I. **Announcements**: No lab today! Break for exam week! Next R Blood Chemistry. Thanks sincerely for helping us optimize safety by reading ≥ 2x Lab 5, LM pp 5-1 to 5-6.

II. **Blood Form & Function** LS ch 11, DC Module 5 pp 35-9
   A. Formed vs Nonformed/cells vs plasma fig+tab 11-1
      Cell origin - bone marrow. What’s in plasma? p 316
   B. Red blood cells/erythrocytes: O₂ carrying pp 317-8
      Normal flexible vs fragile sickle cell fig 11-5 p 320
   C. White blood cells/leukocytes: defense/immunity
differential + general functions pp 326-30 fig 11-1
   D. Platelets/thrombocytes: clotting pp 321-2 fig 11-6

III. **Blood Chemistry Lab: Basics** LM + LS ch 11 & 17
   A. What’s blood typing? ABo System ch 11 LS pp 341- 4
      Rhesus factor? Erythroblastosis fetalis? LS p 343
   B. **Physiology in the News**: Eat right for your type?
   C. What’s blood glucose? Diabetes? LS ch 17 pp 560- 73
   D. Questions about blood chem lab?

IV. **Exam Comments + Return**

*We survived the exam! Happy Halloween!! Remember nutrient ρ & have safe fun!*
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)
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
A & B Antigens
(Agglutinogens)
I. **Announcements** To make Lab 5 educational, fun & safe for all, please read pp 5-1 thru 5-6 in LM twice before Thursday! Remaining exams & notebooks returned > lecture. Key posted in glass box in Huestis near 120 HUE. Estimate grade? Q?

II. **Blood Chemistry Connections** LS ch 11 p 303, ch 17 pp 525-36 Erythroblastosis fetalis, diabetes, insulin, glucagon

III. **Endocrinology Overview** LS ch 17, DC Module 13, SI Fox+

A. Vignette: Cushing's syndrome LS fig 17-20 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 see-saw!) 2. Thyroid 3. Adrenals...This Thursday more fun & data about me! Heck yeah!!
Erythroblastosis Fetalis or Hemolytic Disease of the Unborn/Newborn

Throw Blanket Over This Step!

(a) First pregnancy

Rh⁻ mother

Placenta

First Rh⁺ fetus

Rh⁺ antigens

(c) Second pregnancy

Second Rh⁺ fetus
Inject Mom with RhoGam $\leq 48-72$ hr > each Rh+ Pregnancy

The Blanket is RhoGam $\rightarrow$ Masks the Mom’s Immune System!
Diabetic & Normal Response to Glucose Load
Glucose: Sugar in Blood

Normal: 70-99

Pre-Diabetes: 100-125

Diabetes: ≥ 126 mg/dL
NB: Diabetics have problems either here or here.
### Table 4–9

**Warning Signs of Diabetes**

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

- Excessive urination and thirst
- Glucose in the urine
- Weight loss with nausea, easy tiring, weakness, or irritability
- Cravings for food, especially for sweets
- Frequent infections of the skin, gums, vagina, or urinary tract
- Vision disturbances; blurred vision
- Pain in the legs, feet, or fingers
- Slow healing of cuts and bruises
- Itching
- Drowsiness
- Abnormally high glucose in the blood
Diabetics must constantly juggle diet, exercise & medication to control blood glucose!
Exercise is a must based on its insulin-like effect!
Cushing’s Syndrome = Hypersecretion of Cortisol: Hypothalamic (CRH), Pituitary (ACTH), or Adrenal (Cortisol)

$T = 0$, near normal

$T = 4$ months later
ANP = Atrial Natriuretic Polypeptide
BI 121 Lecture 11

I. Announcements Blood Chem Lab today! Fun day!! Personal data!!! If you haven't already done so, please review Lab 5 in LM & in e-mail. Thanks sincerely! Lab Manual & Exam I Remaining Returns. Q from last t?

II. Safety & Techniques Review for Blood Chem Lab Q?

III. Endocrine Connections LS ch 17, DC Module 13, SI Fox +…
   A. Endocrine/hormone classes ~ LS pp 495 – 6
   B. Hypothalamus (Master) – Pituitary (subcontroller)
      DC pp 104-6 + LS pp 499-506
   C. Posterior pituitary+hormones DC p 108, LS fig 17-4 p 502
   D. Anterior pituitary hormones DC pp 105-7, LS pp 502-6
   E. Endocrine feedback + reflexes LS p 540 fig 17-7
   F. GH: Body builder's dream? Fountain of youth?
      LS pp 506-10, fig 17-10, 17-11
   G. Peripheral endocrine organs DC pp 109-13, LS pp 513-36
      1. Pancreas 2. Thyroid 3. Adrenals
No food, drink or gum in lab today! Thanks sincerely!

...Healthy, tasty & fresh, but not in lab!!
$1^0$ Q? Clumping in Any Wells?

Source: S Wong, BI 121 Lab, 2016
**Hormone/Endocrine Classifications?**

**Exogenous**

- Amino Acid/PP/Protein
- Steroid
- Thyroid

**Endogenous**

- Amino Acid/PP/Protein
- Steroid

- Thyroid

- Protein Synthesis
- Altered Functional Response
- Specific Receptor
- Hormonal Receptor Complex
- DNA
- mRNA
Hypothalamus & Pituitary: Intimate Relationship
Hypothalamus-Anterior Pituitary Vascular Connection!

Neurosecretory neuron

Systemic arterial inflow

Hypothalamic-hypophyseal portal system

Anterior pituitary

Systemic venous outflow

• = Hypophysiotropic hormones
• = Anterior pituitary hormone

LS 2007
Pituitary Nourishing or Growth Hormones

Hypophysis = Pituitary

- = Hypophysiotropic hormones
- = Anterior pituitary hormone

RH + or RIH -

Releasing or Release-Inhibiting Hormones
I. **Announcements** Thanks for your help with blood lab! Great job! No lab this week. Study for Exam II, Dec 7, Wed, 8 am!

II. **Endocrine Connections** GH + Peripheral Endocrine Organs DC Module 13 p 104-113, LS pp 506-25 fig 17-18, 17-19 +…

III. **Introduction to the Nervous System** LS ch 5, DC Module 9

A. How is the nervous system organized? LS fig 5-1 DC p 67
C. What’s myelin? How does it help? DC fig 9-3, LS pp 83-5
D. Brain structure & function DC fig 9-6 thru 9-10 pp 71-5 +…
E. Protect your head with a helmet! Bicycle head injury statistics, NHTSA & BHSI from 2013 & 2014

IV. **Autonomic Nervous System** LS ch 7 pp 178-85+…

A. Sympathetic vs Parasympathetic branches LS fig 7-3
B. Neurotransmitters & receptors LS fig 7-1 & 7-2, tab 7-2
C. Actions LS tab 7-1
D. Fight-or-flight stories!
GH/STH Effects: Insulin Resistance/Type II Diabetes?

↑ Amino Acid uptake & Protein synthesis

↑ Lipolysis & Fatty Acid mobilization

↓ Glucose uptake
   (skeletal muscle & adipocytes)

↑ Glucose production
   (liver glycogenolysis)

↑ Insulin secretion
Increase GH naturally with exercise & sleep!!

Growth hormone (ng/ml plasma)

Strenuous exercise

Time of day

Sleep

ng/ml = nanograms per milliliter
Endocrine Pancreas: Insulin (I) & Glucagon (G)
See-Saw Hormones in Regulating Blood Glucose

Duct cells secrete aqueous NaHCO₃ solution
Acinar cells secrete digestive enzymes

Exocrine portion of pancreas (Acinar and duct cells)

Hormones (insulin, glucagon)

Duodenum
Stomach
Blood

Endocrine portion of pancreas (Islets of Langerhans)

The glandular portions of the pancreas are grossly exaggerated.
Thyroid gland

- Right lobe
- Trachea
- Isthmus
- Left lobe

Larynx

DC 2003
FIGURE 13-12
Adrenal Gland  The adrenal glands sit atop the kidney and consist of an outer zone of cells, the adrenal cortex, which produces a variety of steroid hormones, and an inner zone, the adrenal medulla. The adrenal medulla produces adrenalin and noradrenalin.
~99% of all neurons in humans!
CNS ~100 billion interneurons!!
BI 121 Lecture 13

I. **Announcements**  No lab today – Study for Exam II!!
Optional Lab notebook check after last Lab 6, Mac pulmonary function testing (PFT) next Thursday. Q?

II. **CNS Connections**  Myelin, brain + spinal cord (CNS)
Protect your head with a helmet! Bicycle head injury statistics *NHTSA & BHSI*, 2014 data

III. **Peripheral Nervous System**  LS sections of ch 3, 4, & 7
A. Autonomic NS: Branches, neurotransmitters, receptors, actions, fight-or-flight stories ch 7 pp179-85
B. Why are nerve & muscle unique? ch 4 p 71
C. How do excitable cells signal? ch 3 pp62-7; ch 4 pp74-83
D. How does the signal cross the nerve-muscle gap?
   ch 7 p 185-92 fig 7-5 p 190
1. Ca2+ bones!…but what else? p 190
2. What do black widow spider venom, botulism, curare & nerve gas have in common? Botox pp 189-92
What is myelin? Why is it important?

Lipid insulative coat

↑ v, conserves ions & ATP
Saltatory/Leaping Conduction!
Crucial Sensory & Motor Nerves

L. saltare to hop or leap! Fr. salt, sautier, sauté, leap, high air, vault
M. Supplementary motor area (on inner surface—not visible; programming of complex movements)

M. Premotor cortex (coordination of complex movements)

A. Prefrontal association cortex (planning for voluntary activity; decision making; personality traits)

M. Broca’s area (speech formation)

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)

A. Posterior parietal cortex (integration of somatosensory and visual input; important for complex movements)

A. Wernicke’s area (speech understanding)

A. Parietal-temporal-occipital association cortex (integration of all sensory input; important in language)

S. Primary visual cortex surrounded by higher-order visual cortex (sight)

Key

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

LS 2006, cf: LS 2012 fig 5-8a
~ 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% ♂

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!
Hey, I’m alive because I wore a helmet!!
Autonomic Nervous System

Why overlap or dual innervation?

Fine-tune control & safety!

cf: LS 2012 fig 7-3
BI 121 Lecture 14

I. Announcements Last Lab 6, Pulmonary Function Testing + optional notebook ✓ this Thurs. Exam II Wed, Dec 7, 8 am Q?

II. Nervous System Connections  LS 7
   A. Autonomic NS: Branches, neurotransmitters, receptors, actions, fight-or-flight stories ch 7 pp 179-85
   B. Why are nerve & muscle unique? ch 4 p 71
   C. How do excitable cells signal? ch 3 pp 62-7; ch 4 pp 74-83
   D. How does the signal cross the nerve-muscle gap? ch 7 p 185-92 fig 7-5 p 190
   E. What do black widow spider venom, botulism/Botox?, curare & nerve gas have in common? LS fig 7-5 p 190

III. Muscle Structure-Function & Adaptation  LS ch 8 + DC Mod 12
   A. Muscle types: cardiac, smooth, skeletal LS fig 8-1 pp194-6
   B. How is skeletal muscle organized? LS fig 8-2, DC fig 12-2
   C. What do thick filaments look like? LS fig 8-4, DC fig 12-4
   D. Thin filaments? Banding pattern LS fig 8-5, 8-3, 8-7
   E. How do muscles contract? LS fig 8-6, 8-10
   F. What's a cross-bridge cycle? LS fig 8-11 +…
Homeostasis is a **dynamic balance** between the autonomic branches.

- **Parasympathetic**
  - Rest-and-digest: Parasympathetic activity dominates.

- **Sympathetic**
  - Fight-or-flight: Sympathetic activity dominates.

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Autonomic Neurotransmitters & Receptors

Cholinergic
Nicotinic
Muscarinic

Adrenergic
$\alpha = \text{Alpha}$
$\beta = \text{Beta}$
Autonomic Nerves: Two Chain Pathway with Post-Ganglionic Varicosities

1. Preganglionic fiber
2. Preganglionic neurotransmitter
3. Autonomic ganglion
4. Postganglionic fiber
5. Varicosity
6. Postganglionic neurotransmitter
7. Effector organ

LS 2012 fig 7-1
Nicotine activates both Sympathetic & Parasympathetic post-ganglionic neurons!

Problem?

Like hammering the gas pedal & brake at the same time!!
80% Epinephrine/Adrenaline (E)
20% Norepinephrine (NE)

Hormonal Adrenaline Surge Reinforces Nervous Outflow & Accesses Tissues Not Directly Innervated!!

Adrenals = Paired organs above kidneys

Output to blood
<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>
Why are nerve & muscle unique?

They are excitable!!
**Action Potentials ≡ Spikes ≡ Impulses**

- Ultra-short reversal of membrane potential
- Only in nerve and muscle cells
- Maintains strength over distance

Primary way nerves & muscles communicate!
Stimulate Cell @ Rest

Thermal

Mechanical

Electrical

Chemical
Action Potential has occurred!

Brief (1-2 ms) reversal to + inside cell!
I. **Announcements** Lab 6, Pulmonary Function Testing (PFT) + optional notebook check today. Exam II Dec 7 Wed, 8 am!

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

III. **Neuromuscular Junction Connections** LS fig 7-5 p 190

IV. **Muscle Contraction+Adaptation** DC Mod 12 + LS
   A. Review of structure + banding pattern? LS fig 8-1 thru 8-5
   B. How do muscles contract? LS fig 8-6, 8-10, 8-11 +…
   C. Summary of skeletal muscle contraction with videos
      Courtesy David Bolinsky, XVIVO & Malcolm Campbell, Department of Biology, Davidson College, NC +…
   D. Exercise adaptation variables LS ch 8 pp 210-214
      *mode, intensity, duration, frequency, distribution of training sessions, individual & environmental factors*
   E. **Endurance vs. Strength** training continuum? fiber types…

Fun lab with personal lifetime data! Yes!!
Skeletal Muscle Histology: Microscopic Anatomy

Muscle fiber or cylindrical cell

“Threads” ≡ Myofibrils

Nuclei

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

x1000

H Howard 1980.
Organ = Muscle → Cell = Myocyte = Fiber

Subcellular = Cytoskeleton

Molecules = Actin & Myosin

LS 2006, cf:
LS 2012 fig 8-2
DC 2013 fig 12-3
Golf Club Analogy?

(a) Actin binding site
Myosin ATPase site
Heads

(b) Myosin molecules
Cross bridges

LS 2006, cf:
LS 2012 fig 8-4
Actin molecules

Binding site for attachment with myosin cross bridge

Actin helix

Tropomyosin

Troponin

Thin filament

LS 2006, cf:
LS 2012 fig 8-5
Triad ≡ T tubule abutting cisternae

Mitochondria

Sarcomere

Myofibril
A Band = Dark Band
Anisotropic = Light Can’t Shine Through

I Band = Light Band
Isotropic = Light Can Shine Through
BI 121 Lecture 16

I. **Announcements** Notebooks? Exam II, Dec 7th Wed 8 am. Review session in class next Thursday. Q?

II. **Muscle + Adaptation Connections** LS ch 8, DC Module 12

III. **Respiratory System** LS ch 12, DC Module 7, Fox +...

A. Steps of respiration? External vs. cellular/internal?
   LS fig 12-1 pp 345-347

B. Respiratory anatomy LS fig 12-2 p 347, DC, Fox +...

C. Histology LS fig 12-4 pp 347-349, DC

D. How do we breathe? LS fig 12-12, fig 12-25 pp 349-356, pp 373-378

E. Gas exchange LS fig 12-19 pp 362-5

F. Gas transport LS tab 12-3 pp 365-70

We're on a roll! Bring on Exam II!
1st signal starts in the brain!

Let's look at one bouton & one muscle fiber!
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 tropomyosin 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, tropomyosin slips back to its blocking position over binding sites on actin; contraction ends; actin passively slides back to original resting position.
AEROBIC w/ O₂

MITOCHONDRIA

ANAEROBIC

CYTOSOL

Glycolysis

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

- Size of larger fast vs smaller slow fibers
- CP as well as **creatinine 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.
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 O\(_2\) and CO\(_2\) between air in the alveoli and the blood in the pulmonary capillaries.

3. Transport of O\(_2\) and CO\(_2\) by the blood between the lungs and the tissues.

4. Exchange of O\(_2\) and CO\(_2\) between the blood in the systemic capillaries and the tissue cells.

LS 2012 fig 12-1 modified
**NB:** *In vivo,* Cupola or peak of each lung goes into neck > clavicle line!
16-20 C-shaped bars of hyaline cartilage to prevent collapse
Vocal cords which approximate (move closer together) during Valsalva’s maneuver!
No Gas Exchange

1st alveolar outpouching!

Gas Exchange
I. **Announcements** Exam II Wednesday Dec 7th
   @ 8:00 am! 10 am lab section report to 13 KLA, 2 pm lab section 202 CAS. All others here! Discussion-Review, this Thursday, here in 100 WIL!

II. **Respiratory System Connections** LS ch 12, DC Module 7+
   A. How do we breathe?
      LS fig 12-12, fig 12-25 pp 349-356, pp 373-378
   B. Gas exchange LS fig 12-4, fig 12-19 pp 362-5
   C. Gas transport LS fig 11-2 p 299, tab 12-3 pp 365-70
   D. What happens in a gunshot wound or impalement injury? Pulmonary membranes? Pneumothorax? LS fig 12-5, 12-6, 12-8, 12-9, pp 349-52

III. **Physiology of Cigarette Smoking** LS + DC + ACS +...
   A. ANS, autonomic nerves & nicotine? Chemical route
   B. Emphysema? 2nd-hand smoke?... LS p 356, 365
   C. UO Smoke-Free since Fall 2012! Help is available!
NB: Diaphragm is the chief muscle of ventilation!
**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!
Alveoli are surrounded by jackets of capillaries!
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
O₂ is carried mainly by red blood cell hemoglobin!
Pleura/Peritonea/Lung Membranes

Parietal Pleura

Visceral Pleura
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
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
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 causes 87% of lung cancer deaths and is responsible for most cancers of the larynx, oral cavity & pharynx, esophagus, & bladder.
Emphysema \equiv \textit{Corrosion of Alveolar Walls with }↓\textit{SA \& Labored Breathing}

Internet Journal of Pathology
Mayo Clinic Health
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!

By Mike Reynolds & Bill Jones

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 ≡ ASTHMA?

Petri-dish Effect

Ugh!! Cough! 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
Sunflowers are planted along with our organic tobacco to attract beneficial insects to protect our organic crops...

Cigarettes & 2\textsuperscript{nd}-hand smoke!!

...and to avoid the use of chemical pesticides.

To be buried with sunflowers? Compost?
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