BI 358 Lecture 1- Happy New Year 2016!

I. **Introductions/Announcements** Staff: Anna, Conor & Pat
   Discussions today 10am,12n, 2 pm 112 HUE, registration Q?

II. **Outline Handout** Office hr, text (G&H), discussion/lecture notebook (DLN), optional text, attendance & participation, feedback, quizzes, presentation & paper, expectations, Q?

III. **Discussion Preview** Cigarettes & addiction, e-cigarettes?

IV. **Dr. Eugene Evonuk, Dr. Arthur Guyton & Dr. John Hall**

V. **Introduction to Human & Medical Physiology**
   Anatomy vs. Physiology, Structure vs. Function

VI. **Body Levels of Organization** LS

VII. **Homeostasis + 4 Key Q?** G&H + DLN
   A. Brief History G&H p 3
   B. What?  → Maintenance of ECF, p 4
   C. Where?  → ECF = Plasma + interstitium pp 4-5, fig 1-2 p 4
   D. Why?  → Required for cell survival LS + G&H p 8, 9
   E. ECF Balances + e.g.? H₂O, °C Dr. Evonuk DLN p A-1, A-2
   F. How?  → Simplified homeostatic model (Norris & Evonuk)
      - feedback e.g. pp 6-8, + feedback G&H fig 1-3, p 8
BI 358 Required Texts
http://uoduckstore.com/

Biology 358:
Investigations in Medical Physiology
Discussion-Lecture Notebook (DLN)
Eugene, OR 97403
Winter 2016

G&H
New (2016 ed) $120.00 Used $90.00...

DLN
Notebook $ 25.50
Students who succeed are usually those who:

(1) **Attend** class regularly
(2) **Ask** questions
(3) **Come** to office hours & problem-solving sessions
(4) **Study** outside class both alone & in study groups
(5) **Seek** to understand methods & overarching principles/concepts rather than specific answers
(6) **Teach** or tutor others &
(7) **Discuss** concepts informally with fellow students.

Not only the Lungs, Heart & Brain, but 100s of Other Tissues & Organs are Adversely Affected!

So sorry I was forced to deliver!
Cigarettes ≡ Patient-Assisted Drug-Delivery System
Inhaling Bypasses the Systemic Circulation
& Is Powerfully Reinforcing!
SMOKING ≡ ASTHMA?

Petri-dish Effect

Ugh!! Cough! Cough!!
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 + Smoke: > 7000 Chemicals; ~600 Tobacco Company Additives
Atherogenic, Carcinogenic (C), Tumor Initiating, Tumor Promoting (TP),
Toxic (T), Cornucoppia of Unknowns, Synergistic, Reactive...?

<table>
<thead>
<tr>
<th>Compound</th>
<th>Type</th>
<th>Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-aminobiphenyl</td>
<td>C</td>
<td>140 ng per cigarette...</td>
</tr>
<tr>
<td>benz(a)anthracene</td>
<td>C</td>
<td>40-200 ng</td>
</tr>
<tr>
<td>benzene</td>
<td>C</td>
<td>400 μg</td>
</tr>
<tr>
<td>benz(o)pyrene</td>
<td>C</td>
<td>40-70 ng</td>
</tr>
<tr>
<td>carbon monoxide</td>
<td>T</td>
<td>26.8-61 mg</td>
</tr>
<tr>
<td>formaldehyde</td>
<td>C</td>
<td>1500 μg</td>
</tr>
<tr>
<td>hydrazine</td>
<td>C</td>
<td>90 ng</td>
</tr>
<tr>
<td>hydrogen cyanide</td>
<td>T</td>
<td>14-110 μg</td>
</tr>
<tr>
<td>2-napthylamine</td>
<td>C</td>
<td>70 ng</td>
</tr>
<tr>
<td>nitrogen oxides</td>
<td>T</td>
<td>500-2000 μg</td>
</tr>
<tr>
<td>N-nitrosodimethylamine</td>
<td>C</td>
<td>200-1040 ng</td>
</tr>
<tr>
<td>N-nitrosodiethanolamine</td>
<td>C</td>
<td>43 ng</td>
</tr>
<tr>
<td>N-nitrospyrrolide</td>
<td>C</td>
<td>30-390 ng</td>
</tr>
<tr>
<td>phenol</td>
<td>TP</td>
<td>70-250 μg</td>
</tr>
<tr>
<td>polonium 210</td>
<td>C</td>
<td>0.5-1.6 pCi</td>
</tr>
<tr>
<td>quinoline</td>
<td>C</td>
<td>15-20 μg</td>
</tr>
<tr>
<td>O-toluidine</td>
<td>C</td>
<td>3 μg</td>
</tr>
</tbody>
</table>

**SOURCES:** US Surgeon General's Office, American Cancer Society, American Heart Association.
Absorbs H₂O
Preserves tobacco
Antifreeze & de-icing
Polyester compounds
Artificial smoke in
Theater & e-cigarettes

Propylene Glycol
What in tobacco smoke is harmful?

http://livealittlelonger.wordpress.com/tobacco/whats-inside-that-cigarette/

http://www.smokefree.gov/
**Parasympathetic**

Ach = Acetylcholine

= Nicotinic Receptor
= Muscarinic Receptor

**Sympathetic**

NE = Norepinephrine

= α Receptor ($\alpha_1$, $\alpha_2$)
= β Receptor ($\beta_1$, $\beta_2$)
The tobacco industry has acknowledged that nearly 600 chemicals are added to cigarettes. It is not clear, however, how much of the various additives are used or which combinations appear together. Some of the chemicals among cigarette additives most questioned by tobacco opponents include:

- **Megastigmatrienone**: A flavoring that tobacco companies contend is found naturally in grapefruit juice.

- **Dehydromenthofurolactone**: A flavoring that tobacco companies say is found in peppermint.

- **Ethyl furoate**: Found naturally in coffee, kiwi and peanuts.

- **Maltitol**: A sweetener used in chewing gum and diabetic candy.

- **Sclareolide**: A synthetic form of a naturally occurring tobacco element.

- **Ammonia**: A processing aid.

- **Methoprene**: An insecticide that toxicologists say is biodegradable.

- **Other additives**: Yeast, wine, caffeine, beeswax, beta carotene, chocolate, coconut oil.
Ammonia converts nicotine, the additive 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. Research now indicates that ammonia can boost nicotine availability up to 100x! The Oregon Graduate Institute (now a part of OHSU) was the 1st to research!

http://pubs.acs.org/doi/abs/10.1021/es970402f
http://www.nasw.org/users/sperkins/nicotine.html
Arsenic 33
- Shotgun pellets
- Metal for mirrors
- Glass, lasers
- Light emitting diodes = LED
- $\times 74.9216$

Polonium 84
- Nuclear batteries
- Neutron source
- Antistatic agents
- Film cleaner
- $\times (209)$
Tobacco-free Campus

For better health, smoking and use of tobacco products are prohibited everywhere on our property.

September 1, 2012

For a healthier community and cleaner environment, the University of Oregon will be smoke and tobacco free.

Ready to Quit Tobacco?
Visit tobaccofree.uoregon.edu for free and low cost resources.
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 4:31 PM, JUNE 3, 2014

https://www.sciencenews.org/article/health-risks-e-cigarettes-emerge
DEEP BREATH Half of the pollutant vapors inhaled by an e-cigarette user may make it into the lungs, a new study finds.

Magazine issue: Vol. 185 No. 13, June 28, 2014

Electronic cigarettes, marketed as safer than regular cigarettes, deliver a cocktail of toxic chemicals including carcinogens into the lungs, new studies show. Using e-cigarettes may even make bacterial infections resistant to antibiotics, according to one study.

Engineers developed e-cigarettes several years ago to provide tobacco users a smoke-free source of nicotine. The devices heat up a liquid that a user inhales, or “vapes.” Because e-cigarettes burn nothing, they release no smoke.

“There’s no question that a puff on an e-cigarette is less toxic than a puff on a regular cigarette,” says Stanton Glantz, director of the Center for Tobacco Control Research and Education at the University of California, San Francisco. But few studies have looked at the toxicity of their vapors. As a result, scientists have been circumspect about describing e-cigarettes as safe.

For a May 13 review in Circulation, Glantz and his team pored over emerging data on what vapers are inhaling and found, he says, greater risk than scientists had thought. E-cigarettes deliver high levels of nanoparticles, the researchers found, which can trigger inflammation and have been linked to asthma, stroke, heart disease, and diabetes (SN: 7/18/09, p. 26). The levels “really raise concerns about heart disease and other chronic conditions where inflammation is involved,” he says.

E-cigarettes are no longer niche products, he and others note. Vaping product sales last year were projected to hit an estimated $1.7 billion, report Li-Lun Chen and Corinne Husten of the Food and Drug Administration’s Center for Tobacco Products in Rockville, Md., in a special May issue of Tobacco Control on e-cigarettes. E-cigarette sales may exceed those of traditional cigarettes within 10 years, the pair reports. At least 1 in 5 smokers has tried e-cigarettes, as have 10 percent of U.S. high school students, according to the U.S. Centers for Disease Control and Prevention.

Those people may think vaping is safe, but FDA has seen no data establishing anything like that, writes the agency’s Priscilla Callahan-Lyon in the same journal. She reviewed data from 18 studies on e-cigarettes’ vapors and found that most contain at least traces of the solvents in which nicotine and flavorings had been dissolved. Those solvents, she reports, are known as lung irritants.

And the solvents can transform into something even more worrisome: carbonyls. This group includes known cancer-causing chemicals, such as formaldehyde, and suspected carcinogens, such as acetaldehyde. Because early e-cigarettes didn’t deliver the same powerful hit of nicotine that burning tobacco does, engineers developed second-generation technology that allows users to increase an e-cigarette’s voltage, and thus temperature, to atomize more nicotine per puff.

More than 250 different brands of electronic cigarettes are available on the market (a few examples shown), and many dozens of solutions are used to generate the devices’ vapors.
Dedication to Dr. Eugene Evonuk, 1921-1984
Director, Laboratory of Applied Physiology
University of Oregon, 1967-1984
http://blogs.uoregon.edu/evonuk/
“Never be so narrow as to lose sight of the big picture!”
Walking Medical Dictionary, Demanding Mentor with Unending Dedication & Love for His Students & Family
Infectious Curiosity & Love for Life & the Outdoor World!
Gene, we can always get another plane!
The sudden loss of Dr. Arthur C. Guyton in an automobile accident on April 3, 2003 and the loss of his devoted and remarkable wife, Ruth Weigle Guyton, one week later as a result of injuries from the accident stunned and saddened all who were privileged to know them. Arthur Guyton was a giant in the fields of physiology and medicine, a leader among leaders, a master teacher, and an inspiring role model for people throughout the world.

Arthur Clifton Guyton was born in Oxford, Mississippi, to Dr. William (Billy) S. Guyton, an eye, ear, nose, and throat specialist and dean of the University of Mississippi Medical School, and Kate Smallwood Guyton, a math and physics teacher who had been a missionary in China before their marriage. During his formative years, he enjoyed watching his father work at the Guyton Clinic, playing chess and swapping stories with William Faulkner, and building sailboats (one of which he later sold to Faulkner) and countless mechanical and electrical devices, which he continued to do throughout his life. Arthur Guyton’s brilliance shone early. He graduated top in inventions he received a Presidential Citation. He returned to Oxford where he devoted himself to teaching and research at the University of Mississippi School of Medicine and was named chair of the Department of Physiology in 1948. In 1951 he was named one of the 10 outstanding men in the nation. When the University of Mississippi moved its medical school to Jackson in 1955, he rapidly developed one of the world’s premier cardiovascular research programs. His remarkable life as a scientist, author, and devoted father is detailed in a biography published on the occasion of his “retirement” in 1989.1

A Great Scientist
Arthur Guyton’s research contributions, which include more than 600 papers and 40 books, are legendary and place him among the greatest figures in the history of cardiovascular research. His research covered virtually all areas of cardiovascular regulation and led to many seminal concepts that are now an integral part of our understanding cardiovascular physiology and disorders such as hypertension, heart failure, and edema. It is difficult to discuss cardiovascular
Dr. Guyton Teaching & in the Lab

http://www.umc.edu/Dr_Arthur_Guyton.aspx
John E. Hall, PhD
Arthur C. Guyton Professor & Chair
Department of Physiology & Biophysics
University of Mississippi Medical Center
Jackson, Mississippi
Discussion/Questions?
ANATOMY vs PHYSIOLOGY
STRUCTURE vs FUNCTION
WHAT? vs HOW?
WHERE? vs WHY?
Structure begets **function**!
Structure **gives rise to function**!
Structure & **function are inseparable**!
Body Levels of Organization

1. Molecular
2. Cellular
3. Tissue
4. Organ
5. System
6. Organism
Maintenance of a relative constancy in the Internal environment = ECF = fluid outside of cells

milieu interieur?

100 trillion cells working intimately

Claude Bernard

Walter B. Cannon
ECF = Extracellular

ICF = Intracellular

Plasma (within CV System)

Interstitium (eg, between muscle cells)
**FIGURE 1–2 Components of the Extracellular Fluid (Internal Environment)**

- **Cell**
- **Interstitial fluid**
- **ECF**
- **Blood vessel**
- **Plasma**
- **Extracellular fluid**
Where is extracellular fluid (ECF)?

As long as between/outside cells, ECF everywhere!
Plasma and Interstitium mix/mingle @ Capillary.
HOMEOKINESIS?
**FIGURE 1–3 Interdependent Relationship of Cells, Body Systems, and Homeostasis**  The depicted interdependent relationship serves as the foundation for modern-day physiology: **Body systems maintain homeostasis, homeostasis is essential for survival of cells, and cells make up body systems.**
Dr. Evonuk’s 6 Balances

Metabolic

$\text{O}_2/\text{CO}_2$

$\text{H}_2\text{O}$

$p\text{H}$

Ion$^{+/-}$

$\text{T}_{\text{oC}}$

ToC

$\text{ANA- CATA-}$
70% $\text{H}_2\text{O}$ = 49 L

**INPUT**
- Dietary Drink: 1200 mL
- Dietary Eat: 400 mL
- Oxidation: 400 mL
  
  Total = 2000 mL

**OUTPUT**
- Urine: 1000 mL
- Sweat + Insensible: 900 mL
- Feces: 100 mL
  
  Total = 2000 mL

**INPUT + OUTPUT = BALANCE!**

ECF = 14 L

- Interstitium = 11 L
- Plasma = 3 L

**OUTPUT**

**BALANCE!**

70 kg

DLN A-1, A-2
Controller = Hypothalamus with Set Point

- True Diurnal Variation
- Set Point: 98.6°F (37°C)
- Protein Denaturation: 42°C (110°F)
- Lethal: 33°C (91°F)
- Profound Hypothermia: < 30°C
- Mild Hypothermia: 35°C (95°F)
- Time of Day: 0600, 1400
Invariably, Negative Feedback
**NB**: Though most often negative feedback, there are exceptions:

Selected +FB e.g.:

- LH Surge $\rightarrow$ Ovulation
- Oxytocin $\rightarrow$ Uterine Contraction
- Blood Clotting Cascade
- cAMP Cascade
- Na+ influx during AP

Nonpathological! Temporarily amplifies, but ultimately turned off by - FB!
Recovery of heart pumping caused by negative feedback after 1 liter of blood is removed from the circulation. Death caused by positive feedback when 2 liters of blood are removed.
Venous Pooling

Baroreceptors/Pressure Receptors eg, in Carotids & Aorta

Seated to Standing

NB: Corrective Change Opposes Original Input

- FB eg

Electrochemical Signal

CV Control Center Brain Stem

Electrochemical Signal eg, Symp Accelerator N

Baroreceptors/Pressure Receptors eg, in Carotids & Aorta

Seated to Standing

BP

I

R

C

O

E

Ef

HR

VC

- FB eg
How Effective is a System at Maintaining Relative Constancy? Feedback Gain?

Gain = \frac{\text{Correction}}{\text{Error}}

e.g., Transfuse large volume of blood into person with non-functioning Baroreceptor system

BP: 100 mm Hg → 175 mm Hg

...into person with functioning system

BP: 100 mm Hg → 125 mm Hg

G&H pp 7-8
Gain for Human Baroreceptor System?

Correction

Gain = \frac{-50 \text{ mm Hg}}{+25 \text{ mm Hg}} = -2

cf: Gain for Human Body Temperature = -33