Recitation and Lab # 05

The goal of this recitations / labs is to review material related to the CV and respiratory lectures for the second test of this course. Info required to answer this recitation question has been referred to in lectures and is presented in labs as computer simulations related to circulation (3 expts), blood (2 expts), and respiration (4 expts). Although no additional info is presented in the lab section, its content allows for a better discussion of the material presented in the lecture / recitation course.

Question & answers related to the CV and respiratory lectures:

- Ranking of most important items for recitation / lab # 05
  - What is that this recitation question is really asking, and how would you answer it in an “a, b, c, d” format, consistent with the presence of the pathology known as EIPH (exercise induced pulmonary hemorrhage) ?.
  - For additional help with your answer, look forward to the lecture on exercise in humans and animals in the third segment of the course.
  - In order to answer this recitation question you need to understand all material tested in your first exam plus the material presented in the lecture on CV & respiratory function and summarized in the lab # 04 / 05.

Recitation question # 05

The fifth recitation question attempted to “force” you to practice on the (a,b,c,d) sub-questions in a specific CV-Respiratory pathological condition.

Question #05: CV Integration and the Respiratory System

The question for this week is as follows:

Select a position on the question “how good an athlete is the horse”. Do you think the respiratory limitations of this specie (e.g. pulmonary hypertension, exercise induced pulmonary hemorrhage or EIPH) are expression of physiological compensation for a fit athlete, or are they manifestation of a system being “run down to the ground in a very stressed athlete”? Your answer must follow the outline shown in the introduction (sub-questions a, b, c, d, see above). Please notice that in this question both the structure and the function you are asked to select must be related to the EIPH syndrome.

If you can not write an idea into a single sentence, you probably have not yet understood the material.
Recitation question # 05

The fifth recitation question attempted to “force” you to practice on the (a,b,c,d) sub-questions in a specific CV-Respiratory pathological condition.

a) Name the structure and the function on which your overall answer will be based? Be as specific as you can in delimiting the boundaries of your example (the most important part of your answer, since the following b, c, & d sub-questions are based on your answer to this first sub-question, a). (please notice that 1 item is required in this answer)

b) Why do you think that your structure and your function are related? Support your contention based on 3 lines of evidence on the chemistry, physics, anatomy or physiology involved in your example. (please notice that 3 items are required)

c) Which are the levels of organization involved in your example? Cite events occurring at its main level of organization and indicate how they relate to the whole body homeostatic level. (please notice that 3 items are required in this answer)

d) Which are the main feedback mechanisms involved in your example (cite at least two)? Expand on one of them and indicate an absolute requirement for that feedback to be operational. (please notice that 3 items are required in this answer)

If you can not write an idea into a single sentence, you probably have not yet understood the material.

Virtual Lab # 05

The goal of this recitations / labs is to review material related to the CV and respiratory lectures for the second test of this course. Info required to answer this recitation question has been referred to in lectures and is presented in labs as computer simulations related to circulation (3 expts), blood (2 expts), and respiration (4 expts). Although no additional info is presented in the lab section, its content allows for a better discussion of the material presented in the lecture / recitation course.

Physiology Interactive Lab Simulation (PhILS)

Students should review all simulated experimental labs available in the software package used for this course.

Students should perform the different labs following the instructions and time schedule defined for each lab.
Physiology Interactive Lab Simulations (PhILS version 2.0 has fewer labs than PhILS version 3.0)

Osmosis and diffusion
01 varying ECF concentration

Metabolism
02 size and basal metabolic rate
03 oxygen and electron transfer

Skeletal muscle function
04 stimulus dependent force generation
05 the length - tension relationship
06 principles of summation and tetanus
07 EMG and twitch amplitude

Resting potential
08 resting potential and external K
09 resting potential and external Na

Action potentials
10 the compound action potential
11 conduction velocity and temperature
12 refractory period
13 measuring ion currents

Synaptic potential
14 facilitation and depression
15 temporal summation of EPSPs
16 spatial summation of EPSPs

Endocrine function
17 thyroid gland and metabolic rate

Frog heart function
18 thermal and chemical effects
19 refractory period of the heart
20 Starling's law of the heart
21 heart block

ECG and heart function
22 ECG and exercise
23 the meaning of heart sounds
24 ECG and finger pulse
25 electrical axis of the heart
26 ECG and heart block
27 abnormal ECG

Circulation
28 cooling and peripheral blood flow
29 blood pressure and gravity
30 blood pressure and body position

Blood
31 pH and Hb - O2 binding
32 DPG and Hb - O2 binding

Respiration
33 altering body position
34 altering airway volume
35 exercise - induced changes
36 deep breathing and cardiac function

Digestion
37 Glucose transport

At the completion of this simulation you will be able to:
1) Connect a transducer to a volunteer’s finger
2) Use the Virtual Data Acquisition System to display the finger pulse signal on the screen of a virtual computer
3) Explain why the signal changes when an ice bag is placed on the wrist, is left in place for a short time, and removed from the wrist
Sphincters are bands of smooth muscle and are wrapped around arterioles. A contraction of these sphincters reduces the diameter of the arteriole and decreases blood flow. Arteriole sphincters in the hands and feet are very sensitive to temperature. In this lab, an ice bag is placed on a student wrist to show that cooling dramatically reduces blood flow to the fingers. If the ice bag is left on the wrist, blood flow slowly increases, and if the ice is removed blood flow is quickly restored to or even above resting levels.
How would this pattern (both arms down) change (systolic pressure and pulse amplitude), if the right or left arm is raised?

A force must be applied to move a fluid through a tube. The heart is a pump that provides pressure to push blood through the blood vessels of the circulatory system. The pressure of the fluid will decline if it flows against the force of gravity. This lab demonstrates that elevating a hand above the head decreases the blood pressure and blood flow.

At the completion of this simulation you will be able to:
1) Connect a transducer to a volunteer’s finger
2) Use the Virtual Data Acquisition System to display the finger pulse signal on the screen of a virtual computer
3) Use a blood pressure cuff to prevent blood flow to an arm and release the pressure to measure the systolic pressure as blood flow returns, as monitored by the finger pulse signal
4) Describe what happens to blood pressure when the volunteer lies down
The brain must be perfused at all times with blood at the appropriate pressure, irrespective of body position. Baroreceptors measure the blood pressure in the carotid arteries, which supply the brain with blood. In a standing individual, the head is above the heart, so blood pressure will decline as blood flows against gravity. When lying down, however, the head and heart are at the same level. Therefore, the heart creates a lower blood pressure because no compensatory blood pressure increases are required to overcome the effect of gravity.
A low pH can be created by cell production of lactic acid and CO2, which reacts with H2O to form H + HCO3. This reaction catalyzed by carbonic anhydrase, enzyme found inside RBCs. The H ions bind to beta chains and decrease Hb’s affinity to O2. In high cellular respiration, arterioles sphincters relax to direct blood to these cells. Factors in environment created by respiring cells, e.g. high CO2, increase O2 – Hb dissociation.
2,3-diphosphoglycerate (DPG) binds to the beta chains and decreases Hb's affinity for O₂. DPG facilitates O₂ unloading to the tissues, but decreases O₂ loading at the lung. DPG levels increase at high elevations, where less O₂ is available in the air and blood PO₂ levels are low. Therefore, while DPG promotes O₂ unloading from Hb at the tissues, at the lungs less O₂ is available and Hb is less capable of picking-up O₂.
Pressure of a fluid declines as it moves against gravity. The heart is located in the thorax and pumps blood to the lungs. In the standing individual, gravitational effects produce lower blood pressure in the apex of the lung (shoulder region) than at the base. As a result pulmonary capillaries in the apex of lungs are closed so that alveolar air in this region is not available for gas exchange with blood. In a person lying down, however, gravity has less effect and alveolar capillaries are open. This provides a larger surface area for gas exchange compared with someone standing, so tidal volume is less.
The human lung consists of alveoli and airways. O2 and CO2 are exchanged across alveoli walls between air and pulmonary blood supply. Air that enters the lung at the end of a breathing cycle remains in the airways and is not available for exchange. In this lab, the volume of airways or “anatomical dead space”, was artificially enlarged by breathing through a plastic tube. The volunteer exhibits compensatory changes in the depth of breathing or tidal volume. The lab demonstrates that the volunteer increases the tidal volume of the air that enters the alveoli, however, the alveolar ventilation remained constant.

At the completion of this simulation you will be able to:

1) Use virtual instruments to monitor breathing of a student volunteer and display the signal on a computer virtual screen
2) Measure the respiratory reserve volume, tidal volume, and the expiratory reserve volume
3) Explain the changes in breathing patterns when the volunteer exercises
Exercise increases the depth (tidal volume) and rate of breathing. The volume of the airways remain constant, so every extra ml of air that is inhaled goes into the alveoli and is available for exchange with the blood in the pulmonary capillaries, this is seen as an increase in alveolar ventilation during exercise. Force expiration during exercise decreases the expiratory reserve volume. This means that less (stale) air remains in the lungs after the volunteer has breathed out, so there is less stale air to mix with the incoming fresh air.
The breathing cycle consists of a period of inhalation and exhalation. During inhalation, the volume of the thorax increases and the pressure inside the thorax decreases. This draws air into the lung and also pulls blood towards the heart, which is located inside the thorax. One theory maintains that the increase in venous return produces a faster stretching of the wall of the atria, and this increases heart rate. During exhalation, the volume of the thorax decreases and pressure of the thorax increases. This pushes air out of the lungs and increases venous return. The result is a decrease in heart rate.