroglobulin  
Pentamer!!!!

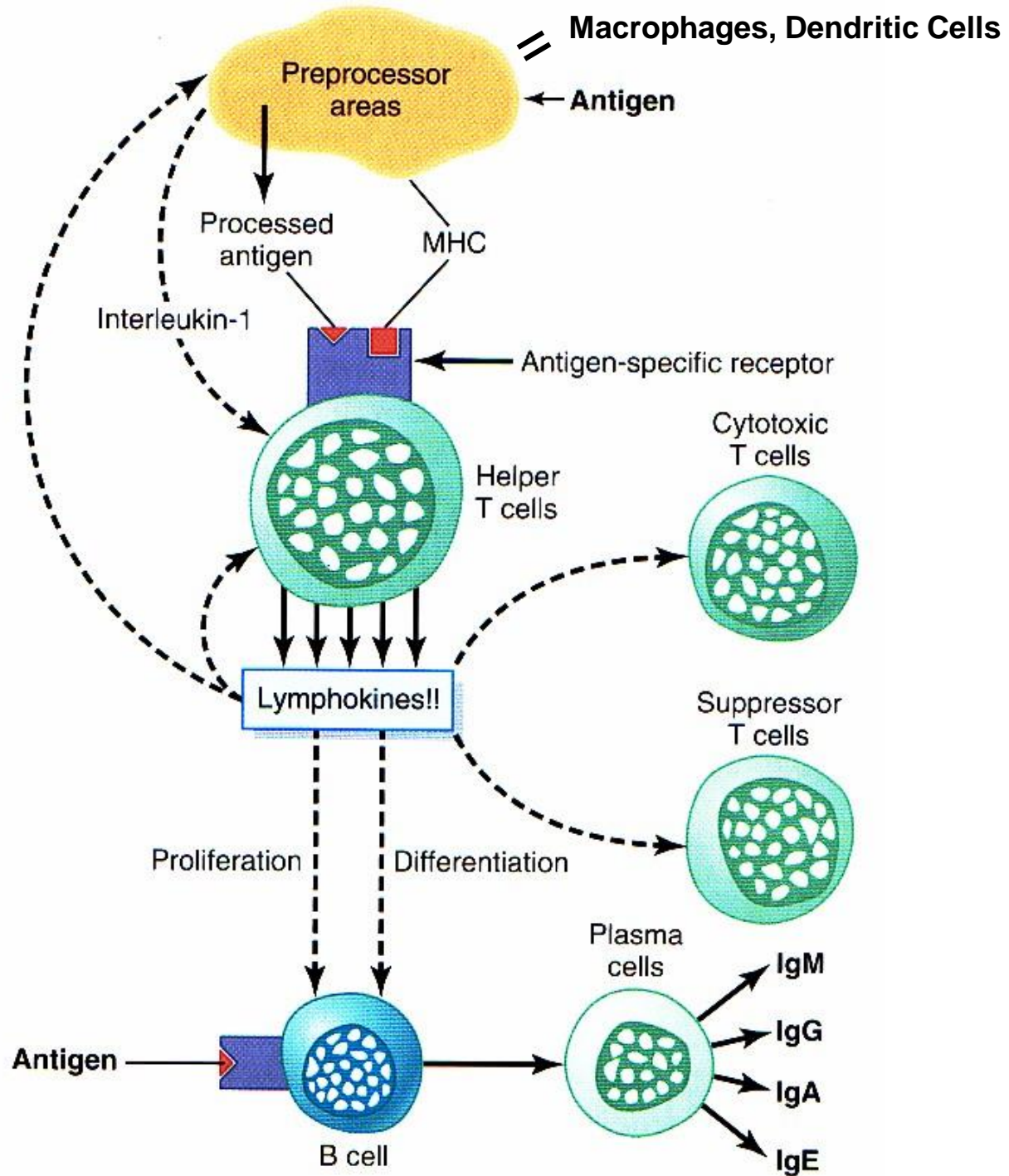


*Valence?* 10





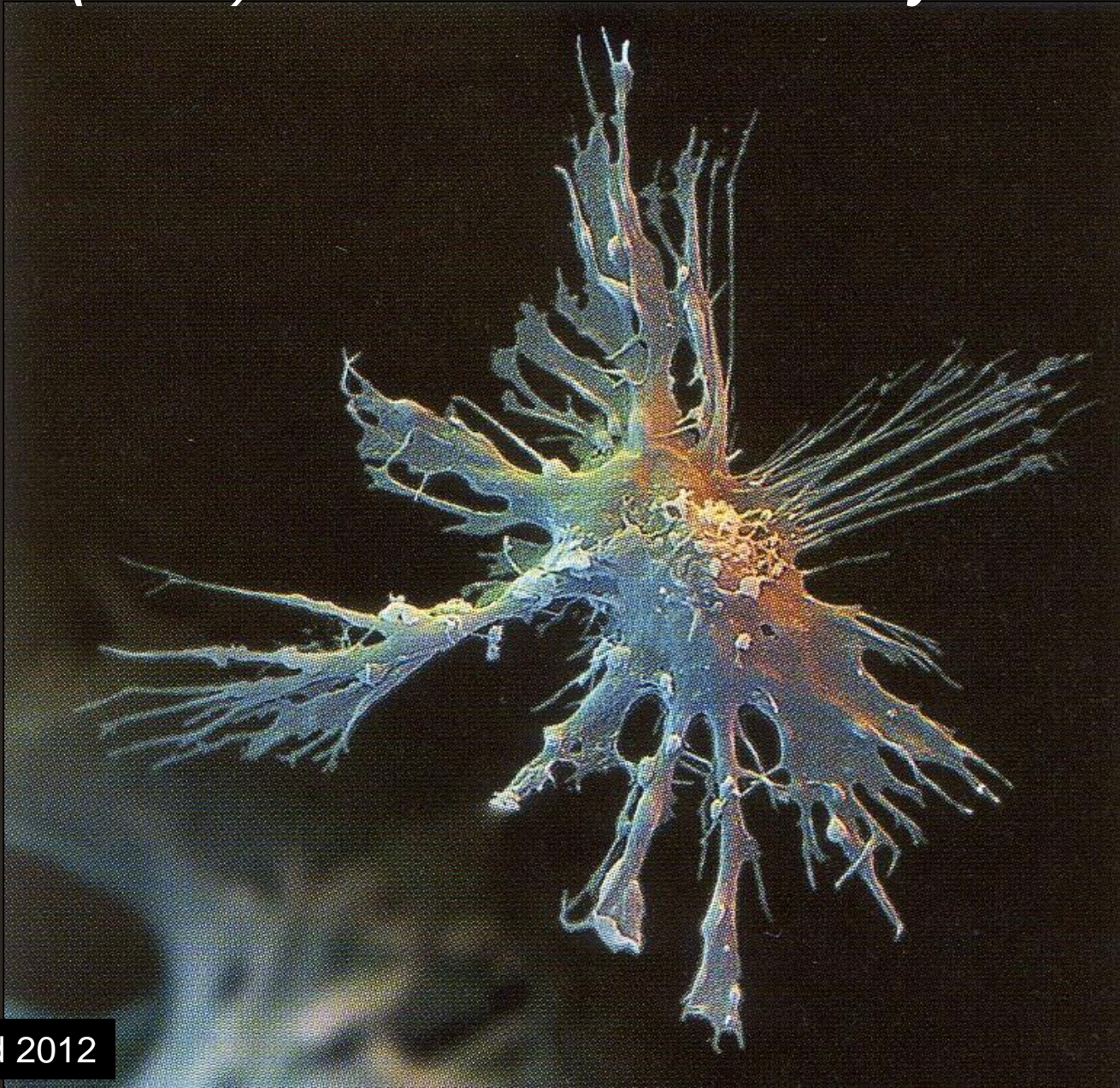




G&H 2011 fig 34-8  
 G&H 2016 fig 35-8



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





# Protein messages trigger responses

The pivotal discovery of lymphokines, the proteins by which immune cells communicate with each other, ushered in a new era of medical research. Scientists now produce some of them in sufficient quantities for promising therapies against a host of immunologic diseases.

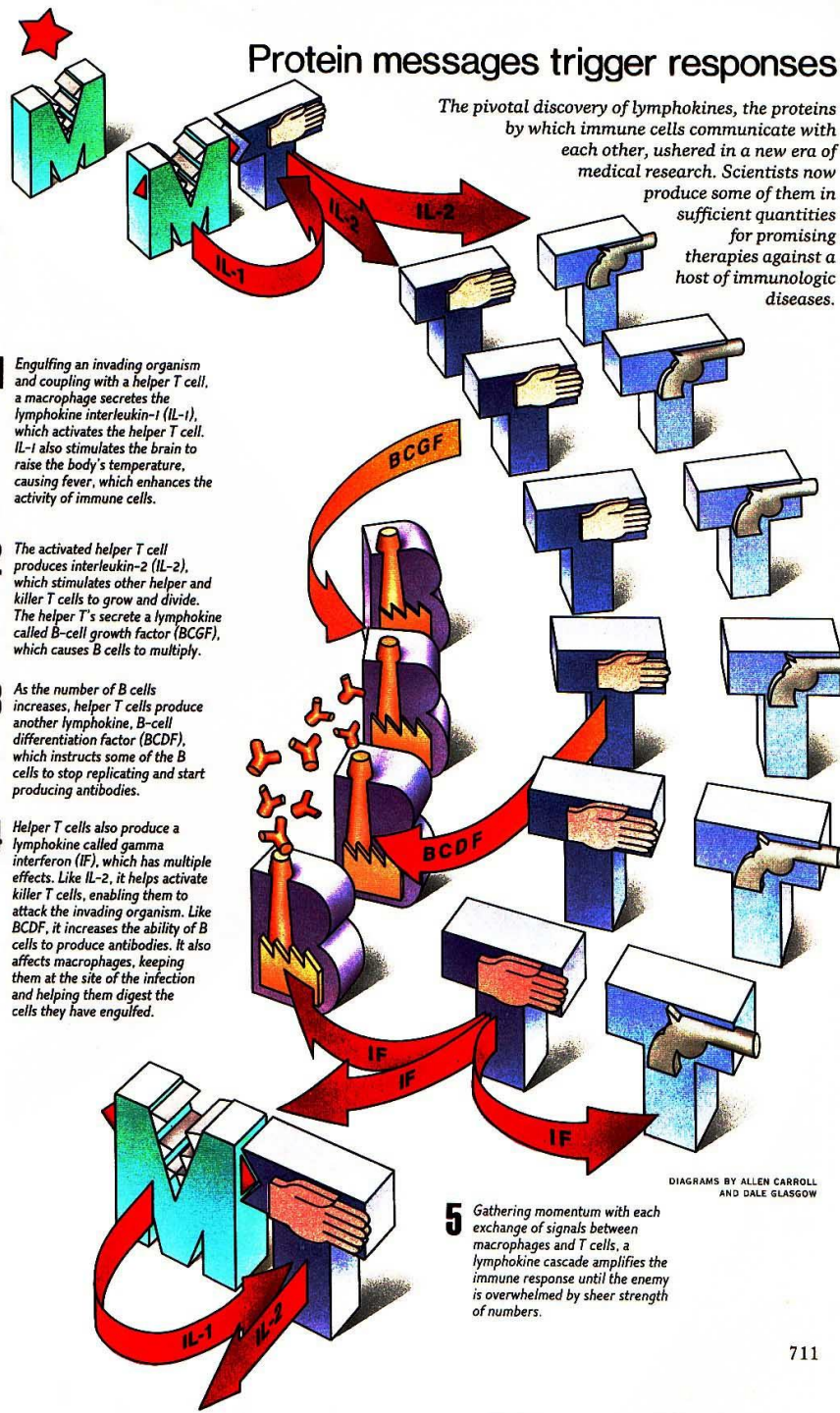
**1** Engulfing an invading organism and coupling with a helper T cell, a macrophage secretes the lymphokine interleukin-1 (IL-1), which activates the helper T cell. IL-1 also stimulates the brain to raise the body's temperature, causing fever, which enhances the activity of immune cells.

**2** The activated helper T cell produces interleukin-2 (IL-2), which stimulates other helper and killer T cells to grow and divide. The helper T's secrete a lymphokine called B-cell growth factor (BCGF), which causes B cells to multiply.

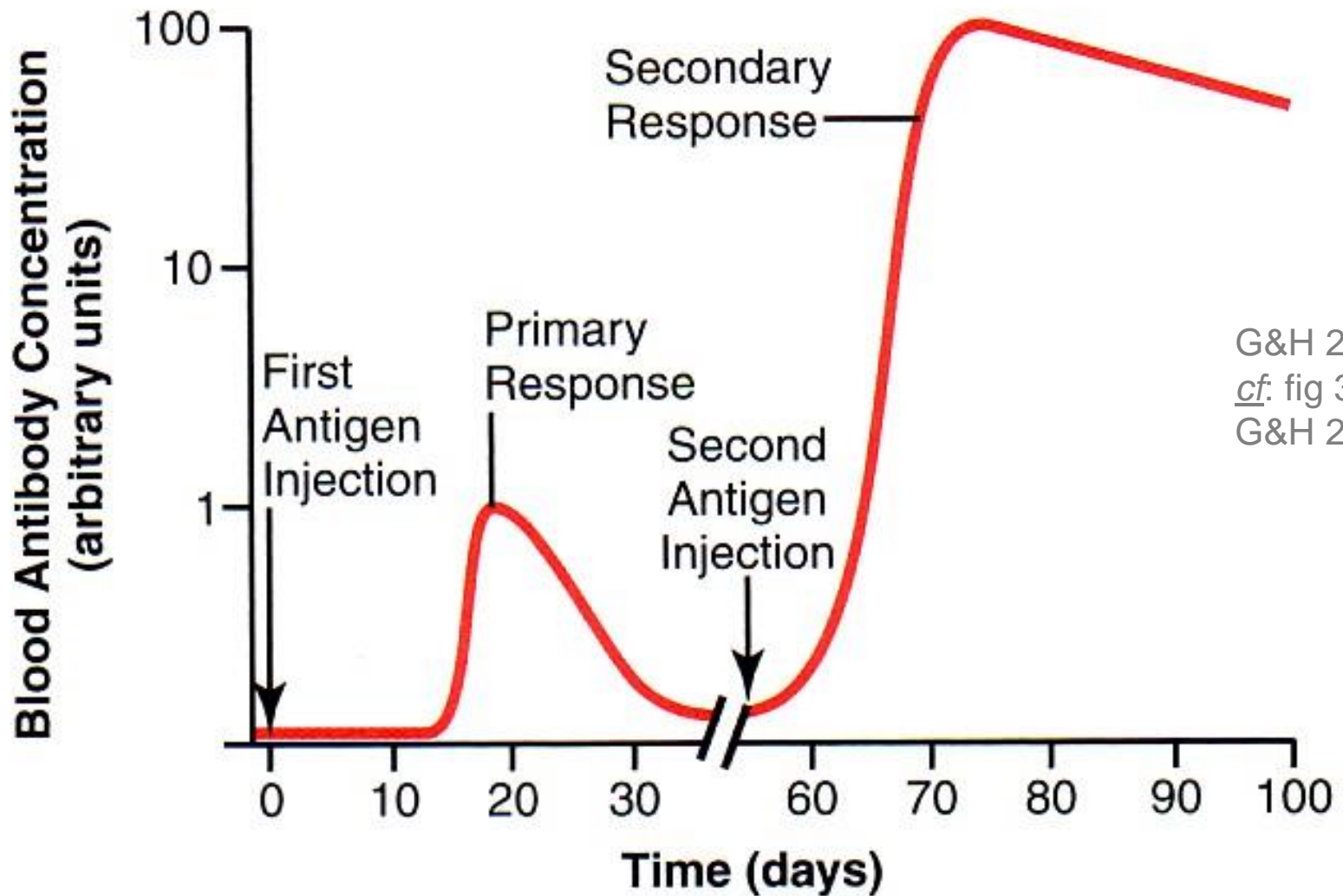
**3** As the number of B cells increases, helper T cells produce another lymphokine, B-cell differentiation factor (BCDF), which instructs some of the B cells to stop replicating and start producing antibodies.

**4** Helper T cells also produce a lymphokine called gamma interferon (IF), which has multiple effects. Like IL-2, it helps activate killer T cells, enabling them to attack the invading organism. Like BCDF, it increases the ability of B cells to produce antibodies. It also affects macrophages, keeping them at the site of the infection and helping them digest the cells they have engulfed.

**5** Gathering momentum with each exchange of signals between macrophages and T cells, a lymphokine cascade amplifies the immune response until the enemy is overwhelmed by sheer strength of numbers.



DIAGRAMS BY ALLEN CARROLL AND DALE GLASGOW



G&H 2011  
*cf.* fig 35-3  
G&H 2016

**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.





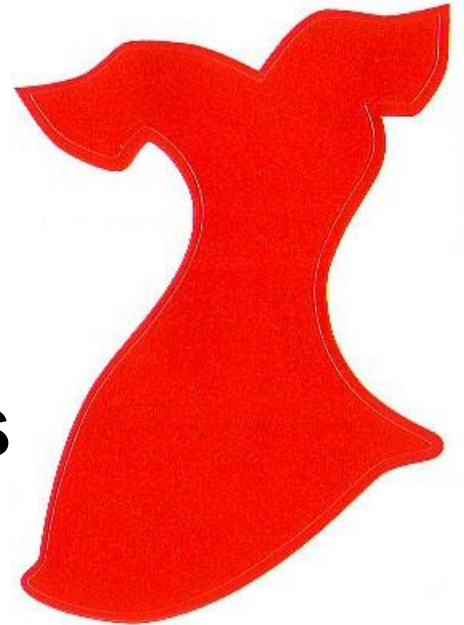
**Wear Red this Friday (Feb 3<sup>rd</sup>!)  
Help raise awareness about  
Women & ♥ disease**

**<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***

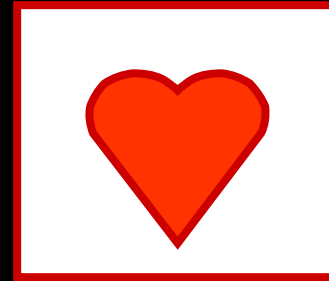
- **Quit smoking**
- **Avoid 2<sup>nd</sup> –hand smoke**
- **Know your numbers**
- **Process out processed foods**
- **Get moving**
- **Get your friends & family on board**
- **Spread awareness**



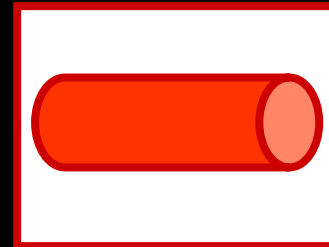
**[http://www.goredforwomen.org/about-heart-disease/symptoms\\_of\\_heart\\_disease\\_in\\_women/just-a-little-heart-attack/](http://www.goredforwomen.org/about-heart-disease/symptoms_of_heart_disease_in_women/just-a-little-heart-attack/)**



***Cardiovascular (CV) = Heart + Vessels + Blood!***



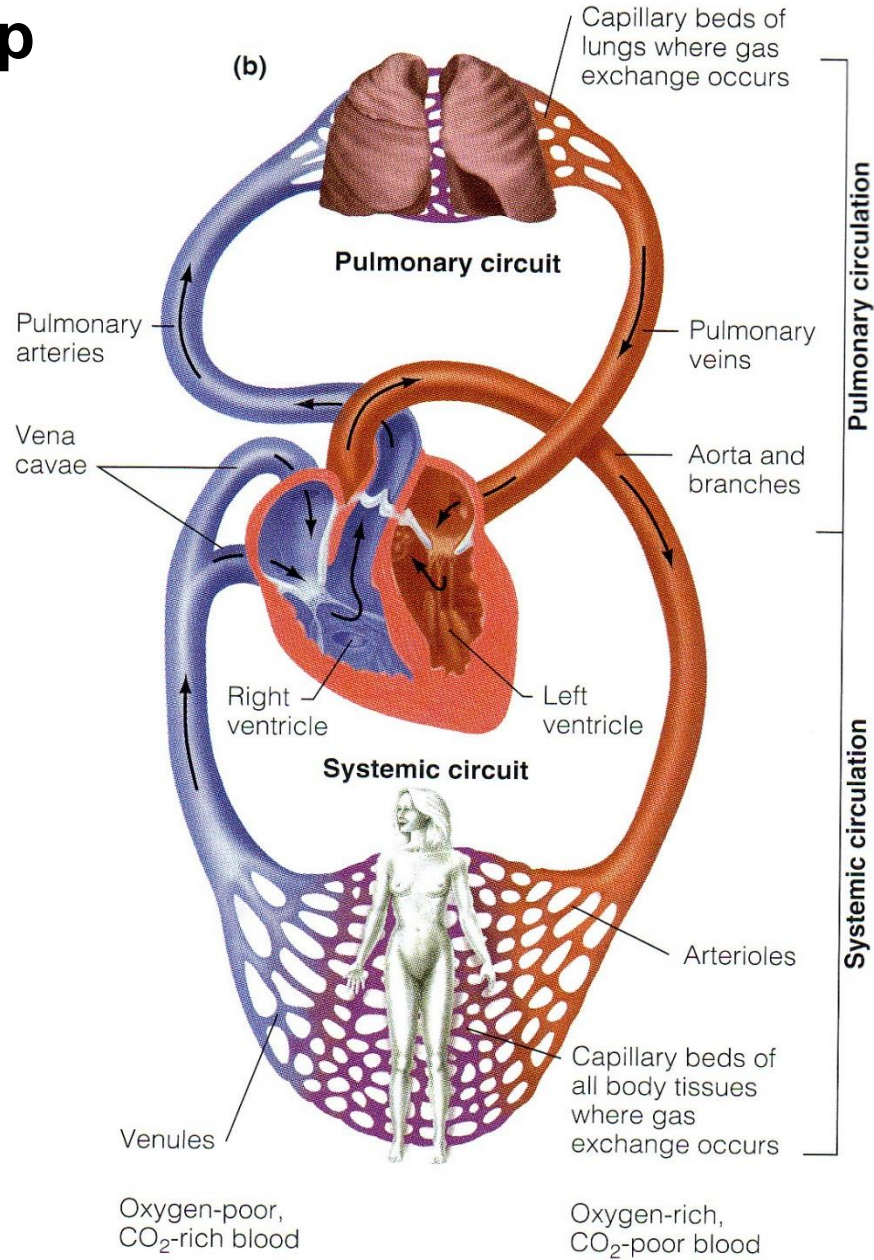
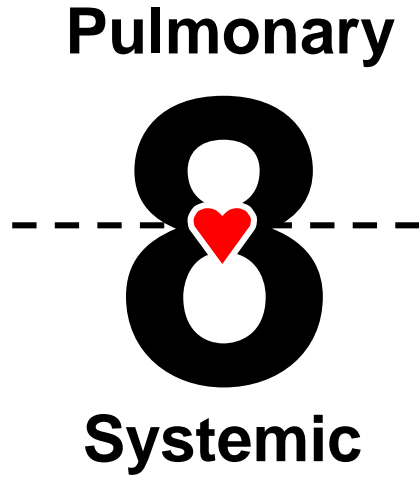
+



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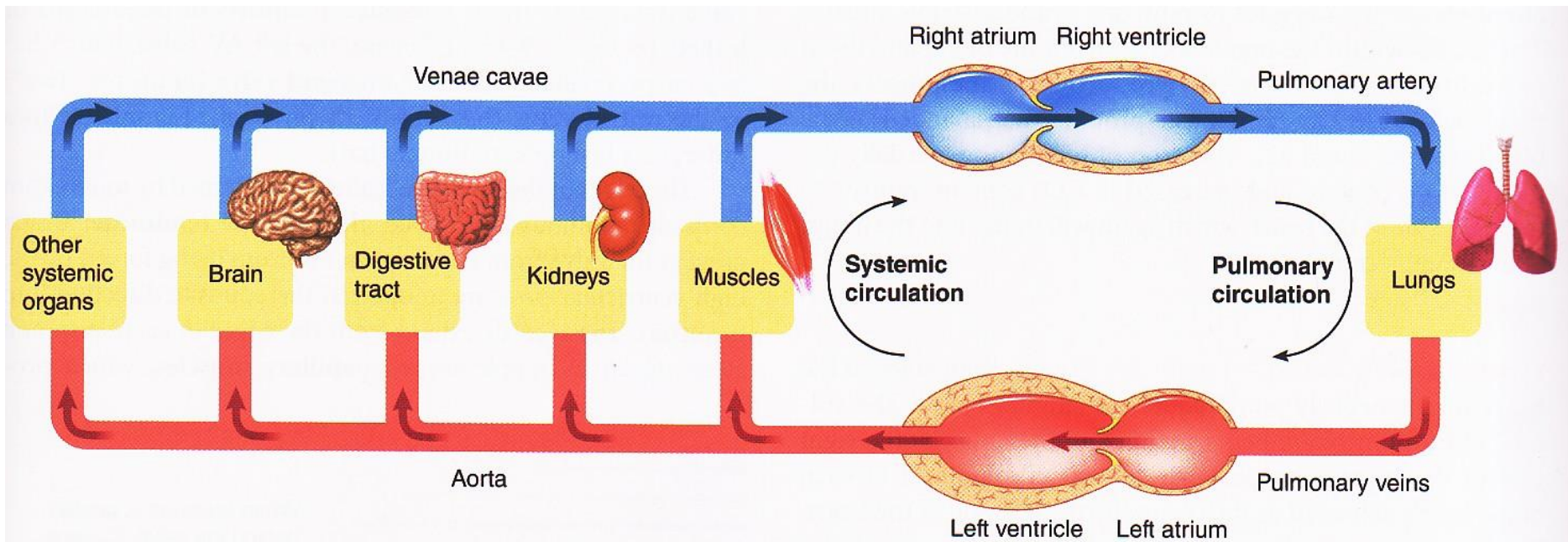


**NB: Figure-8 loop**





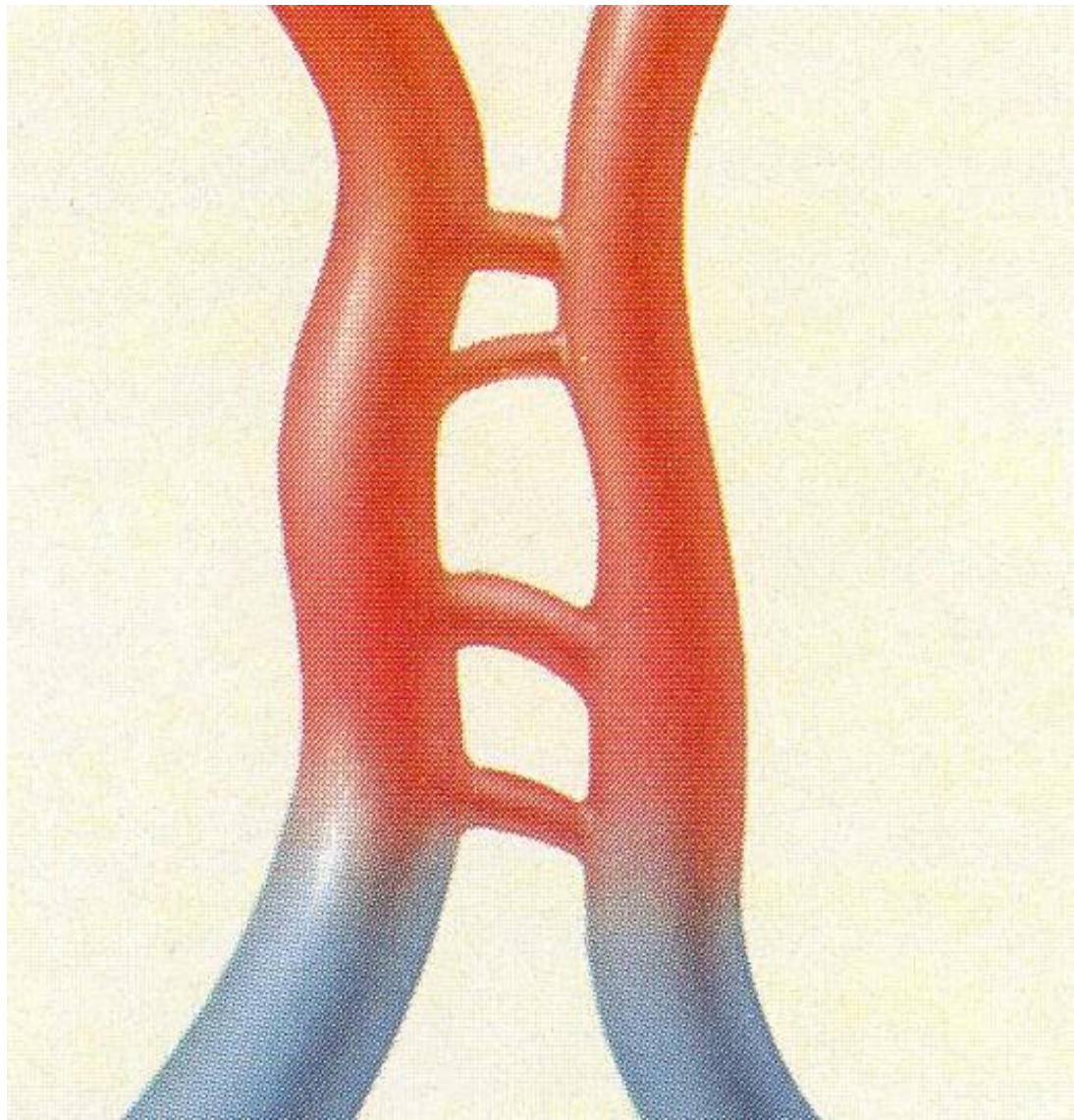
# Dual Pump Action & Parallel Circulation

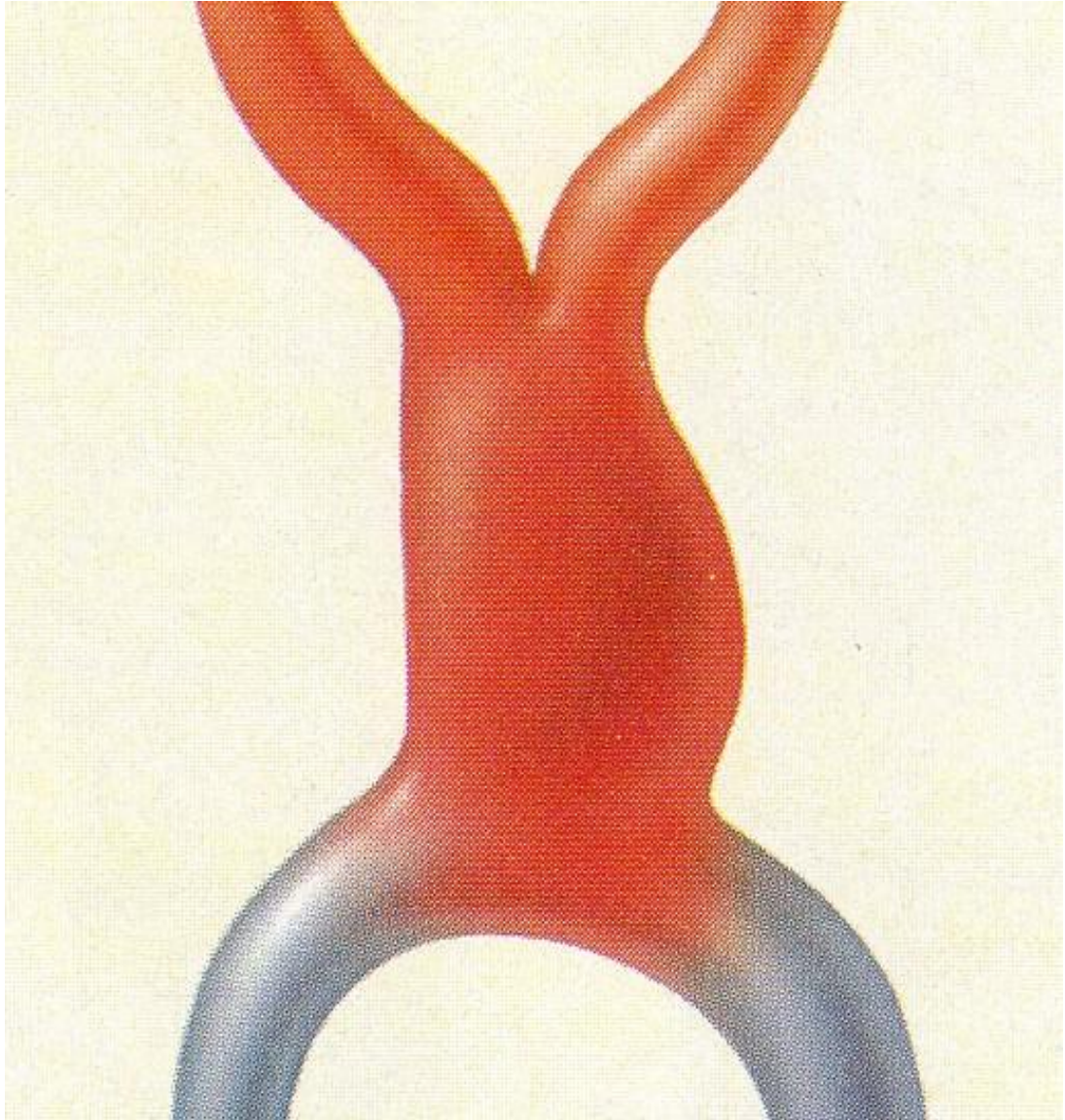




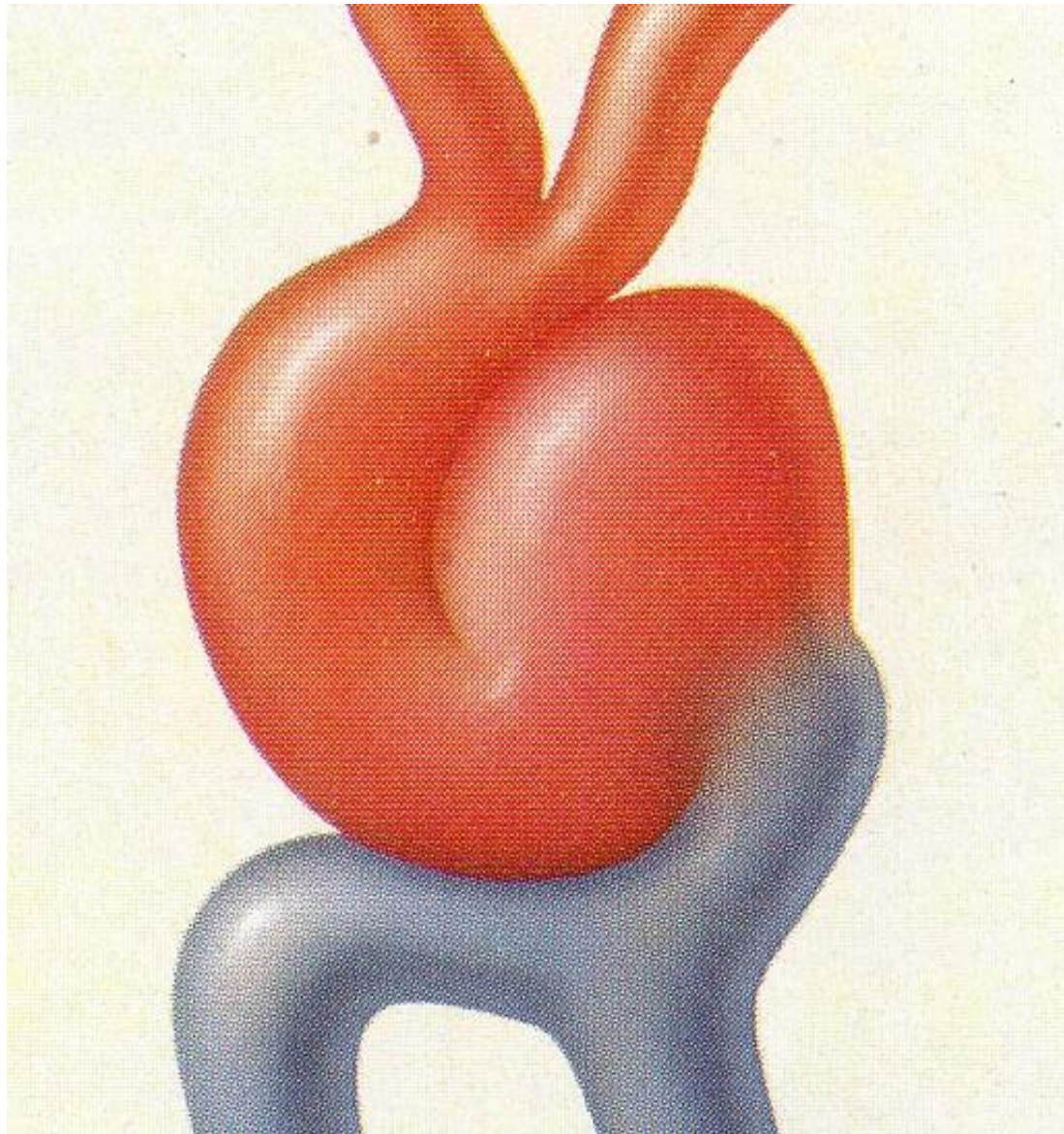




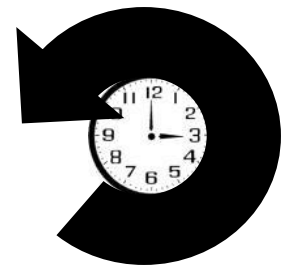




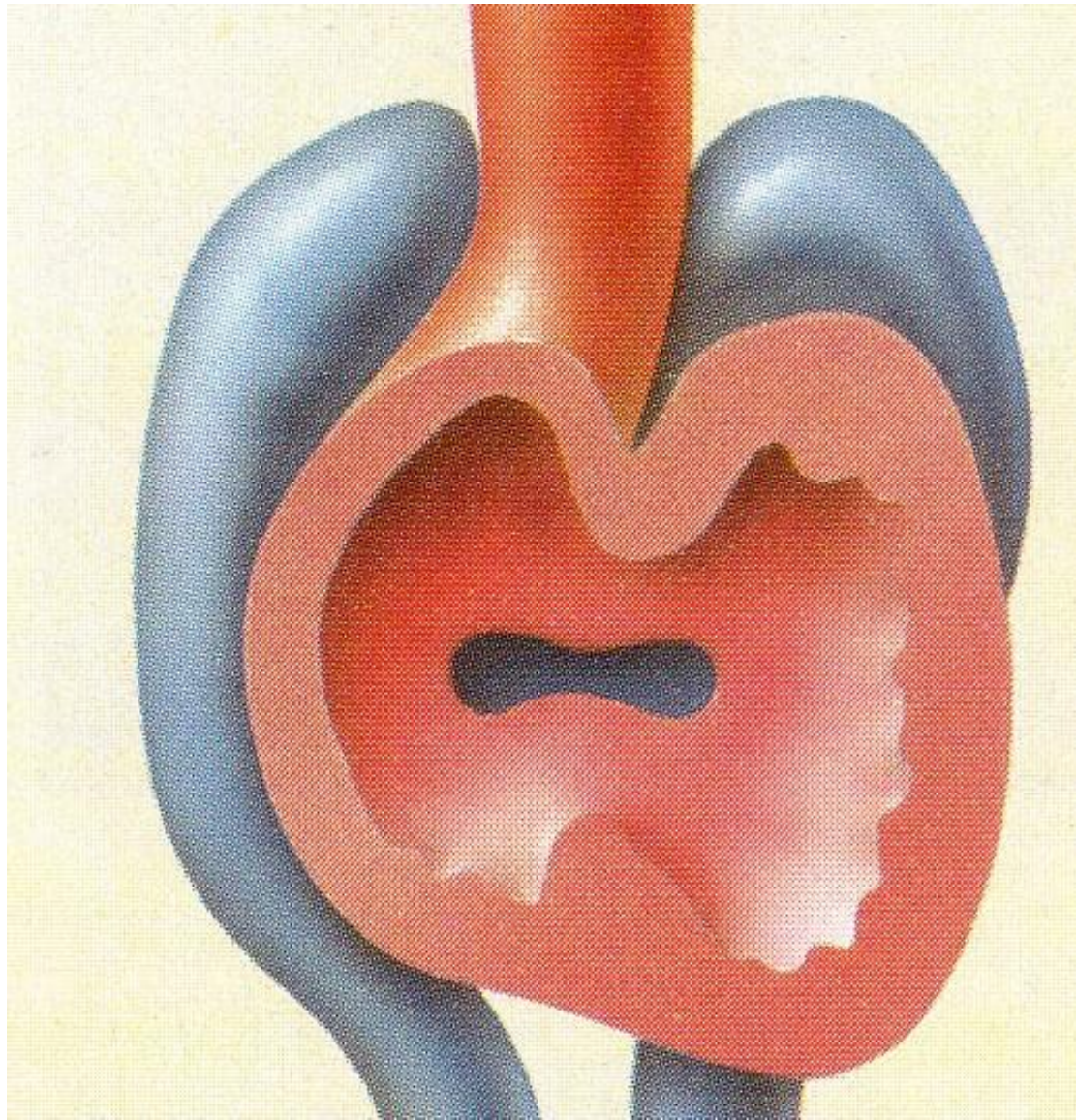




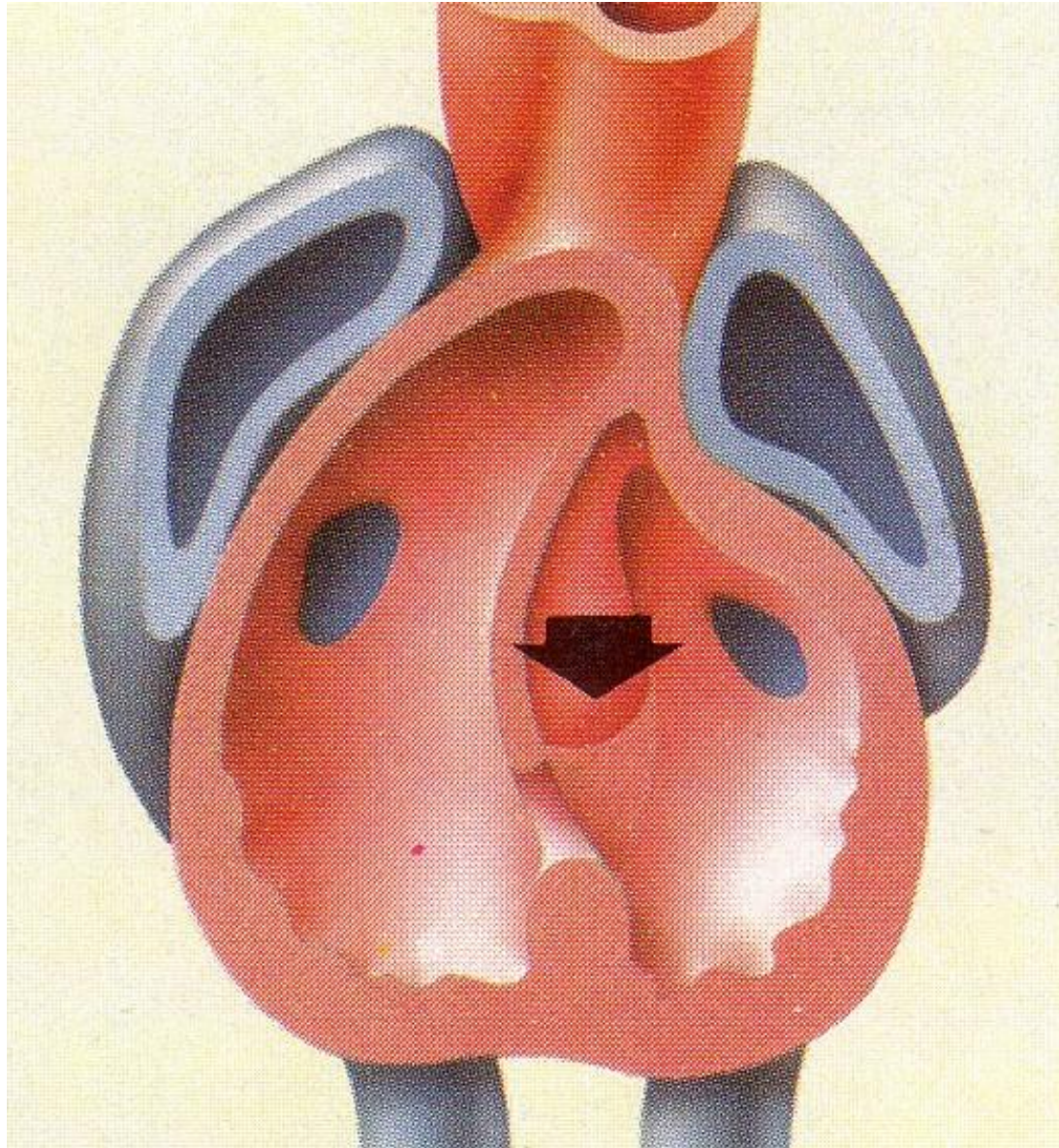
Counter-clockwise



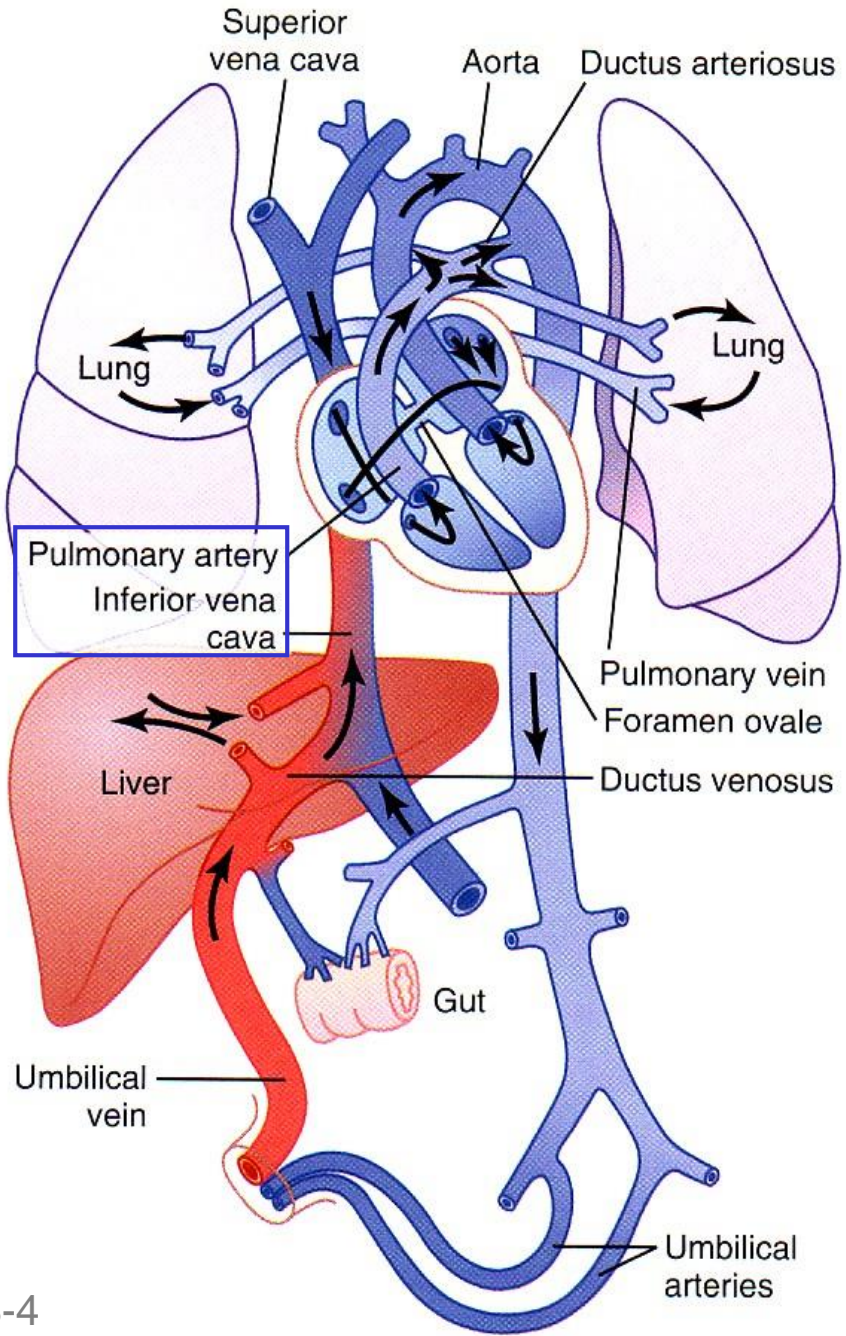






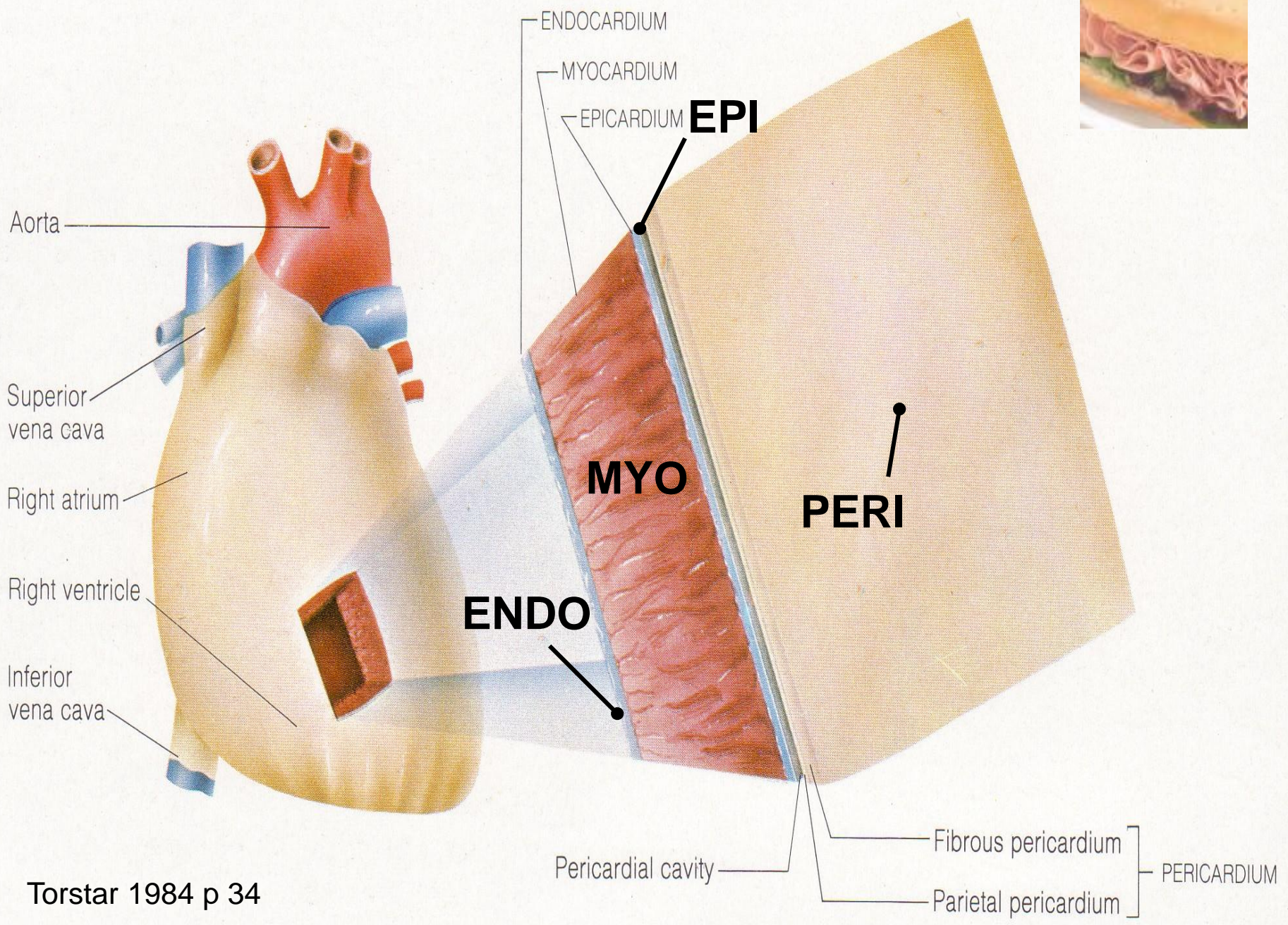


*Fetal Circulation*  
 ≡ *Aqua Animal*  
*Bypass Lungs*  
 R → L ♥ Shunt



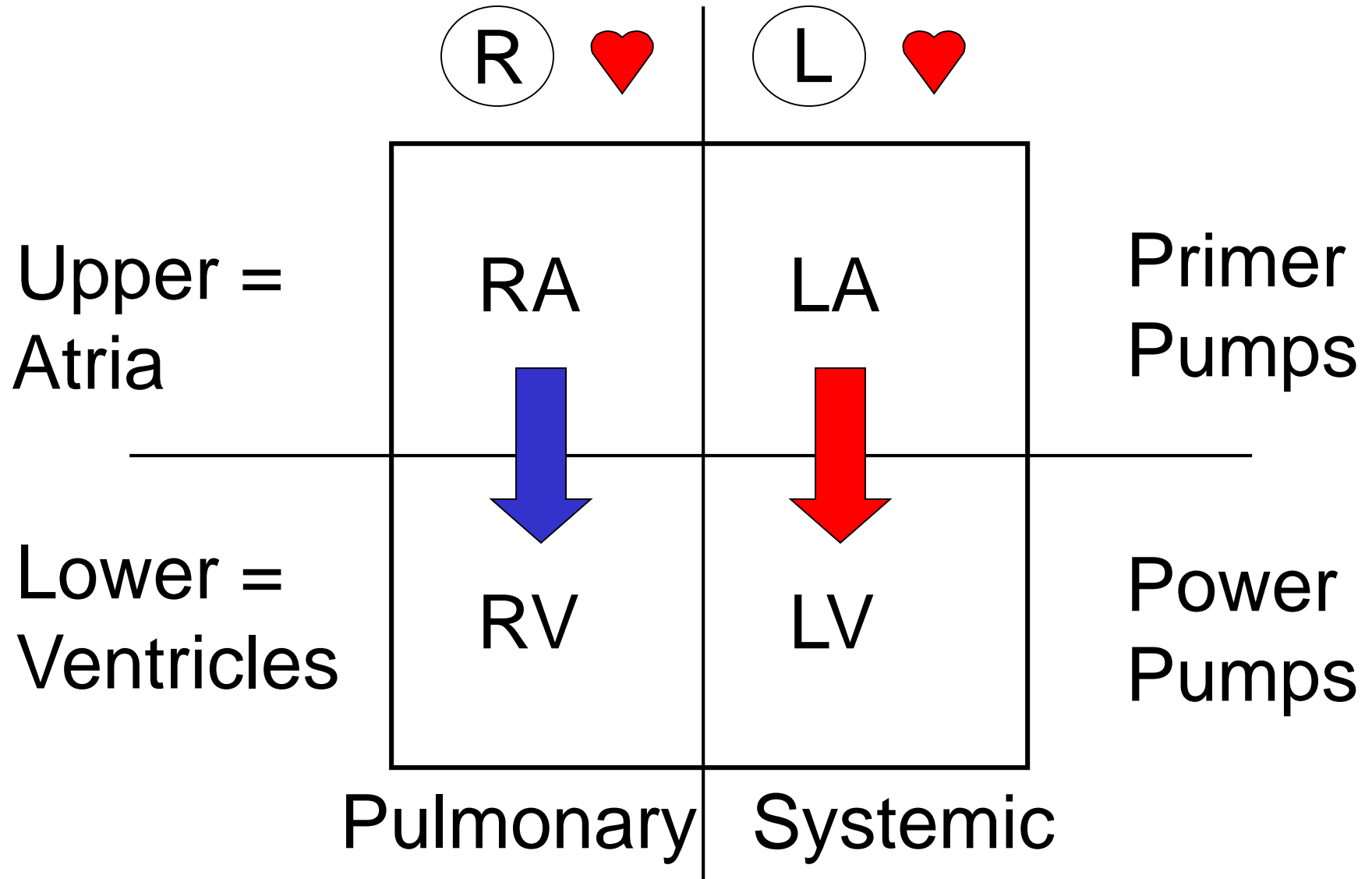
G&H 2016 fig 84-4, G&H 2011 fig 83-4



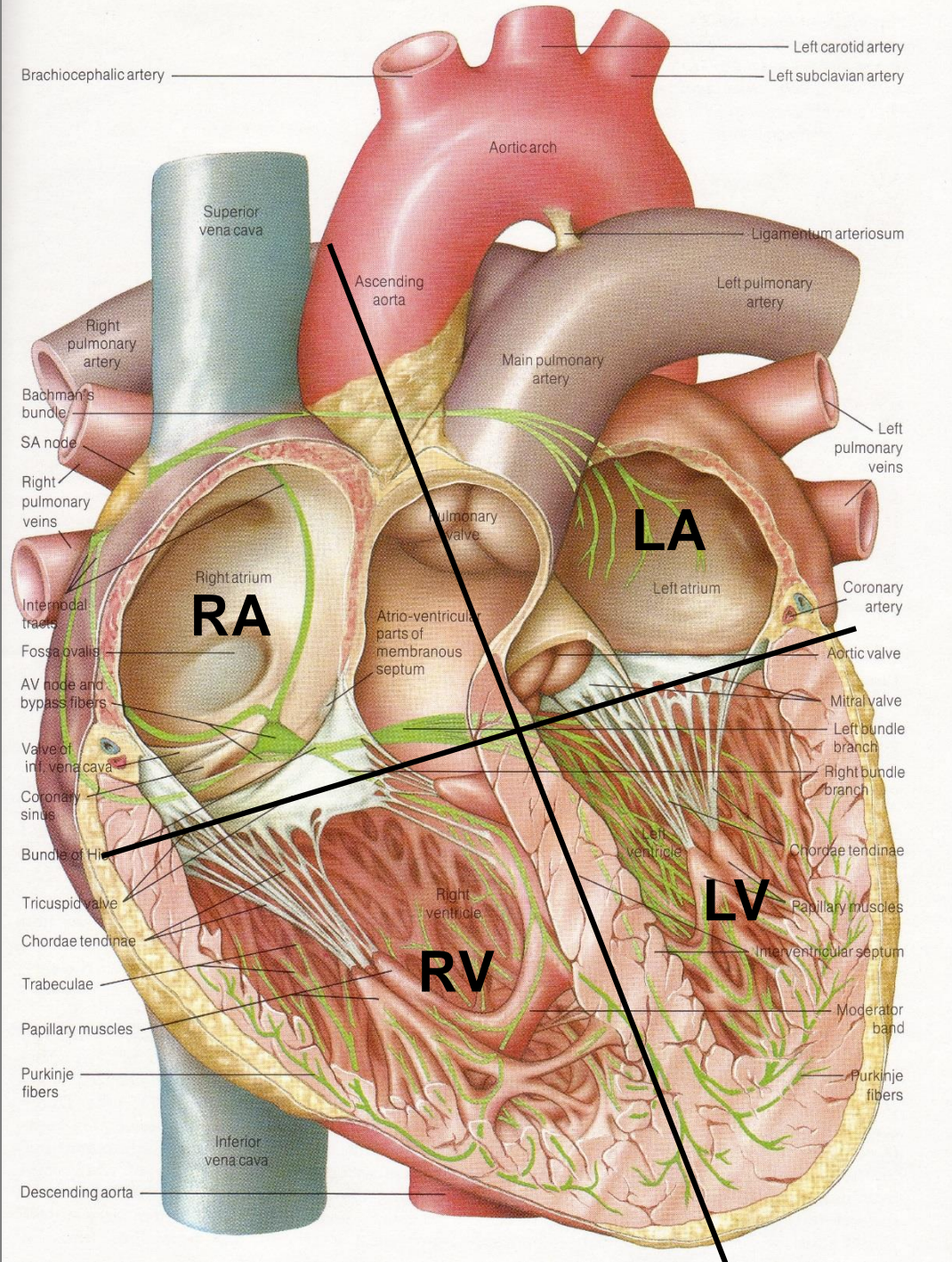


Torstar 1984 p 34

Human  = 4-chambered box?  
2 separate pumps?







Human ♥ = 4 unique valves?  
2 valve sets?

Semilunar = Half-moon shaped

More  
rigid

1. Pulmonic/Pulmonary
2. Aortic



AV = Atrioventricular

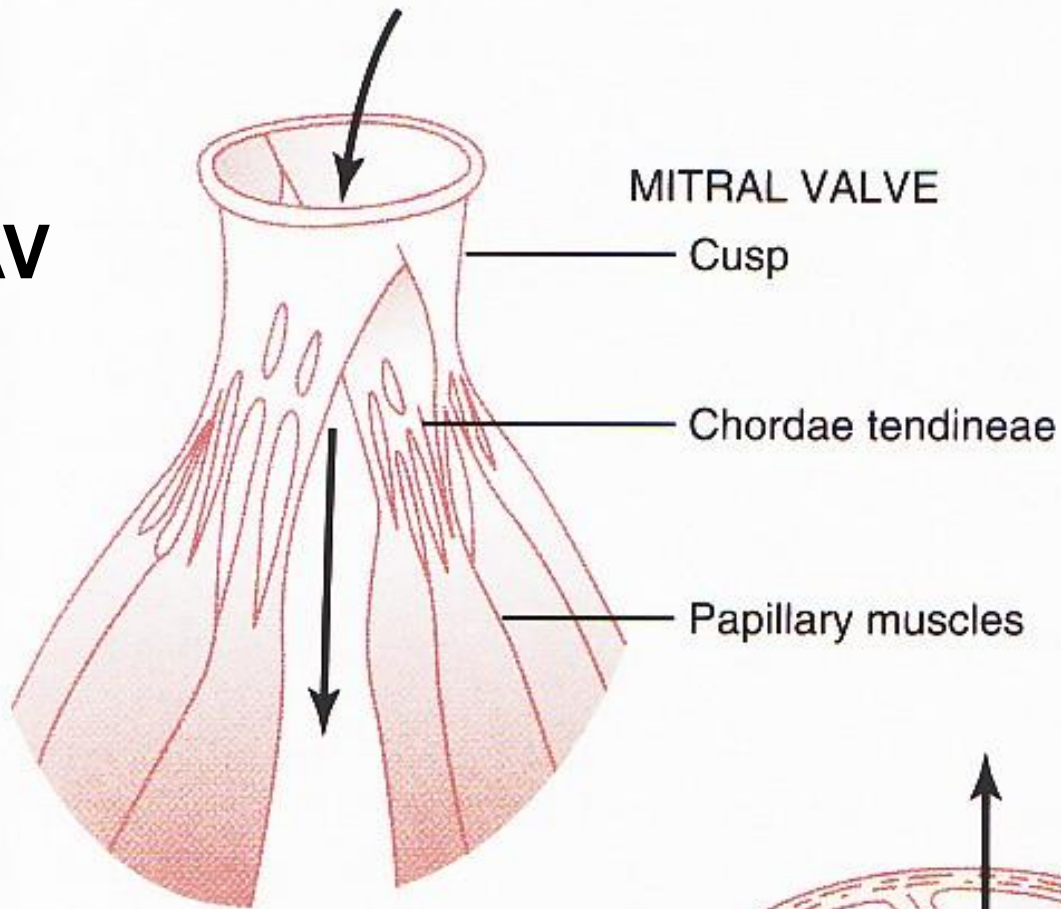
More  
flimsy

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





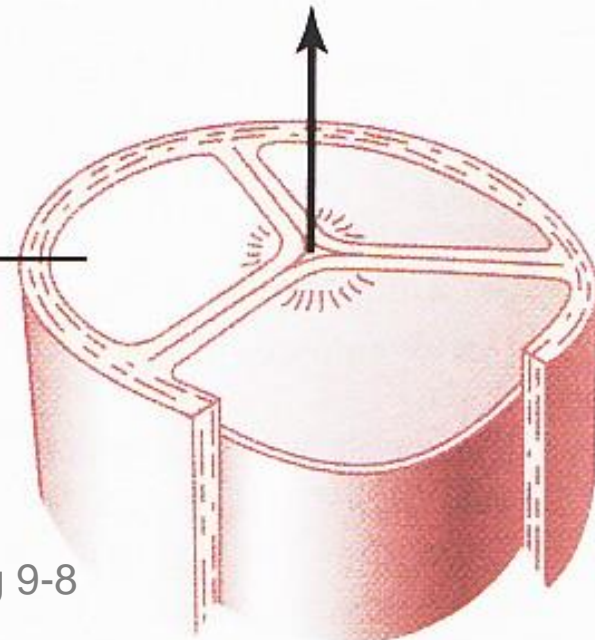
Ⓛ AV



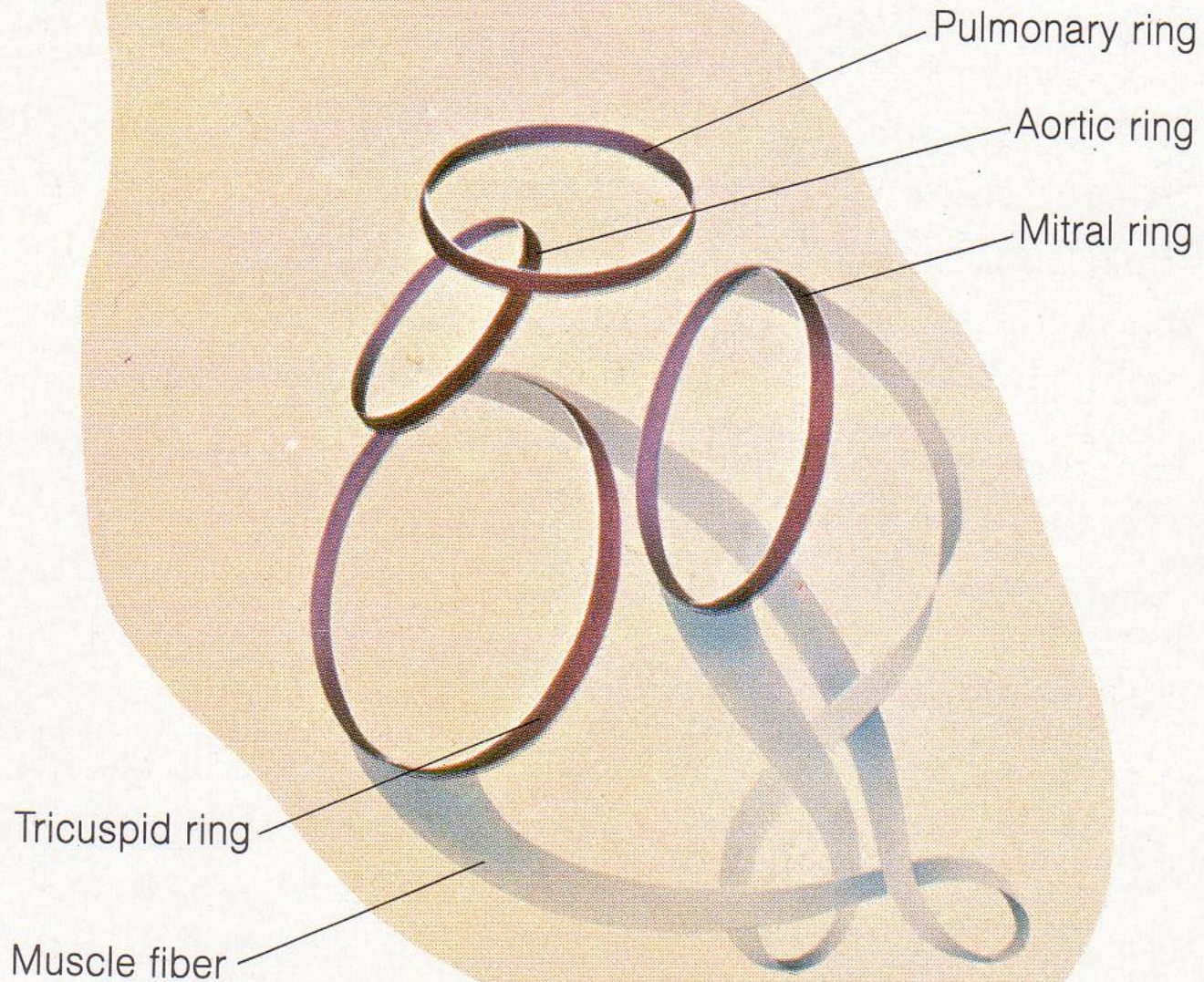
SL

Cusp

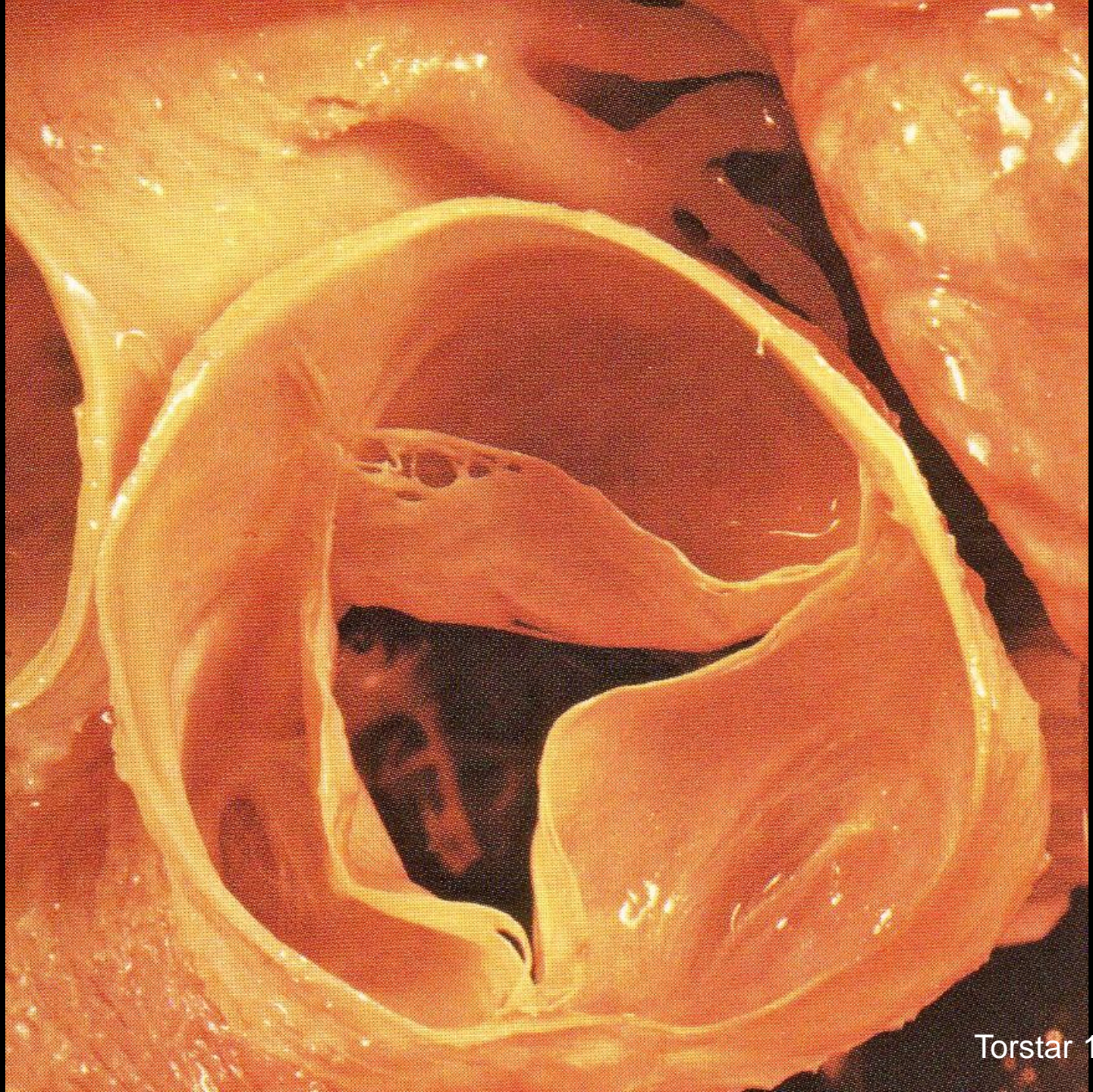
AORTIC VALVE



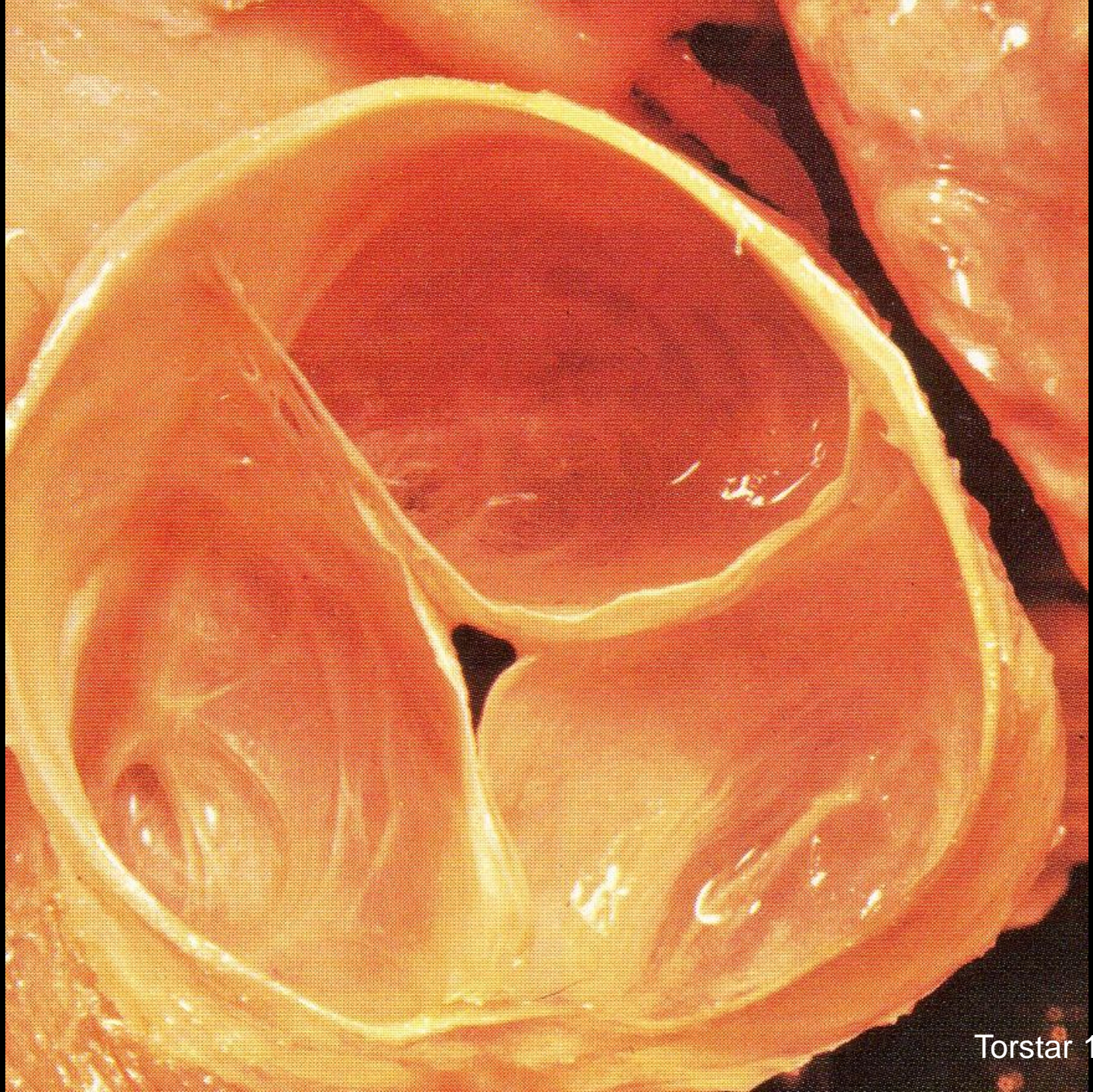
# Heart Valve Orientation & Scaffolding



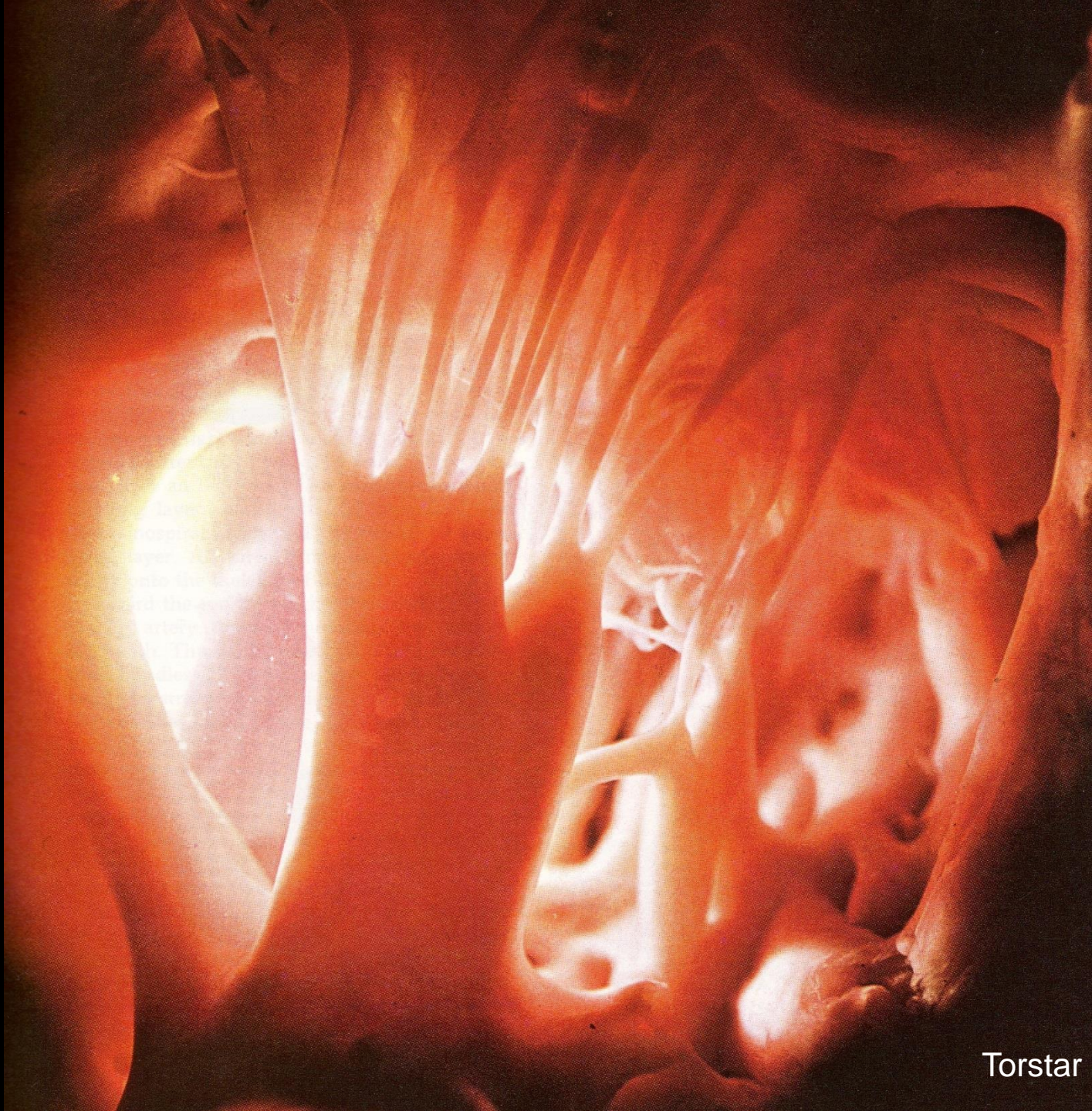














# What the heck's a *bruit*? (brwe, brōot) [Fr.] sound $\geq$ 25 subclassifications!

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

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

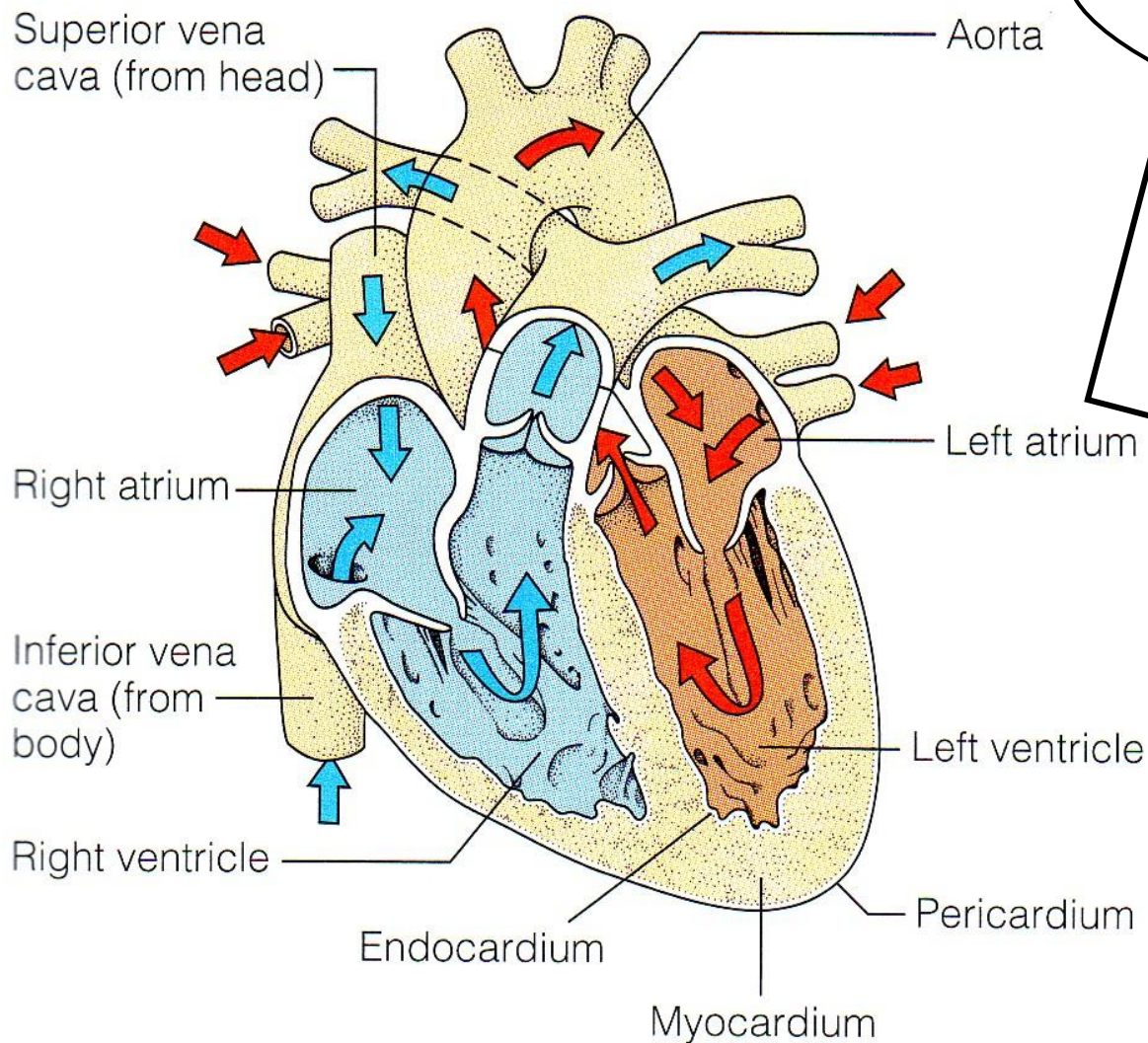
***b. de craquement*** [Fr. sound of crackling] a crackling pericardial or pleural bruit.

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

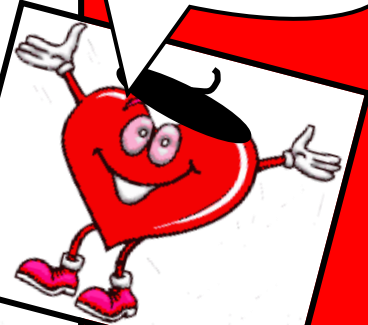
***b. de lime*** [Fr. sound of a file] cardiac sound resembling filing.



# Veins → Atria → Ventricles → Arteries

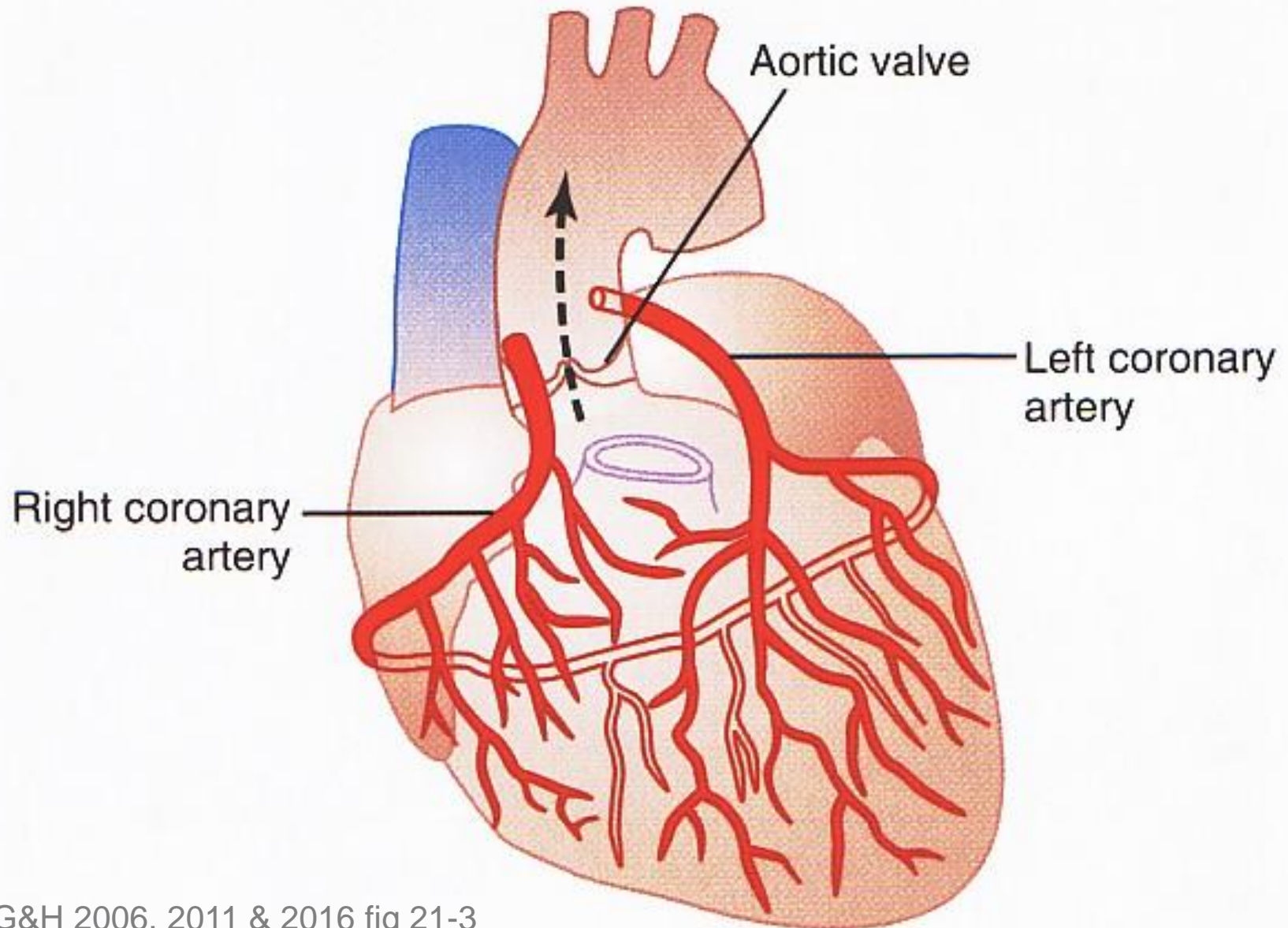


VAVA!



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

# ***Coronary Circulation ≡ Crowns the Heart!***

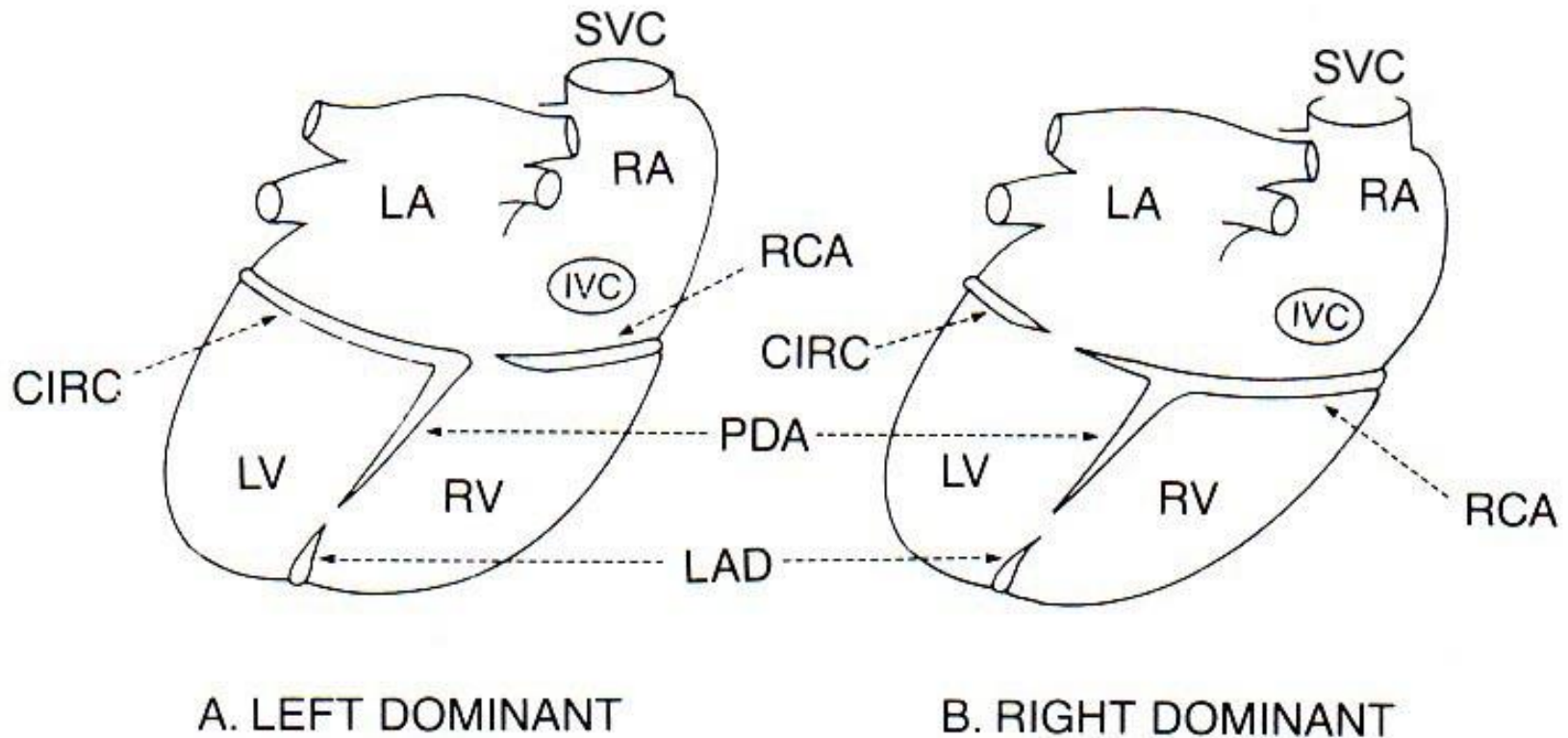








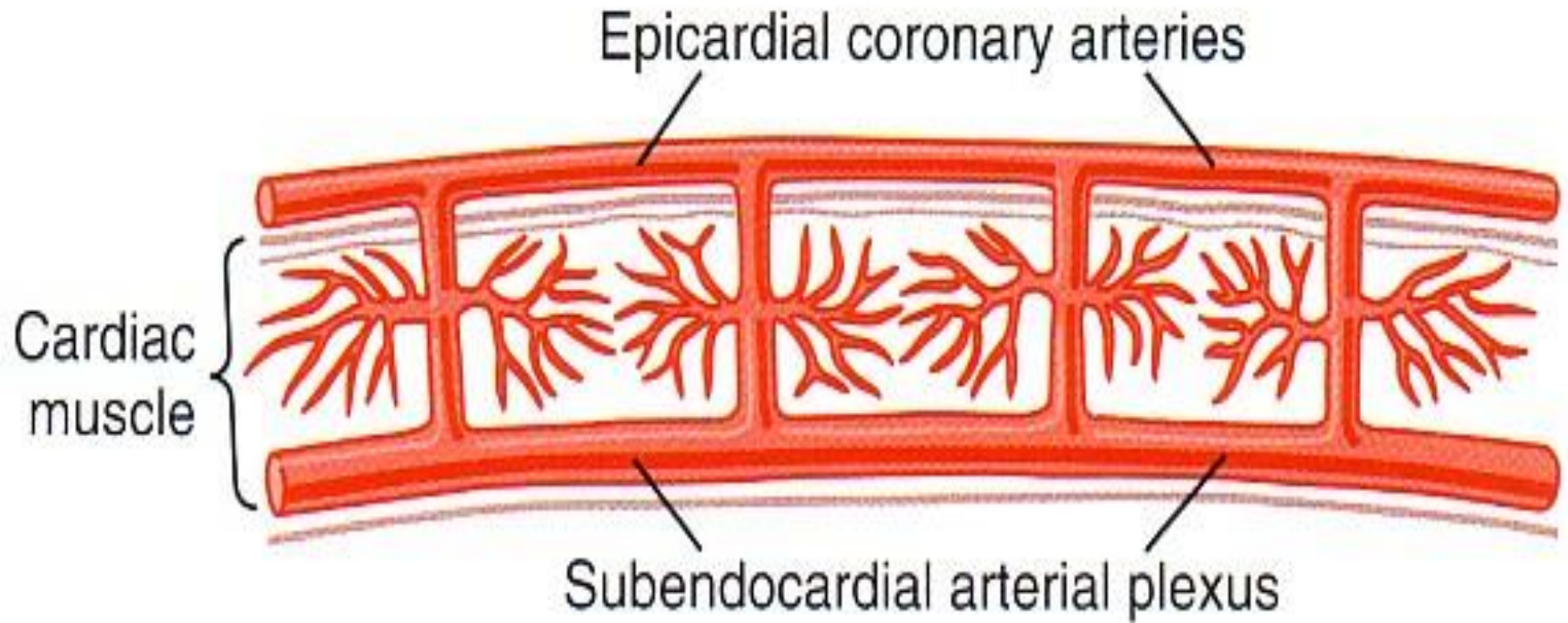
# Heart Dominance May Influence Survival



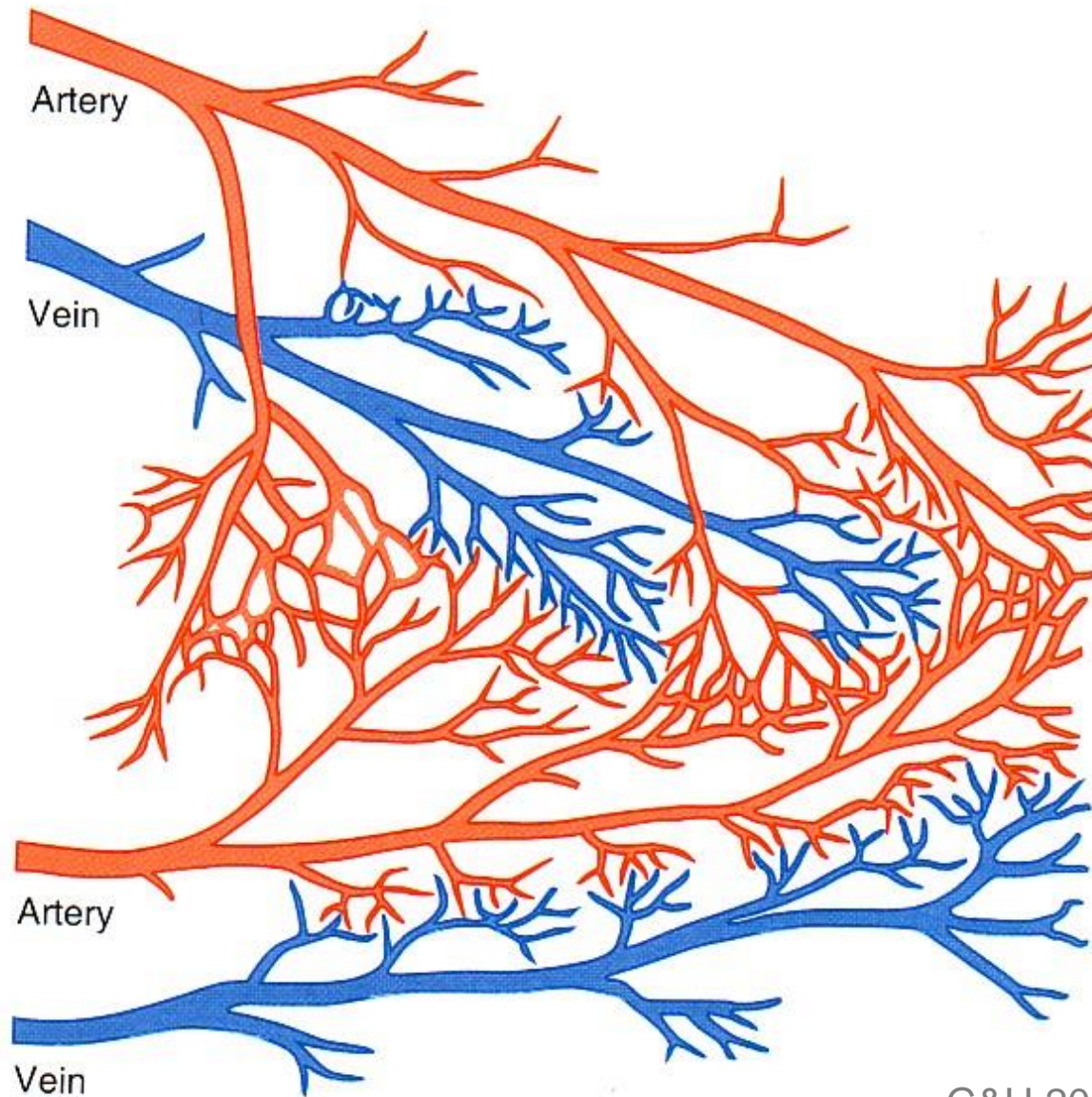
**FIG. 1.9.** Diagrammatic views of the posterior surfaces of the human heart showing left (A) and right dominant (B) patterns of coronary artery supply. In the left dominant pattern, the posterior descending artery (PDA) is supplied by the circumflex branch of the left coronary artery (CIRC). In the 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.



# ***Coronary Arteries Pierce the Heart from Epi to Endo***

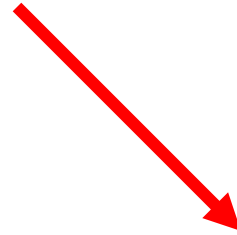
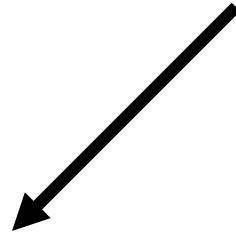


# ***Anastomoses May Provide Lifesaving Collateral Circulation!!***





# Cardiac Cycle

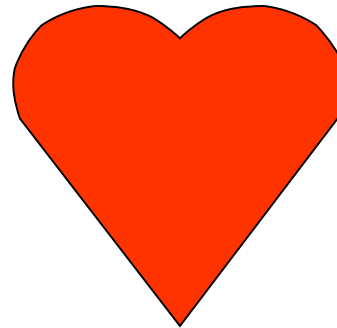
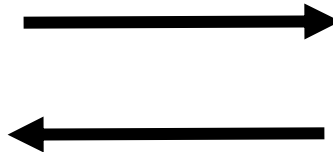
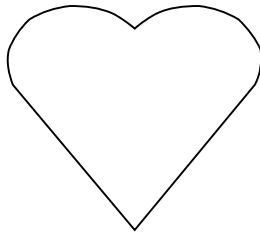


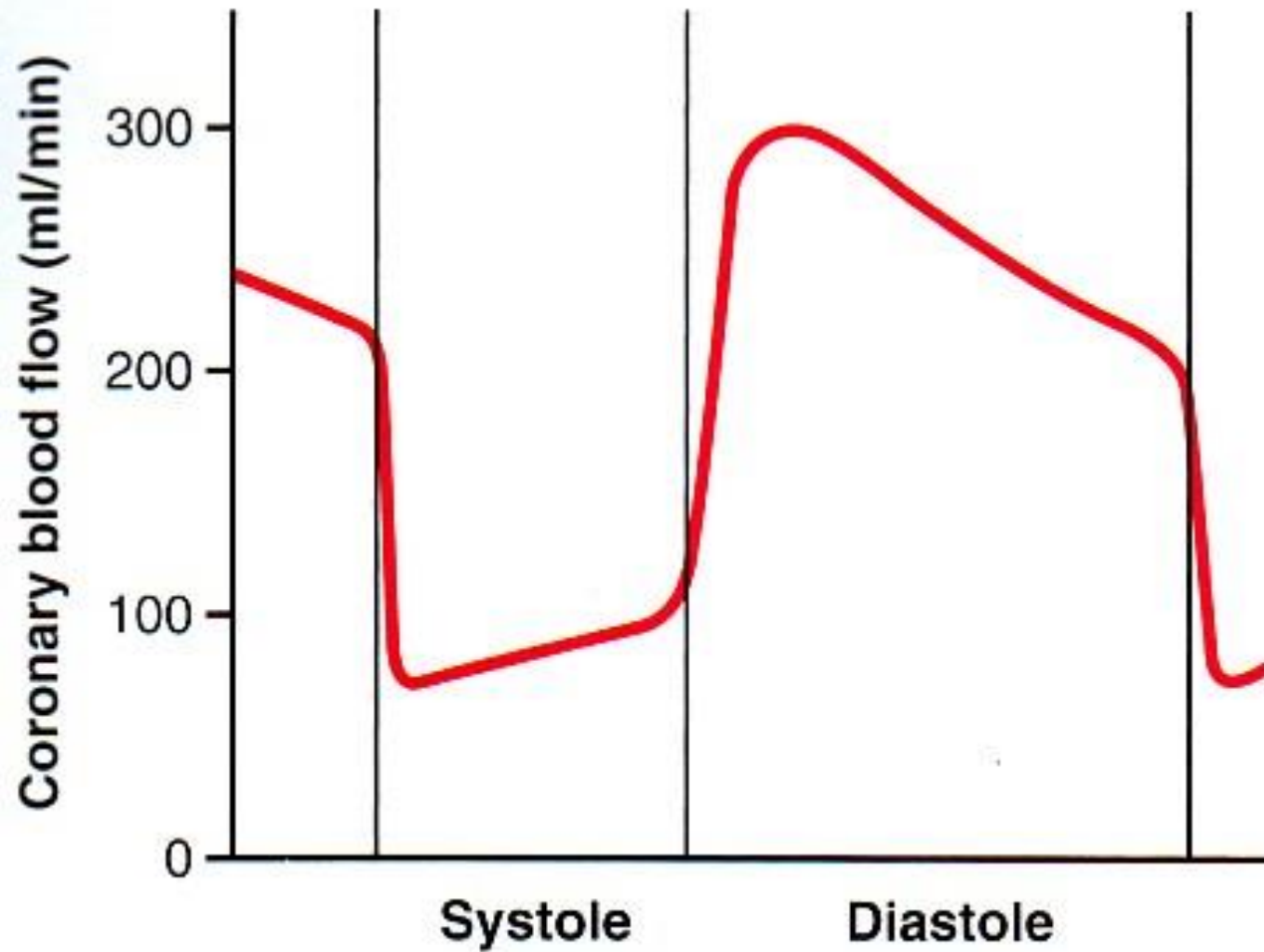
***Systole***

Contract  
& Empty

***Diastole***

Relax  
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**Contract  
& Empty**

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# Electrical Events Precede **Mechanical Events!**

