I. **Announcements**

Next Tues HR & BP Lab 4 + Required Notebook Check. Turn in today? Next Thurs Blood Chemistry Lab 5. Please read Lab 5 twice < Thurs. Thanks!

II. **Cardiovascular System**

LS 2012 ch 9, Torstar Books 1984, DC 2013 Module 4, Guyton & Hall (G&H) 2011 +...

A. Circulatory vs Cardiovascular (CV)? cf + parts
   LS pp 229, CV vs Lymphatic, DC pp 23, 31

B. CV Pulmonary & Systemic circuits
   DC fig 4-1 p 24, LS fig 9-2b p 231

C. Arteries, capillaries, veins G&H + Torstar

D. Varicose veins? Phlebitis? DC

E. ♥ layers, box, chambers, valves, inlets, outlets
   LS fig 9-4 p 233, fig 9-2a p 231; DC pp 23-6

F. Normal vs abnormal blood flow thru ♥ & CV system
   Billy has a hole in his ♥ SI Fox 2009 fig 13.16, 13.17

III. **Comments on Midterm & Tests Returned?**

... Have a Safe, Happy 4th of July!!
Cardiovascular (CV) = Heart + Vessels + Blood!
NB: Figure-8 loop

Pulmonary

8

Systemic

Capillary beds of lungs where gas exchange occurs

Pulmonary arteries

Pulmonary veins

Vena cavae

Aorta and branches

Right ventricle

Left ventricle

Arterioles

Capillary beds of all body tissues where gas exchange occurs

Venes

Oxygen-poor, CO₂-rich blood

Oxygen-rich, CO₂-poor blood

D Chiras 2013 fig 4-1b
Dual Pump Action & Parallel Circulation

[Diagram of Dual Pump Action & Parallel Circulation]
Lymphatic System

1. Lymph Nodes
2. Vessels
3. Lymph

No pump!
Lymphatic System Blockage in Elephantiasis from Mosquito-borne Parasitic Filaria Worm
Microcirculation Exchange: 10 Billion Capillaries!

No cell > 25-50 μ away from a capillary! Like having bus stops @ every other block!

Guyton & Hall 2011 fig 1-2
Human \( \heartsuit = 4 \)-chambered box? 2 separate pumps?

Upper = Atria

Lower = Ventricles

Pulmonary

Systemic

RA

LA

RV

LV

Primer Pumps

Power Pumps

R \hspace{1cm} L
Human \( \heartsuit \) = 4 unique valves?  
2 valve sets?

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

1. Pulmonic/Pulmonary  
2. Aortic

**AV** = *Atrioventricular*

3.  \( \text{R} \) AV = Tricuspid  
4.  \( \text{L} \) AV = Mitral/Bicuspid
Veins ➔ Atria ➔ Ventricles ➔ Arteries

http://www.nhlbi.nih.gov/health/health-topics/topics/hhw/contraction.html
BI 121 Lecture 9

I. **Announcements** Lab notebook due today! Lab 4 HR & BP.
Thursday, Lab 5 Blood Chemistry. Read 2x pp 5-1 thru 5-6. Q?

II. **Overview of Labs** HR & BP. ♥Cycle. Blood chem lab review

III. **Cardiovascular Connections** LS 2012 ch 9
A. Normal vs abnormal blood flow!
B. ♥‘s electrical highway + Pacemaker activity
   LS fig 9-7 p 235, tab 9-1 p 236, fig 9-8 p 237

IV. **CV Physiology in the News** Randy Foye, NBA player with
   Situs Inversus? 1:10,000! NHLBI & AHA websites
   Nicole Kidman & exercise? ACSM, AHA, CDC guidelines

V. **CV Pathophysiology & Risk Reduction** LS ch 9, 10 +...
A. AMI, CVA, CVD, PVD, TIA, HTN? + surgical treatments
B. Atherosclerosis? LS fig 9-27, 9-25, 9-26 pp 266-8
C. How to minimize risk of CVDs? Treatment triad:
   Exercise, Diet, Drugs + Surgery
D. Food choices make a difference?
   What’s HAPOC?
Cardiac Cycle

**Systole**
- Contract
- & Empty

**Diastole**
- Relax
- & Fill

![Diagram](image-url)
Patent or still open!

SI Fox 2009 fig 13.17 p 420
Heart's Electrical Highway!

- Interatrial pathway
- Sinoatrial (SA) node
- Right atrium
- Internodal pathway
- Atrioventricular (AV) node
- Left atrium
- Left branch of bundle of His
- Right ventricle
- Left ventricle
- Right branch of bundle of His
- Purkinje fibers

LS 2012 fig 9-7a p 235
Normal (A) vs Situs Inversus (B): 1:10,000 live births!

Randy Foye, NBA Player & Situs Inversus!

http://www.pbs.org/program/nine-months-that-made-you/
Guidelines: Healthy Adults < 65 yr

Do moderately intense aerobic exercise
30 min/d, 5 d/wk

OR

Do vigorously intense aerobic exercise
20 min/d, 3 d/wk

AND

Do 8-10 strength-training exercises
8-12 repetitions/each exercise, 2 d/wk
**FIGURE 9-35**

Extent of myocardial damage as a function of the size of the occluded vessel.
I. **Announcements** Remember to read Lab 5 before Thursday. Thanks for helping us be well-prepared. Q from last time? Calculating grade from estimated final. Keys to success? Q?

II. **CVDs Prevention & Treatment** Exercise, dietary modifications anti-inflammatory oils? PTCA, CABG, ... Torstar, S&W ch 5+...

III. **Blood Form & Function** LS ch 11 pp 296-304, 309-12
DC Module 5 + SI Fox + *National Geographic* Lennart Nilsson
A. Formed vs. nonformed/cells vs. plasma fig+tab 11-1
B. **Red blood cells/erythrocytes:** \(O_2\)-carrying sickle cells, ABO blood typing, Rh factor pp 299-304.
C. **White blood cells/leukocytes:** Defense/immunity differential + general functions pp 309-12
D. **Platelets/thrombocytes:** Initial clotting p 304

IV. **Blood Glucose & Diabetes Mellitus** LS ch 17, DC Module 13
Treatment Triad

**NB:** Last blasted resort!!

- **Drugs/Surgery**
- **Exercise**
- **Dietary Modification**
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
**Apple** type of obesity predisposed to CVD!

*Pear* type of fat pattern...

implies lower disease risk!

Eat more apples... to help prevent the *apple* type of obesity!
HEALTH-RELATED FITNESS

Cardiorespiratory Endurance

Muscular Strength/Endurance

Flexibility

Neuromuscular Relaxation
Pick an abundance of whole grains, legumes, nuts, vegetables & fruits!
Healthy Oils to Minimize Atherosclerosis

HAPOC?
Fish Oil Intakes & Cardiovascular Death Rates

![Bar chart showing cardiovascular deaths per 100,000 population for Ireland, USA, France, and Japan. Ireland has the lowest rate at 0.09%, followed by USA at 0.13%, France at 0.14%, and Japan at 0.37%.]
What's in Blood? Plasma & Blood Cells

- Plasma (55% of whole blood)
- Buffy coat: platelets and leukocytes (<1% of whole blood)
- Erythrocytes (45% of whole blood)
- Platelets
- Leukocytes (white blood cells)
- Erythrocytes (red blood cells)
A & B Antigens
(Agglutinogens)
Erythroblastosis Fetalis?

eg, Rh- mom Rh+ baby

What a difference one amino acid can make!

Amino acid sequence of normal hemoglobin:
Val → His → Leu → Thr → Pro → Glu → Glu

Amino acid sequence of sickle-cell hemoglobin:
Val → His → Leu → Thr → Pro → Val → Glu
Diabetic & Normal Response to Glucose Load

Blood glucose level (mg/100 ml) vs. Hours

- Diabetes
- Normal

Guyton & Hall 2000
I. **Lab 5 Review: Safety & Techniques** Q?

II. **Introduction to Endocrinology** LS ch 17, DC Module 13, SI Fox+
   A. Endocrine vignette: Cushing's syndrome LS fig17-20 p 521-2
   B. Endocrine system DC p 103 fig 13-1, LS fig 17-1, tab 17-1
   C. What’s an endocrine? + classes ~ LS pp 495 – 6
   D. Hypothalamus (Master) – Pituitary (subcontroller) DC pp 104-6 + LS pp 499-506
   E. Posterior pituitary + hormones DC p 108, LS fig 17-4 p 502
   F. Anterior pituitary + hormones DC pp 105-7, LS pp 502-6
   H. Peripheral endocrine organs DC pp 109-13, LS pp 513-36
      1. Pancreas (insulin, glucagon, diabetes) 2. Thyroid 3. Adrenals

III. **Nervous System & Excitable Cell Connections** LS ch 5, 4, 7
   A. How is the nervous system organized? fig 5-1 p 108
   B. Neurons? What kind? fig 5-2 p 109
   C. Brain structure & function fig 5-7, 5-8 pp 116 - 7
   D. **Protect your head with a helmet!** Bicycle head injury statistics, *NHTSA & BHSI*
No food, drink or gum in lab today! Thanks sincerely!

...Healthy, tasty & fresh, but not in lab!!
Glucose: Sugar in Blood

Normal: 70-99
Pre-Diabetes: 100-125
Diabetes: ≥ 126 mg/dL
Cushing’s Syndrome = Hypersecretion of Cortisol: Hypothalamic (CRH), Pituitary (ACTH), or Adrenal (Cortisol)
ANP = Atrial Natriuretic Polypeptide
Hormone/Endocrine Classifications

Exogenous

Endogenous
Nervous Connection!!

- Neurosecretory neurons
- Hypothalamic-posterior pituitary stalk
- Posterior pituitary

Systemic arterial inflow
Systemic venous outflow

• = Vasopressin
• = Oxytocin

LS 2007
Hypothalamus-Anterior Pituitary Vascular Connection!

Vascular Connection!!

- Neurosecretory neuron
- Systemic arterial inflow
- Hypothalamic-hypophyseal portal system
- Anterior pituitary
- Posterior pituitary

Systemic venous outflow

• = Hypophysiotropic hormones
• = Anterior pituitary hormone

LS 2007
Pituitary Nourishing or Growth Hormones

Hypophysis = Pituitary

RH + or RIH -
Releasing or Release-Inhibiting Hormones

Systemic arterial inflow

Hypothalamic-hypophyseal portal system

Neurosecretory neuron

Systemic venous outflow

• = Hypophysiotropic hormones
• = Anterior pituitary hormone

LS 2007
Growth Hormone = Somatotrophic Hormone
Body Builder’s Dream?
Increase GH naturally with exercise & sleep!!

![Graph showing growth hormone levels over time with peaks associated with strenuous exercise and sleep.]

**Growth hormone (ng/ml plasma)**

**Time of day**

ng/ml = nanograms per milliliter
**Times of Plenty!!**

**NB:** Diabetics have problems either here or here.

Cellular uptake and utilization of glucose

Fox 1987
### Warning Signs of Diabetes

These signs appear reliably in type 1 diabetes and, often, in the later stages of type 2 diabetes.

<table>
<thead>
<tr>
<th>Warning Sign</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excessive urination and thirst</td>
</tr>
<tr>
<td>Glucose in the urine</td>
</tr>
<tr>
<td>Weight loss with nausea, easy tiring, weakness, or irritability</td>
</tr>
<tr>
<td>Cravings for food, especially for sweets</td>
</tr>
<tr>
<td>Frequent infections of the skin, gums, vagina, or urinary tract</td>
</tr>
<tr>
<td>Vision disturbances; blurred vision</td>
</tr>
<tr>
<td>Pain in the legs, feet, or fingers</td>
</tr>
<tr>
<td>Slow healing of cuts and bruises</td>
</tr>
<tr>
<td>Itching</td>
</tr>
<tr>
<td>Drowsiness</td>
</tr>
<tr>
<td>Abnormally high glucose in the blood</td>
</tr>
</tbody>
</table>
Like others, diabetics benefit from whole grains, vegetables, fruits, legumes & non-/low-fat milk products!
Central nervous system (CNS)

Input to CNS from periphery

Brain and spinal cord

Output from CNS to periphery

Peripheral nervous system (PNS)

Afferent division

Sensory stimuli

Visceral stimuli

Efferent division

Somatic nervous system

Motor neurons

Skeletal muscles

Smooth muscle
Cardiac muscle
Exocrine glands
Some endocrine glands

Autonomic nervous system

Sympathetic nervous system

Parasympathetic nervous system

Enteric nervous system

Stimuli in digestive tract

Enteric organs only

KEY

Central nervous system

Peripheral nervous system

Afferent division of PNS

Efferent division of PNS

Somatic nervous system

Autonomic nervous system

Enteric nervous system

Effector organs
(made up of muscle and gland tissue)

LS 2012 fig 5-1
~99% of all neurons in humans! CNS ~100 billion interneurons!!
Thanks for your help with the blood chemistry lab!

I. **Announcements** Optional notebook check + Lab 6 tomorrow. Pulmonary Function Testing. Final exam > your Q on Wed. Q?

II. **Brain + Autonomic Nervous System Overview** DC pp 71-77, LS pp 178 – 85, tab 7-1 p 183 + stories to remember *fight-or-flight!*

III. **Neuromuscular Connections** LS ch 7 pp 186-92, DC pp 69-71 How does the signal cross the nerve-muscle gap? LS fig 7-5
   A. Normal function? Ca2+ for bones!…but what else? LS p 190
   B. What do black widow spider venom, botulism, curare & nerve gas have in common? Botox? LS p 189-91

IV. **Muscle Structure, Function & Adaptation** LS ch 8, DC Module 12
   A. Muscle types: cardiac, smooth, skeletal LS fig 8-1 p 194-6
   B. How is skeletal muscle organized? LS fig 8-2, DC fig 12-2
   C. What do thick filaments look like? LS fig 8-2, DC fig 12-4
   D. How about thin filaments? LS fig 8-5
   E. Banding pattern? LS fig 8-3, fig 8-7
   F. How do muscles contract? LS fig 8-6, 8-10
   G. What's a cross-bridge cycle? LS fig 8-11 +…
   H. Summary of skeletal muscle contraction
   I. Exercise adaptation variables: *mode, intensity, duration, frequency, distribution, individual* & environmental char…?
   J. Endurance vs. strength training continuum? fiber types…
**Motor**

- M. Supplementary motor area (on inner surface—not visible; programming of complex movements)
- M. Premotor cortex (coordination of complex movements)

**Sensory**

- S. Primary sensory cortex (sensation)

**Key**

- M. Motor cortex
- A. Association cortex
- S. Sensory cortex

**Labels**

- A. Prefrontal association cortex (planning for voluntary activity; decision making; personality traits)
- A. Wernicke's area (speech understanding)
- A. Parietal-temporal-occipital association cortex (integration of all sensory input; important in language)

- M. Broca's area (speech formation)
- S. Primary visual cortex surrounded by higher-order visual cortex (sight)
- S. Primary auditory cortex surrounded by higher-order auditory cortex (hearing)
- A. Limbic association cortex (mostly on inner and bottom surface of temporal lobe; motivation and emotion; memory)

*LS 2006, cf: LS 2012 fig 5-8a*
Helmets Cheap, Brains Expensive!!
Use Your Head, Get a Helmet!!

http://www.bhsi.org/stats.htm

~ 500,000 bicyclists/yr visit emergency rooms
As of 2014, the population estimate of
State of Wyoming 584,153
Albany OR 51,980
Corvallis OR 54,953
Springfield OR 60,263

~ 26,000 traumatic brain injuries
743 of ~900 cyclist deaths, 2013 ≡ ~2% of all traffic fatalities
13% of deaths children ≤ 14 yr, 87% σ
11% involved wrong-way riding!

Bicycle crashes & injuries are under reported,
since majority not serious enough for ER visits.

Helmets may reduce head & brain injury risk by 85%!

~$2.3 billion/yr = indirect injury costs from not using helmets!
The "typical" bicyclist killed on our roads is a sober male over 16 riding without a helmet. He's hit by a car on a major road between intersections in an urban area on a summer evening. Please wear a helmet – it can make the difference between life and death.
Homeostasis is a **dynamic balance** between the autonomic branches.

- **Parasympathetic** (Rest-and-digest): Parasympathetic activity dominates.
- **Sympathetic** (Fight-or-flight): Sympathetic activity dominates.
Table 7-1  Effects of Autonomic Nervous System on Various Organs

<table>
<thead>
<tr>
<th>Organ</th>
<th>Effect of Sympathetic Stimulation</th>
<th>Effect of Parasympathetic Stimulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart</td>
<td>Increases heart rate and increases force of contraction of the whole heart</td>
<td>Decreases heart rate and decreases force of contraction of the atria only</td>
</tr>
<tr>
<td>Blood Vessels</td>
<td>Constricts</td>
<td>Dilates vessels supplying the penis and the clitoris only</td>
</tr>
<tr>
<td>Lungs</td>
<td>Dilates the bronchioles (airways)</td>
<td>Constricts the bronchioles</td>
</tr>
<tr>
<td>Digestive Tract</td>
<td>Decreases motility (movement)</td>
<td>Increases motility</td>
</tr>
<tr>
<td></td>
<td>Contracts sphincters (to prevent forward movement of tract contents)</td>
<td>Relaxes sphincters (to permit forward movement of tract contents)</td>
</tr>
<tr>
<td></td>
<td>Inhibits digestive secretions</td>
<td>Stimulates digestive secretions</td>
</tr>
<tr>
<td>Urinary Bladder</td>
<td>Relaxes</td>
<td>Contracts (emptying)</td>
</tr>
<tr>
<td>Eye</td>
<td>Dilates the pupil</td>
<td>Constricts the pupil</td>
</tr>
<tr>
<td></td>
<td>Adjusts the eye for far vision</td>
<td>Adjusts the eye for near vision</td>
</tr>
<tr>
<td>Liver (glycogen stores)</td>
<td>Glycogenolysis (glucose is released)</td>
<td>None</td>
</tr>
<tr>
<td>Adipose Cells (fat stores)</td>
<td>Lipolysis (fatty acids are released)</td>
<td>None</td>
</tr>
<tr>
<td>Exocrine Glands</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exocrine pancreas</td>
<td>Inhibits pancreatic exocrine secretion</td>
<td>Stimulates pancreatic exocrine secretion (important for digestion)</td>
</tr>
<tr>
<td>Sweat glands</td>
<td>Stimulates secretion by sweat glands important in cooling the body</td>
<td>Stimulates secretion by specialized sweat glands in the armpits and genital area</td>
</tr>
<tr>
<td>Salivary glands</td>
<td>Stimulates a small volume of thick saliva rich in mucus</td>
<td>Stimulates a large volume of watery saliva rich in enzymes</td>
</tr>
<tr>
<td>Endocrine Glands</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adrenal medulla</td>
<td>Stimulates epinephrine and norepinephrine secretion</td>
<td>None</td>
</tr>
<tr>
<td>Endocrine pancreas</td>
<td>Inhibits insulin secretion</td>
<td>Stimulates insulin secretion</td>
</tr>
<tr>
<td>Genitals</td>
<td>Controls ejaculation (males) and orgasm contractions (both sexes)</td>
<td>Controls erection (penis in males and clitoris in females)</td>
</tr>
<tr>
<td>Brain Activity</td>
<td>Increases alertness</td>
<td>None</td>
</tr>
</tbody>
</table>
Muscle fiber or cylindrical cell

“Threads” ≡ Myofibrils

Nuclei

Dark-Light...bands ≡ Overlapping thick & thin filaments

x1000
Sarcomere

Z line

H zone

I band

A band

Z line

Relaxed

H zone shorter

I band shorter

A band same width

Contracted

Sarcomere shorter

Thick filament

Thin filament
1. Acetylcholine released by axon of motor neuron crosses cleft and binds to receptors/ channels on motor end plate.

2. Action potential generated in response to binding of acetylcholine and subsequent end plate potential is propagated across surface membrane and down T tubules of muscle cell.

3. Action potential in T tubule triggers Ca\(^{2+}\) release from sarcoplasmic reticulum.

4. Calcium ions released from lateral sacs bind to troponin on actin filaments; leads to troponin being physically moved aside to uncover cross-bridge binding sites on actin.

5. Myosin cross bridges attach to actin and bend, pulling actin filaments toward center of sarcomere; powered by energy provided by ATP.

6. Ca\(^{2+}\) actively taken up by sarcoplasmic reticulum when there is no longer local action potential.

7. With Ca\(^{2+}\) no longer bound to troponin, troponyosin slips back to its blocking position over binding sites on actin; contraction ends; actin passively slides back to original resting position.

LS 2006 cf: LS 2012 fig 8-10
## Characteristics of Skeletal Muscle Fibers

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Slow Oxidative (Type I)</th>
<th>Fast Oxidative (Type Ila)</th>
<th>Fast Glycolytic (Type IIb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Myosin-ATPase Activity</td>
<td>Low</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Speed of Contraction</td>
<td>Slow</td>
<td>Fast</td>
<td>Fast</td>
</tr>
<tr>
<td>Resistance to Fatigue</td>
<td>High</td>
<td>Intermediate</td>
<td>Low</td>
</tr>
<tr>
<td>Aerobic Capacity</td>
<td>High</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Anaerobic Capacity</td>
<td>Low</td>
<td>Intermediate</td>
<td>High</td>
</tr>
<tr>
<td>Mitochondria</td>
<td>Many</td>
<td>Many</td>
<td>Few</td>
</tr>
<tr>
<td>Capillaries</td>
<td>Many</td>
<td>Many</td>
<td>Few</td>
</tr>
<tr>
<td>Myoglobin Content</td>
<td>High</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Color of Fibers</td>
<td>Red</td>
<td>Red</td>
<td>White</td>
</tr>
<tr>
<td>Glycogen Content</td>
<td>Low</td>
<td>Intermediate</td>
<td>High</td>
</tr>
</tbody>
</table>
AEROBIC

w/O₂

ANAEROBIC

MITOCHONDRIA

CYTOSOL

Glycolysis

Immediate/ATP-PC
Changes in Muscle Due to **Strength Training**

↑ Size of larger fast vs smaller slow fibers
↑ CP as well as creatine phosphokinase (CPK) which enhances short-term power output
↑ Key enzymes which help store and dissolve sugar including glycogen phosphorylase (GPP) & phosphofructokinase (PFK)
↓ Mitochondrial # relative to muscle tissue
↓ Vascularization relative to muscle tissue
↑ Splitting of fast fibers? Hyperplasia?
With growth hormone (GH), androgenic-anabolic steroids (AAS)?
Changes in Muscle Due to Endurance Training

- ↑ Mitochondria, # & size
- ↑ Mitochondrial (aerobic) enzymes including those specific for fat burning
- ↑ Vascularization of muscles (better blood flow)
- ↑ Stores of fat in muscles accompanied by
- ↓ Triglycerides/fats in bloodstream
- ↑ Enzymes: activation, transport, breakdown (β-oxidation) of fatty acids
- ↑ Myoglobin (enhances O₂ transport)
- ↑ Resting energy levels which inhibit sugar breakdown
- ↑ Aerobic capacity of all three fiber types.
I. **Announcements**  Optional notebook check today. Discussion-Review followed by final exam tomorrow. Q?

II. **Introduction to PFT Lab 6**  Pulmonary Function Testing

III. **Respiratory System**  LS ch 12, DC Module 7, SI Fox +...
   A. Steps of respiration? External vs. cellular/internal?
      LS fig 12-1 pp 345-7
   B. Respiratory system anatomy LS fig 12-2 p347, DC, SI Fox +...
   C. Histology LS fig 12-4 pp 347-9, DC
   D. How do we breathe? LS fig12-12, fig12-25 pp 349-56, 373-8
   E. Gas exchange LS fig 12-19 pp 362-5
   F. Gas transport LS tab 12-3 pp 365-70

IV. **Physiology of Cigarette Smoking**
   A. ANS, autonomic nerves & nicotine? Route of chemicals,...
   B. Emphysema? 2nd-hand smoke?... p 356, 365
   C. UO Smoke-Free since Fall 2012! Help is available!
Spirogram graphing complete *PFT* from computer simulation.

Normal Spirogram of Healthy Young Adult Male

- **TV** = Tidal volume (500 ml)
- **IRV** = Inspiratory reserve volume (3,000 ml)
- **IC** = Inspiratory capacity (3,500 ml)
- **ERV** = Expiratory reserve volume (1,000 ml)
- **RV** = Residual volume (1,200 ml)
- **FRC** = Functional residual capacity (2,200 ml)
- **VC** = Vital capacity (4,500 ml)
- **TLC** = Total lung capacity (5,700 ml)
Lombo’s simplified steps!

1. Breathe in & out!

2. Cross membranes!

3. Move with blood!
   Go with the flow!

4. Cross membranes!

---

**Steps of External Respiration**

1. Ventilation or gas exchange between the atmosphere and air sacs (alveoli) in the lungs.

2. Exchange of O₂ and CO₂ between air in the alveoli and the blood in the pulmonary capillaries.

3. Transport of O₂ and CO₂ by the blood between the lungs and the tissues.

4. Exchange of O₂ and CO₂ between the blood in the systemic capillaries and the tissue cells.

---

*LS 2012 fig 12-1 modified*
**Respiratory System Anatomy**

**NB:** *In vivo*, Cupola or peak of each lung goes into neck > clavicle line!
No Gas Exchange

1st alveolar outpouching!

Gas Exchange
Inhale (active)

Contract & flatten diaphragm

Exhale (passive @ rest)

Relax & pouch up diaphragm!
Brain stem = Control Center for automatic breathing!
**Respiratory membrane** separates air from blood, is 6 layers, yet 1/50th thickness of tracing paper!
Gas Exchange

**Across pulmonary capillaries:**
O₂ partial pressure gradient from alveoli to blood = 60 mm Hg (100 → 40)
CO₂ partial pressure gradient from blood to alveoli = 6 mm Hg (46 → 40)

**Across systemic capillaries:**
O₂ partial pressure gradient from blood to tissue cell = 60 mm Hg (100 → 40)
CO₂ partial pressure gradient from tissue cell to blood = 6 mm Hg (46 → 40)

Numbers are mm Hg pressure.

cf: LS 2012 fig 12-19
$O_2$ is carried mainly by red blood cell hemoglobin!
American Cancer Society Great American Smoke Out!

Help create a world with less cancer and more birthdays.

http://www.cancer.org/healthy/stayawayfromtobacco/greatamericansmokeout/
Cigarette Smoking: #1 Preventable Cause of Premature Death in the US

CARDIOVASCULAR MORTALITY (average annual incidence per 1,000)

- None: 7
- Less than 20: 8.4
- More than 20: 10.2
- Quit One Year: 12.4

CIGARETTES SMOKED PER DAY
Not only the Lungs, but the Heart, Brain & 100s of Other Tissues & Organs Adversely Affected!

Tobacco smoke = Deadly mix of > 7000 chemicals!

http://www.cdc.gov/tobacco/data_statistics/sgr/50th-anniversary/index.htm#fact-sheets
Ach = Acetylcholine

Parasympathetic

Ach = Acetylcholine

Nicotinic Receptor
Muscarinic Receptor

Sympathetic

NE = Norepinephrine

α Receptor (α₁, α₂)
β Receptor (β₁, β₂)
Cigarettes ≡ Patient-Assisted Drug-Delivery System
Inhaling Bypasses the Systemic Circulation
& Is Powerfully Reinforcing!
Tracing the Route of Cigarette Smoke
Puff to Brain Time 5 to 8 seconds!!

Mouth → Pharynx → Larynx → Trachea → Bronchi → Bronchioles → Alveoli → Blood → Pulmonary Veins → Left Atrium → Left Ventricle → Aorta → Heart → Brain

Systemic Circulation
Respiratory Membrane
Cigarette smoking is the most important preventable cause of premature death in the U.S. accounting for 443,000 annual deaths.

http://www.cdc.gov/tobacco/data_statistics/fact_sheets/health_effects/tobacco_related_mortality/#cigs
Cigarette smoking causes 87% of lung cancer deaths and is responsible for most cancers of the larynx, oral cavity & pharynx, esophagus, & bladder.
Emphysema ≡ Corrosion of Alveolar Walls with ↓ SA & Labored Breathing
Why you have to tell your gynecologist you smoke. Even if it’s only at parties.

On the Pill & Smoke?

Increased Risk of:

1. Blood Clots
2. Heart Attack
3. Strokes!

You figure an occasional cigarette can’t hurt, and you really don’t want to listen to the “stop smoking” lecture from your doctor. But if you want any type of hormonal birth control, smoking is a vitally important issue.

Hormonal birth control is a prescription drug, and while the risks are rare, they can be serious, and smoking, even a little, increases the risks, especially if you’re over 35.

Risks include blood clots, stroke, and heart attack. If you have a history of these conditions or certain cancers, you shouldn’t use hormonal birth control.

Of course, you should tell your healthcare professional if you could be pregnant, and because hormonal birth control doesn’t protect against HIV or sexually transmitted diseases, learn how to stay safe and healthy.

Hormonal birth control has been used safely by millions of women for 45 years, and is 99.9% effective when used correctly. It could be a good choice for you. To find out, talk to your healthcare professional. And to help you get started, there’s a list of questions to ask at www.orthowomenshealth.com

Be smart about your body.
Be smart about your birth control.

THREE STRIKES AND YOU’RE OUT!
... a promise to Kimber

By Mike Reynolds & Bill Innes

With Dan Evans
Breathing 2nd-hand smoke for as little as ½ hr activates platelets almost as much as if you were a pack-a-day smoker.
2nd-hand smoke is the 3rd leading preventable cause of death in the US!

"Mind if I smoke?"

"Care if I die?"

Each year ~45,000 Americans die due to 2nd-hand smoke exposure!
Health risks of e-cigarettes emerge

Vaping pollutes lungs with toxic chemicals and may even make antibiotic-resistant bacteria harder to kill

By JANET RALOFF 4:31PM, JUNE 3, 2014

https://www.sciencenews.org/article/health-risks-e-cigarettes-emerge
SMOKING $\equiv$ ASTHMA?

Bronchiole
- Tightened muscle
- Alveoli filled with trapped air

Bronchoconstriction
During an asthma attack, bands of muscles surrounding the bronchial tubes contract, causing the airway to narrow.

Bronchus
- Cartilage
- Mucous gland
- Airway
- Muscle Layer

Normal

Asthma Triggers
- Allergens
- Drugs
- Exercise
- Occupational stimuli
- Infections
- Environmental changes
- Air pollutants
- Chemical irritants
- Emotions
- Weather/Temps.
- Food additives

Inflammation
- Reduced airway opening
- Excess mucus
- Muscle layer contracts

Petri-dish Effect

Ugh!!
Cough!!!
Ammonia converts nicotine, the addictive agent in tobacco, into a more volatile form, Pankow said. “Ammonia is the thing that helps tobacco companies hook the smoker by providing a means of delivering the nicotine.”

Last October a former tobacco industry employee revealed that secret industry documents indicated that ammonia was added to tobacco to double the impact of nicotine. The Oregon Graduate Institute study confirms the contention that...
Nicotine Addiction & Help Quitting Smoking
http://www.cancer.org/healthy/stayawayfromtobacco/guide
toquittingsmoking/guide-to-quitting-smoking-help-phys-nrt

2nd-Hand Smoke or ETS & 3rd-Hand Smoke?
http://www.cancer.org/cancer/cancercauses/tobaccocancer/
secondhand-smoke

2nd-Hand Smoke Addictive?
%20smoke%20addictive