

Homi Bhabha Centre for Science Education
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Sindhu Mathai - PhD project on
“Visual and Verbal literacies in the context of human body systems”
Questionnaires, coding schemes, analysis and results

Numbers given in brackets refer to the total number of points for each question. Only questions which checked for comprehension of structure-function relationships were taken into account in calculation of average scores. These questions are marked with *. A summary of the questions used is given at the end of the questionnaire.

Respiratory system: Phase 2, Part 2, Questionnaires with scores assignation

Read the passages and answer the questions given below each of them. To answer the questions you may use words or drawings as you wish.

Passage 1 (*understanding of structure*)

The nasal cavities are passages for air to go into the lungs, and to be sent out from the lungs. These cavities also have special receptors for smell. The pharynx is a short, common passageway for both air and food. It also carries air from the mouth. The pharynx leads to the larynx. This organ is involved in voice production. The larynx is followed by the trachea. The trachea is a cylindrical tube. Its wall is composed of soft tissue as well as rings of tough tissue called cartilage. It is lined with mucous membrane. The mucous membrane has hair-like structures called cilia. The trachea divides into two bronchi. The two bronchi lead to two lungs on each side. The lungs are divided into the right and the left lung. The left lung is smaller to accommodate the heart. The bronchi further divide into tubes which are smaller in diameter and are called bronchioles. The bronchioles end in tiny air-sacs called alveoli. Each alveolus has a thin wall lined with a fine network of capillaries.

Questions

- a. Draw the respiratory organs mentioned in the passage and the location of each of them with respect to each other (9).
- b. What would happen if there was no pharynx, or a common passage, before it divides into the trachea and oesophagus? (1) *
- c. Why do you think the larynx or “voice-box” is located at the opening of the trachea? Do you think it could be located elsewhere? (1) *

- d. Why does the trachea have both soft as well as tough tissue? (1) *
- e. Why does the trachea divide further and further into smaller and smaller passages till it ends in the air-sacs or alveoli? (1) *
- f. What is a capillary? Why are the alveoli lined with a network of capillaries? (1) *

Passage 2 (*understanding of function*)

Three mechanisms help in the removal of foreign materials from the respiratory passage:

- i) ciliary action
- ii) peristaltic motion of the bronchioles
- iii) cough reflex

The respiratory passage from the nasal cavities to the bronchi is lined by a layer of sticky mucus. Particles which come in with the inhaled air get trapped in this mucus. They get stuck mainly because of two reasons:

- i) To trap the larger particles in the mucus, the direction of movement of air in the throat changes.
- ii) To trap the smaller particles, there is a random or unplanned movement of particles in the same direction as the air.

Once the particles get stuck, they have to be removed along with the mucus in which they have been trapped. This is carried out by the cilia lining the inner wall of the trachea, which move the mucus towards the nose and mouth. The cilia in the nose beat downwards, while those in the trachea and the passages below it beat upwards.

A cough is a result of the irritation of the larynx, trachea and bronchi. A sneeze happens because of the irritation of the nasal passages. The outward movement of air sweeps the foreign particles out of the respiratory passages.

Irritation of the respiratory passages and the organs beyond the nose, results in a cough. Excessive irritation of the external respiratory organs results in a sneeze.

Questions

- a. Draw diagrams and explain how small and large particles get trapped or stuck in the mucus lining the respiratory passage. (1) *
- b. Draw diagrams and explain what is meant by “ciliary action”. (1) *

- c. Taking a clue from what we have seen in the case of the digestive system, what do you understand by the “peristaltic motion of the bronchioles”? (1)
- d. How do you think peristaltic motion could help in removing the foreign particles from the respiratory passage? (1)
- e. Explain the difference between a cough and a sneeze in your own words or using diagrams (1).

Passage 3 (*understanding of function*)

Breathing happens in two parts or phases: inspiration or taking in air and expiration or giving out air. When we take in air, the size of the thorax is increased by the contraction of the diaphragm. This causes the elastic tissue of the lungs to expand and fill up the entire region enclosed by the ribs. When we breathe out, the ribs and diaphragm return to their normal positions and the lungs return to their normal size.

Questions

- a. How do you think a cross-section of the lung would look like? (1) *
- b. Can you think of another object or process in your daily life which you think is similar to the appearance or functioning of the lungs. (1) *
- c. What would happen if there was no diaphragm in the respiratory system? (1) *
- d. Draw diagrams to show the differences between inspiration and expiration. (2) *

Comprehension of structure-function relationship from text passage

Question nos:

S-F: 1b (1), 1c (1), 1d (1), 1e (1), 1f (2), 2a (2), 2b (1), 3a (1), 3b (1), 3c (1), 3d (4)

Total: 16

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Respiratory system Phase 2 Part 2: Average scores, maximum scores and nature of questions

Questions taken into account for calculation of average scores are marked with *

Q No	Mean Score	Max score	Nature of question
1a	0.58	9	draw respiratory organs mentioned in passage along with location with respect to each other what if no pharynx or common passage
1b*	0.35	1	before it divides into trachea and oesophagus?
1c*	0.57	1	why is larynx located in the beginning?
1d*	0.3	1	why trachea has soft as well as tough tissue
1e*	0.22	1	why does trachea divide further and further until it reaches the alveoli
1f*	0.2	2	what is a capillary how do small and large particles get trapped
2a*	0.25	2	or stuck in the mucus lining respiratory passage?
2b*	0.11	1	what is meant by ciliary action?
2c	0.3	1	what is peristaltic motion of bronchioles?
2d	0.22	1	how do you think peristaltic motion could help in removing foreign particles?
2e	0.61	2	difference between cough and sneeze
3a*	0.22	1	how does a C S of lung look like?
3b*	0.37	1	another object / process similar to appearance, functioning of lungs
3c*	0.35	1	what would happen if no diaphragm in the respiratory system?
3d*	0.13	4	diagrams to show the differences between inspiration and expiration

Q No **Nature of inferencing required**

	the organs are mentioned along with spatial location,
1a	converting text to diagram, prior knowledge can be useful
1b	some visualisation about the location of structures and movement of air through it
1c	some visualisation of structure, function and structure-function relationships
1d	from prior knowledge of function, not necessarily of understanding of structure
1e	from prior knowledge of function of capillaries in gas exchange
1f	from prior knowledge

- 2a from the passage, converting text into diagrammatic form
- 2b again from the passage, converting text to diagrams
- 2c from earlier understanding of peristaltic motion
- 2d prior understanding of peristaltic motion and also some visualisation
- 2e from experience with a cough and sneeze
from understanding of cross section,
- 3a as well as knowledge about the structure of lungs
from knowledge of the structure and functioning of the lung,
- 3b and some thinking of an analogous example
prior knowledge about the functioning of the diaphragm
- 3c as well as some visualisation of the effect without it
difference is explained, can be read off from the passage,
- 3d has to be converted into a diagrammatic form

Mean scores and Standard deviations for passages in Part 2 of the respiratory system

Passage no.	Mean score	Standard deviation
Passage 1	0.33	0.26
Passage 2	0.18	0.27
Passage 3	0.26	0.26

Wilcoxon's tests between mean scores across passages in Part 2 of the respiratory system

Tests done between	Z scores	Significance level
Part 2 (S-F scores)		
Passage 1 and 2	-3.228	0.001
Passage 1 and 3	-1.938	0.053
Passage 2 and 3	-1.791	0.073