### Respiratory system (chapter 16) Page 1

## Respiratory system

## The organ system that exchanges gases between the air in the lungs

## and the blood

• In lungs, O2 enters blood and CO2 exits blood

• The two major parts are the airway passages and the lungs

Figs 16.4, 16.5, and 16.22

The passageways that carry air in and out of the lungs

• The airways also clean and warm the air

• Cells of passageways secrete mucus (to trap contaminant particles in

air) and have beating cilia (hairs to propel mucus up away from

lungs)

Fig 16.5

### Respiratory system Page 2

Airway organs:

• Nasal cavity = open air chamber behind nose

• Pharynx = The upper throat (behind the nasal and oral cavities)

√ Conducts air, food, and water

• Larynx (voice box) = A hollow cartilage structure at the junction of

the trachea and the pharynx

√ Epiglottis = A cartilage flap that covers the windpipe when

we swallow, to divert food and water into the esophagus

√ Vocal cords = Vibrating folds in the larynx that make the

sounds when we speak

√ Thyroid cartilage (Adam’s apple) = The largest part of the   
 larynx cartilage

• Trachea (windpipe) = A tube that conducts air from the larynx down

into the thorax, towards the lungs

• Primary (left and right) bronchi = tubes formed by branching of

trachea

√ Each bronchus enters a lung

Figs 16.4, 16.5, and 16.6

### Respiratory system Page 3

Lungs

Two spongy elastic organs in the thoracic cavity that draw in air and exchange gases with blood

• Each bronchus branches repeatedly in lungs

• Bronchioles = The smallest branchings of the bronchi

• Alveoli = Round air sacs at the end of bronchioles where O2 enters

blood and CO2 exits blood

√ Gases easily diffuse through the walls of the alveoli and the

capillaries, which are both simple squamous epithelial tissue

• Air is drawn into lungs (inspiration) when we expanded them using

theinspiratory muscles

Figs 16.4 and 16.20

### Respiratory system Page 4

Inspiratory muscles

Muscles that expand the lungs to a larger size, which causes

inspiration of air into the lungs

• Diaphragm = Dome shaped muscle under the lungs that expands the

lungs downward

• External intercostal muscles = Muscles between the ribs that expand

the lungs anteriorly and laterally

• (No muscles are needed for expiration: The elastic recoil of the

lungs automatically contracts the lungs back to a smaller size,

which causes expiration of air out of the lungs).

Figs 16.12, 16.13, and 16.14; table 16.2

Pleura

A fluid-filled double membrane (a serosa) between the lungs and the

thoracic cavity wall

• Inner membrane attaches firmly to lungs

• Outer membrane attaches firmly to thoracic cavity wall

• Pleural fluid = fluid between inner and outer membrane of pleura

√ Creates a vacuum that holds lungs to thoracic cavity wall

√ Lubricates sliding of lungs along wall when breathing

Figs 16.7 and 16.9; table 16.4

### Respiratory system Page 5

Spirometry

Measurement of the volumes of air breathed in an out

• Spirometer = The device that measures the breathed air volumes

Fig 16.15

### Respiratory system Page 6

Gases always move in and out of blood by simple diffusion (molecules moving spontaneously from high to low concentration areas directly through cell membranes)

• In systemic loop capillaries…

√ O2 exits blood because cells in surrounding tissues have used

up O2 (tissues have lower [O2] than blood)

√ CO2 enters blood because cells in tissues have produced CO2

(tissues have higher [CO2] than blood)

• In pulmonary loop capillaries…

√ CO2 exits blood because blood gained CO2 from tissues

(blood has higher [CO2] than air in lungs)

√ O2 enters blood because blood lost O2 in tissues (blood has

lower [O2] than air in lungs)

Fig 16.22

How oxygen is carried in the blood:

• O2 enters the blood in the pulmonary loop and exits the blood in the

systemic loop

• O2 is carried on Fe (iron) atoms

• The iron atoms are part of hemoglobin protein

• The hemoglobin proteins are inside red blood cells

Fig 16.32

### Respiratory system Page 7

How carbon dioxide is carried in the blood:

• CO2 enters the blood from cells in the systemic loop. When CO2

enters the blood, most of it becomes HCO3– (bicarbonate ion)

CO2 ->  HCO3– + H+

√ For each CO2 that becomes HCO3–, a hydrogen ion is created

in the blood

√ The more CO2 that enters the blood = The more H+ in the

blood

• In the pulmonary loop, HCO3– becomes CO2 again. The CO2 exits

the blood into the lungs

HCO3– + H+ -> CO2

√ For each HCO3– that becomes CO2, a hydrogen ion is

removed from the blood

√ The breathing rate controls how fast HCO3– becomesCO2,

and therefore controls the blood’s H+ concentration

√ Normally, our breathing rate is set so that the amount of

H+ removed from the blood by breathing exactly balances the

amount of H+ that created in the blood by CO2

- Hypoventilation (less than normal breathing) increases

the blood’s H+ concentration. Hyperventilation (greater

than normal breathing) decreases the blood’s H+

concentration.

Figs 16.38, 16.39, and 16.40; table 16.4

CO2 + H2O H2CO3 H+ + HCO3–

(from cells) (carbonic acid) (bicarbonate)

### Respiratory system Page 8

Breathing control center of brain

The pons and the medulla (in the brain stem) control respiration rate

(breaths per minute)

• Normal respiration rate = 12 -18 breaths per minute

√ The breathing control center sends nerve signals to contract

the diaphragm and external intercostal muscles at the

breathing rate

• Breathing rate changed when blood's CO2 and O2 levels change

√ CO2 high *or* O2 low = breathing rate increases

√ CO2 low *or* O2 high = breathing rate decreases

• Oxygen level measured by O2 sensors in aorta and carotid artery

√ The O2 information is sent to the breathing control center

• CO2 (not O2) is the major determinant of breathing rate

• CO2 level not directly measured by breathing control center; Brain

uses H+ level (blood pH) to estimate CO2 level

√ Because one H+ is made for each CO2 that enters blood

√ High CO2 = High H+ = low blood pH = acidosis (acidic

blood)

√ Low CO2 = Low H+ = high blood pH = alkalosis (basic

blood)

Figs 16.24, 16.25, 16.26, 16.28, and 16.30

### Respiratory system Page 9

Respiratory system disorders:

• Emphysema\* = walls of alveoli break down

√ Passages collapse during expiration

√ Victims have difficulty expiring

Fig 16.17

• Chronic bronchitis\* = lower respiratory passages inflamed; produce

excess mucus

√ Coughing, increased lung infections, gas exchange reduced

√ Victims tend to display cyanosis (blue color due to hypoxia

(insufficient O2))

• Lung cancer\* = uncontrolled cell growth in bronchi or lungs

√ Cancer metastasizes (invades other tissues) rapidly

√ 90% of victims smoked

√ Only 7% of victims survive

• Asthma = easily inflamed bronchi

√ Inflammation often triggered by specific irritant (allergies)

√ Causes coughing and shortness of breath

(\* respiratory disease associated with smoking)