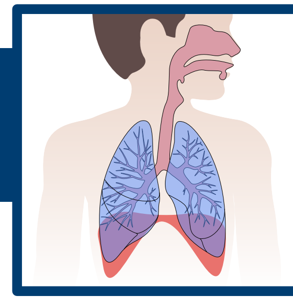
PULMO PARK

Lesson 3: *Respiratory Exploratory – Diving Deeper*



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HEALTH STARTS WITH SCIENCE

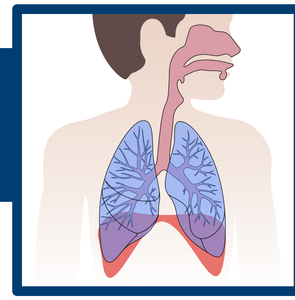
Teacher Background: In this Constructivist Lab Lesson, students will dive deeper into the mechanics of the respiratory system while applying Nature of Science principles. Much as scientists do, students will apply critical thinking to analyze the data they collect and correlate their discoveries to functions of the respiratory system.

Recommendation: Before starting the labs, students may benefit from reviewing student background information from selected activities from Lesson 2; specifically, Activities 2B and 2C. The following YouTube link reviewing the mechanics of breathing may be beneficial.

1. **Education Standards:** Identifies Texas Essential Knowledge and Skills (TEKS) and Next Generation Science Standards (NGSS). This lesson addresses:
   a. **TEKS:** High School – Biology, Anatomy & Physiology, Health, Environmental
   b. **NGSS:** Middle School and High School Life Science

2. **Activities**
   a. **Activity 3A: Dust and Us**
      i. **Students will investigate** the question "How much dust does our respiratory system handle?" Students will create a "dust collector", and analyze the particulates (aka: dust) collected to answer the guiding questions. Students will use evidence to support their analysis as to how particulates impact the respiratory system and other body systems.
      ii. **Teacher Notes:** Prior to the activity, identify a sufficient number of places, inside and outside, which students can access with ease to collect particulates (dust). Establish clear rules regarding behavior and time limits prior to students departing the classroom. This activity can be done in "shifts" during the class so as to limit the number of students out of class at any given time. If done is shifts, this activity can be used in tandem with Lesson 1, Activity 1C: Reverse Lung Dissection.

      As part of the Processing Out, students will generate a hypothesis. To review: scientists generate testable hypotheses based on their observations and questions resulting from these observations. Although if/then statements are frequently used to create hypotheses, scientists do not use if/then statements. To generate a hypothesis, start with an observation of the particulates on your card. Have students compare particulate samples. What questions do students have regarding these samples (aka: these data). Write their questions down. Once all questions have been shared, students can start to craft hypotheses from these questions. Hypotheses test correlations between independent and dependent variables. It is important for student hypotheses are testable.



iii. **Extensions:**

1. Students conduct an internet search to identify the types of particulates collected.
2. Students gather class data and represent graphically by particulate shapes, size, and number of particulates.
3. Working as a team of "scientists", the class can analyze these data for patterns and use evidence to explain possible sources of the particulates.
4. After generating hypotheses, students can design an experiment to test their hypotheses. If time permits, students can carry out their experiments.

b. **Activity 3B: Branching Out**

i. **Students will investigate** the question: "How and why do the lungs branch out on the inside?". Students will use a cauliflower floret to create a model of the branching which occurs inside the lungs. From their observations, students will correlate their observations to the respiratory system and the impact on other body systems.

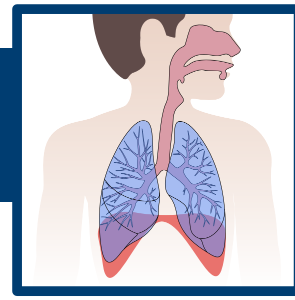
ii. **Teacher Notes:** This is a common lab activity, often used at the elementary level. However, in this experiment, students will be tasked to make connections to body systems and their function. Caution should be taken as students will be using a sharp instrument to slice the cauliflower. If safety is a concern, the slices can be made prior to class on a chef's mandolin to make thin cauliflower slices. The sliced cauliflower simulates the alveoli within the lung. A white carnation can be used as a substitute for the cauliflower. When placed in colored water, the dye will show in the veining within the petals. If carnations are used, care must be taken to ensure students connect branching within the petal to branching within the lung. However, this may be more challenging to connect the activity to the branching within the lungs.

c. **Activity 3C: Exchange It!**

i. **Students will investigate** the question: "How do we know when oxygen is exchanged for carbon dioxide?". To test for the presence of carbon dioxide, this activity uses the indicator bromothymol blue. The presence of carbon dioxide lowers the pH of water. Bromothymol blue is sensitive to this change in pH, resulting in a color change. This color change provides evidence for the presence of the invisible gas, carbon dioxide.

ii. **Teacher Notes:** If students are not familiar with indicators or pH, this is an excellent introduction. An indicator is sensitive to the level of free hydrogen ions (H+). Water has a pH of 7. Solutions with a pH less than 7 are considered acidic, meaning there are free hydrogen ions. The lower the pH, the more hydrogen ions are present. Solutions with a pH higher than 7 are considered basic. Instead of free hydrogen ions, there is an increase in the number of free hydroxide ions (OH-). When carbon dioxide is introduced into water, as in this experiment, some of the bonds within water break. The free hydrogen ions bond with the carbon dioxide, creating carbonic acid (H2CO3). Carbonic acid is a weak acid which means it dissociates, releasing hydrogen ions back into the solution.

$$CO_2 + H_2O \leftrightarrow H_2CO_3 \leftrightarrow HCO_3^- + H^+$$



The presence of hydrogen ions lowers the pH which causes the bromothymol blue to change from blue to yellow. The lower pH indicates the presence of carbon dioxide.

iii. Extension:

1. Students can conduct an internet search to determine the pH of oxygenated blood and oxygen-poor blood. They can use this information to develop a short presentation to the class about the impact changes in pH, such as acidosis and alkalosis, can have on body organs and tissue.
2. Indictors are sensitive to different pH levels. Using two common indicators, bromothymol blue and phenolphthalein, students can develop an experiment to determine the pH range of each indicator. Applying what they discovered about controls in the Processing Out, students will develop an experiment which uses vinegar and ammonia to determine the sensitivity of each indicator.

d. Activity 3D: Confusion About Diffusion

i. Students will investigate the question: "How can gases cross through or be contained by tissue or a membrane?". In this experiment, students will record observations at timed intervals. These observations are data points which they will analyze for evidence to support their conclusions on the Processing Out.

ii. Teacher Notes: Students are often confused about differences between diffusion and osmosis. For this experiment, the following definitions are applied:

Osmosis: the movement of ***solvent*** particles across a semipermeable membrane from a dilute solution into a concentrated solution. The solvent moves to dilute the concentrated solution and equalize concentration on both sides of the membrane.

Diffusion: the ***movement of particles*** from an area of higher concentration to lower concentration. The overall effect is to equalize concentration throughout the medium.

It will be beneficial to share these definitions prior to or during the experiment. However, as this experiment asks students to determine which process applies based on their observations, it is recommended not to expand on the definitions.