I. Announcements
Dr. Jacobson next T, Dr. Padgett next R!

II. 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 84-4
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 9-7
G. Autorhythmic cells & ♥ 's electrical highway G&H fig 10-1

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

IV. CVDs
Definitions, US Disease Statistics: CDC 2012 + AHA

V. Atherosclerosis + Mechanisms
Torstar Books, G&H, +...
A. Linking proposed historical mechanisms
   Endothelial Injury Hypothesis (Ross & Glomset)
   Lipid Infiltration Hypothesis (Steinberg & Witzum) + new!
B. Cholesterol metabolism: Dr. Kottke’s bathtub analogy
C. 1⁰ modifiable risks: cigarette smoking, hypertension,
   hypercholesterolemia/hyperlipidemia, lack of exercise
D. Treatment triad, PTCA, CABG, prevention, practical tips!
Wear Red this Friday (Feb 5th!)
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 2nd –hand smoke
• Know your numbers
• Process out processed foods
• Get moving
• Get your friends & family on board
• Spread awareness

Cardiovascular (CV) = Heart + Vessels + Blood!
NB: Figure-8 loop

Pulmonary Systemic

Pulmonary circuit
- Pulmonary arteries
- Pulmonary veins
- Vena cavae
- Aorta and branches
- Right ventricle
- Left ventricle

Systemic circuit
- Arterioles
- Capillary beds of all body tissues where gas exchange occurs
- Venules
- Oxygen-poor, CO₂-rich blood
- Oxygen-rich, CO₂-poor blood

Capillary beds of lungs where gas exchange occurs
Dual Pump Action & Parallel Circulation
Fetal Circulation
≡ Aqua Animal
Bypass Lungs
R → L ❤️ Shunt

G&H 2011 fig 83-4
Human ❤️ = 4-chambered box? 2 separate pumps?

Upper = Atria

Lower = Ventricles

Pulmonary

Systemic

RA

LA

RV

LV

Primer Pumps

Power Pumps
Human $\heartsuit = 4$ unique valves?
2 valve sets?

**Semilunar** = *Half-moon shaped*

1. Pulmonic/Pulmonary
2. Aortic

**AV** = *Atrioventricular*

3. $\textcircled{R}$ AV = Tricuspid
4. $\textcircled{L}$ AV = Mitral/Bicuspid
G&H 2006 fig 9-6; cf: G&H 2011 fig 9-7
What the heck’s a *bruit*? (brwe, brôot) [Fr.] sound > 25 subclassifications!

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

**b. de canon** [Fr. sound of cannon] abnormally loud 1\textsuperscript{st} 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
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!!

G&H 2011 fig 21-6
Cardiac Cycle

**Systole**
Contract & Empty

**Diastole**
Relax & Fill
Coronary blood flow (ml/min)

Systole
Contract & Empty

Diastole
Relax & Fill

G&H 2011 fig 21-4
Electrical Events Precede Mechanical Events!
**FIGURE 9-35**

Extent of myocardial damage as a function of the size of the occluded vessel.
What is the **Ultimate Cause of Death**?

1. $\downarrow Q$, CO or Cardiac Output
2. Pulmonary damming w/edema
3. Cardiac fibrillation
4. Thromboembolism
5. Cardiac rupture

G&H 2011 p 250
Systolic Stretch Due to Necrotic Tissue

- Normal Muscle
- Nonfunctional Muscle
- Systolic Stretch
Treatment Triad

- Exercise
- Dietary Modification
- Drugs/Surgery

NB: Last blasted resort!!
300/200

KA-BOOM!

Hg
An LDL to HDL ratio greater than 5 to 1 in men or 4.5 to 1 in women.

Increased risk of heart disease.
A typical lipoprotein

- Phospholipid
- Cholesterol
- Triglyceride
- Protein
The diagram illustrates the composition of LDL and HDL cholesterol in terms of percent of each component:

- **LDL** (Lower density, More lipid, Less protein)
- **HDL** (Higher density, Less lipid, More protein)

The components are labeled as:
- **Protein**
- **Cholesterol**
- **Phospholipid**
- **Triglyceride**

The lower density LDL cholesterol is shown with a red face, indicating a more unhealthy lipid profile, while the higher density HDL cholesterol is shown with a green smiley face, indicating a healthier lipid profile.
Selected Atherosclerotic Genetic Determinants – Ultra-short List!

Genes for HDL, LDL+ receptors, Apolipoproteins Apo B-100, Apo-E, Apo-M, lipoprotein a/Lp\(_a\), homocysteine metabolism enzymes N5,N10-methylene-tetrahydrofolate reductase, cystathione beta-synthase, Type I antithrombin, mitochondrial haplogroup A, Protein tyrosine phosphate PTPN22 C/T single nucleotide polymorphism (SNP) @ +1858, HMG COA reductase, SNPs in TNF-alpha, IL-1beta & TGF-beta1, IL-6, IL-10, CD14, TLR-4 receptors, Human Leukocyte Antigens HLA-DRB1*01, HLA-B*07 + haplotype LTA+253a-LTA+633g-C4A3-C4B1, HDL-associated paraoxonase (PON1), lysosomal acid lipase (LAL), MEF2A protein affecting artery walls…
Bruce Kottke’s Bathtub Analogy

5 forms of cholesterol:
Chylomicrons, VLDL, LDL, IDL, HDL

Atherogenic

Anti-Atherogenic

Bruce Kottke

“Biological Artifact!?"

“I don’t think the total cholesterol test by itself is worth a damn.”
—Eliot Corday
Ross & Glomset

Endothelial Injury
→ Platelet Adherence
→ PDGF Release
→ Cell Proliferation
→ Advanced Lesion

Steinberg & Witztum

High Plasma LDL
→ LDL Infiltration into Intima
→ Oxidized LDL + Macrophages
→ Foam Cells
→ Fatty Streak

Other Growth Factors

http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2032127/
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC295745/
How Inflammation Attacks the Heart

1. LDL Oxidized
   Oxidized LDL cholesterol creates the “injury” by burrowing into the artery wall. Cigarette smoking, high blood pressure, and high blood sugar make the injury worse.

2. Monocytes Migrate
   In response to the injury, the immune system sends in a team of inflammatory cells, including white blood cells called monocytes.

3. Monocytes → Macrophages
   Monocytes migrate into the artery wall, where they turn into macrophages. The macrophages’ job: gobble up the LDL cholesterol.

4. Fatty Streak
   The macrophages, now stuffed with LDL cholesterol, form a “fatty streak” in the artery wall.

5. Fibrous Plaque
   Over the decades, more cholesterol, connective and elastic tissue, calcium, and cell debris accumulate and turn the fatty streak into plaque. As the artery tries to heal itself, smooth muscle cells migrate in to cover the plaque, forming a fibrous cap around it.

6. Cap Breakdown
   Macrophages kill the smooth muscle cells and release enzymes that break down the fibrous cap.

7. Cap Rupture
   The cap ruptures.

8. Clot Formation
   When a clot forms around the rupture, blood flow is blocked, which triggers a heart attack. (If the blocked artery feeds the brain, the blockage triggers a stroke.)
Brain Basics

Plaques and tangles. Those are the classic hallmarks of Alzheimer's disease.

The plaques are clumps of a protein fragment called beta-amyloid. The tangles are clusters of misshapen “tau” proteins that show up later in the disease.

But plaques and tangles alone don’t explain what happens to many aging brains. “Thirty percent of people over the age of 70 have elevated beta-amyloid and are cognitively normal,” says David Knopman, professor of neurology at the Mayo Clinic in Minnesota.

Scientists aren’t sure why. “The most prevalent idea is that amyloid deposits are only the initiating step often assume that it’s just Alzheimer’s,” notes Reed. “But it’s uncommon to find people with dementia who just have a single pathology. Very often, it’s mixed pathology.”

The most common other problem: damaged blood vessels in the brain.1,2 “The arteries become stiffened, narrowed, and sort of tortuous,” says Reed. “It’s much harder for the blood flow to occur normally.”

That can lead to a stroke that’s obvious, or to one that’s never noticed. “Around

"In fact, some of the symptoms we think of as normal brain aging may be due to injury to the brain's blood vessels,” he notes. Researchers know the major threats. "The big risks for vascular brain injury are smoking, high blood pressure, and diabetes," says Reed.

The causes of Alzheimer's pathology are more murky. But new evidence suggests that insulin may play a role.

Here’s how to keep your brain in good working order.

1. Watch your blood pressure

"There’s a wealth of evidence that high blood pressure is a risk factor for late-life cognitive impairment," says Knopman.
Middle Cerebral Artery Branches

Cerebral vasculature! Oh my!

The Window to the CV System?
Renal Vasculature

Guiding catheter in proper position → Balloon catheter approaching site of blockage → Balloon catheter advanced to middle of blockage → Balloon inflated → then deflated; blockage reduced

CABG = Coronary Artery Bypass Graft

Double?
Triple?
Quadruple?
Quintuple?

SI Fox 2013 fig 14.19
Procedures and heart attack deaths
Per 10,000 population

Angioplasties

Bypasses

Heart attack deaths

As noninvasive techniques improve, the rate for bypass surgery goes down.

Sources: Thomas Thom, National Heart, Lung, and Blood Institute; Gautam Gowrisankaran, Washington University in St. Louis; Salim Yusuf, McMaster University, the INTERHEART Study
CardioWest artificial heart = $106,000!
3000 await transplants, but only 2100
donors are available…
Discussion

Comments

Q?