NAME _____ LAB TIME/DATE _____

REVIEW SHEET
exercise
37A

Respiratory System Physiology

Mechanics of Respiration

1. For each of the following cases, check the column appropriate to your observations on the operation of the model lung.

	Diaphragm pushed up		Diaphragm pulled down	
Change	**Increased**	**Decreased**	**Increased**	**Decreased**
In internal volume of the bell jar (thoracic cage)		✓	✓	
In internal pressure	✓			✓
In the size of the balloons (lungs)		✓	✓	
In direction of air flow	Into lungs	Out of lungs ✓	Into lungs ✓	Out of lungs

2. Base your answers to the following on your observations in question 1.

Under what internal conditions does air tend to flow into the lungs? *↑ thoracic volume, and ↓ pressure.*

Under what internal conditions does air tend to flow out of the lungs? Explain why this is so. *↓ thoracic volume, ↑ pressure.*

Gases move in the direction that tends to equalize pressure inside and outside the "container."

3. Activation of the diaphragm and the external intercostal muscles begins the inspiratory process. What effect does contraction of these muscles have on thoracic volume, and how is this accomplished? *↑ thoracic volume. The diaphragm moves inferiorly, increasing the superior-inferior dimension; the ribs swing up and out, increasing the lateral and anterior/posterior dimensions.*

4. What was the approximate increase in diameter of chest circumference during a quiet inspiration?

(student data) inches During forced inspiration? *(student data)* inches

What temporary physiological advantage is created by the substantial increase in chest circumference during forced inspiration?

Increases the thoracic volume more; therefore, creates a greater negative internal pressure, causing the gases to rush in quickly. Also, more "fresh" air reaches the alveoli.

5. The presence of a partial vacuum between the pleural membranes is integral to normal breathing movements. What would happen if an opening were made into the chest cavity, as with a puncture wound?

Destroys the partial vacuum in the pleural space and the lung on the affected side collapses.

How is this condition treated medically? *Air is withdrawn (chest tube) and the chest is closed.*

Respiratory Sounds

6. Which of the respiratory sounds is heard during both inspiration and expiration? *Bronchial*

Which is heard primarily during inspiration? *Vesicular*

7. Where did you best hear the vesicular respiratory sounds? *Heard over most of the lung area.*

Respiratory Volumes and Capacities—Spirometry

8. Write the respiratory volume term and the normal value that is described by the following statements.

Volume of air present in the lungs after a forceful expiration: *residual volume (~1100 ml)*

Volume of air that can be expired forcibly after a normal expiration: *expiratory reserve (~1200 ml)*

Volume of air that is breathed in and out during a normal respiration: *tidal volume (~500 ml)*

Volume of air that can be inspired forcibly after a normal inspiration: *inspiratory reserve (~2700–2800 ml)*

Volume of air corresponding to TV + IRV + ERV: *vital capacity (~4800 ml)*

9. Record experimental respiratory volumes as determined in the laboratory. (Corrected values are for the recording spirometer only.)

Average TV: *(student data)* ml

Corrected value for TV: *(student data)* ml

Average IRV: *(student data)* ml

Corrected value for IRV: *(student data)* ml

MRV: *(student data)* ml/min

Average ERV: *(student data)* ml

Corrected value for ERV: *(student data)* ml

Average VC: *(student data)* ml

Corrected value for VC: *(student data)* ml

% predicted VC: *(student data)* %

FEV_1: *(student data)* % FVC

10. Would your vital-capacity measurement differ if you performed the test while standing? *Yes* While lying down? *Yes* Explain. *When lying down or sitting, the abdominal organs press against the diaphragm, making it more difficult for the diaphragm to move inferiorly.*

11. Which respiratory ailments can respiratory volume tests be used to detect?

Chronic bronchitis and emphysema (often associated). Chronic bronchitis ↓ the volume of air that can be inhaled due to excessive mucus production; emphysema ↓ the amount of air that can be exhaled (check-valve effect).

12. Using an appropriate reference, complete the chart below:

		O_2	CO_2	N_2
% of composition of air	Inspired	*~21%*	*~0.04%*	*~78%*
	Expired	*~16%*	*~4%*	*~74%*

Use of the Pneumograph to Determine Factors Influencing Rate and Depth of Respiration

13. Where are the neural control centers of respiratory rhythm? *medulla oblongata* and *pons*

14. Based on pneumograph reading of respiratory variation, what was the rate of quiet breathing?

Initial testing *(student data)* breaths/min

Record observations of how the initial pneumograph or respiratory belt transducer recording was modified during the various testing procedures described below. Indicate the respiratory rate, and include comments on the relative depth of the respiratory peaks observed.

Test performed	Observations
Talking	*Respiratory rate becomes irregular during talking.*
Yawning	*Yawning is reflected by extremely deep prolonged inspiration.*
Laughing	*Respiratory rate becomes irregular. Respiratory depth may be ↑ or ↓ depending on the nature of the laugh.*
Standing	*Regular rhythm and rate.*
Concentrating	*Respiratory rate is regular unless punctuated by intervals of apnea in individuals who hold their breath when concentrating.*
Swallowing water	*Respiration ceases during the period of swallowing.*
Coughing	*Respiration rate becomes irregular and marked by expirations during coughing.*
Lying down	*Regular rhythm and regular (or slightly depressed) rate. Depth decreases.*
Running in place	*Increased rate and depth of breathing.*

15. Student data:

Breath-holding interval after a deep inhalation _____ sec length of recovery period _____ sec

Breath-holding interval after a forceful expiration _____ sec length of recovery period _____ sec

After breathing quietly and taking a deep breath (which you held), was your urge to inspire or expire? *expire*

After exhaling and then holding one's breath, was the desire for inspiration or expiration? *inspiration*

Explain these results. (*Hint:* what reflex is involved here?) *Hering-Breuer reflex. Both extreme deflation and inflation of the lungs excites receptors there. Impulses are transmitted to the medulla oblongata, which then initiates inspiration or expiration (respectively).*

16. Observations after hyperventilation: *(student data)*

17. Length of breath holding after hyperventilation: *(s.d.)* sec

Why does hyperventilation produce apnea or a reduced respiratory rate? *Hyperventilation washes CO_2 out of the blood. Since CO_2 is the major chemical stimulus for inspiration, the desire or drive to breathe is decreased.*

18. Observations for rebreathing breathed air: *(student data)*

Why does rebreathing breathed air produce an increased respiratory rate? *CO_2 (exhaled) accumulates in the bag; this stimulates increased force/rate of respiration.*

19. What was the effect of running in place (exercise) on the duration of breath holding? *↓ the duration.*

Explain this effect. *The body's need for oxygen and to get rid of CO_2 is increased by exercise.*

20. Relative to the test illustrating the effect of respiration on circulation. *(student data)*

Radial pulse before beginning test: _____ /min Radial pulse after testing: _____ /min

Relative pulse force before beginning test: _____ Relative force of radial pulse after testing: _____

Condition of neck and facial veins after testing: _____

Explain these data. *Forced expiration increases intrathoracic pressure, reducing blood flow back to the heart, resulting in dilation of the neck and facial veins. Decreased cardiac output results in increased cardiac rate (seen here as increased pulse rate).*

21. Do the following factors generally increase (indicate with I) or decrease (indicate with D) the respiratory rate and depth?

1. increase in blood CO_2 *I*
2. decrease in blood O_2 *I*
3. increase in blood pH *D*
4. decrease in blood pH *I*

Did it appear that CO_2 or O_2 had a more marked effect on modifying the respiratory rate? *CO_2*

22. Where are sensory receptors sensitive to changes in blood pressure located? *Aortic arch and carotid sinus.*

23. Where are sensory receptors sensitive to changes in O_2 levels in the blood located? *Aortic bodies in the aortic arch and carotid bodies at the bifurcation of the common carotid artery*

24. What is the primary factor that initiates breathing in a newborn infant? *↑ levels of CO_2 in the blood.*

25. Blood CO_2 levels and blood pH are related. When blood CO_2 levels increase, does the pH increase or decrease? *Decrease* Explain why. *CO_2 combines with water (H_2O) to produce carbonic acid (H_2CO_3), which dissociates and liberates a hydrogen ion (H^+).*

Role of the Respiratory System in Acid-Base Balance of Blood

26. Define *buffer.* *A molecule or molecular system that acts to resist changes in pH.*

27. How successful was the laboratory buffer (pH 7) in resisting changes in pH when the acid was added? *(student data) (Anticipated response: very successful.)*

When the base was added? *(student data) (Anticipated response: very successful.)*

How successful was the buffer in resisting changes in pH when the additional aliquots (3 more drops) of the acid and base were added to the original samples? *Successful; only slight pH changes are seen.*

28. What buffer system operates in blood plasma? *Carbonic acid–bicarbonate system.*

Which of its species resists a *drop* in pH? *HCO_3^-*

Which resists a *rise* in pH? *H_2CO_3*

29. Explain how the carbonic acid–bicarbonate buffer system of the blood operates. *H_2CO_3, a weak acid, remains undissociated at physiologic pH or acid pH. However, if the pH starts to rise, H_2CO_3 dissociates and liberates H^+, which acts to ↓ the pH. HCO_3^- (bicarbonate ion) is the "alkaline reserve"; it acts to tie up excess H^+ into H_2CO_3 when the environment becomes too acidic. Since it is a weak base, it does not function under physiologic or alkaline conditions.*

30. What happened when the carbon dioxide in exhaled air mixed with water? *Phenol red turned yellow as CO_2 mixed with water to form carbonic acid.*

What role does exhalation of carbon dioxide play in maintaining relatively constant blood pH? *CO_2 leaves the blood during exhalation. This prevents an accumulation of carbonic acid.*

Measuring Respiratory Volumes Using BIOPAC®

31. Which, if any, of the measurable volumes would likely be exaggerated in a person who is cardiovascularly fit, such as a runner or a swimmer?

It is common to observe abnormally large vital capacities in athletes who have trained aerobically for considerable periods of time in their life.

Which, if any, of the measurable volumes would likely be exaggerated in a person who has smoked a lot for over twenty years?

Increases in TLC, FRC, and RV may occur as a result of hyperinflation of the lungs in obstructive diseases, whereas VC, TLC, FRC, and RV are reduced in restrictive diseases, which limit lung expansion.