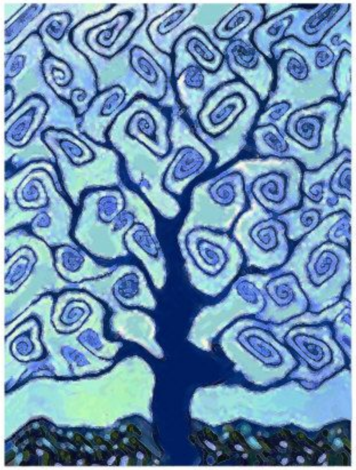


Control of body temperature

Lynne Powell

Aims

- To understand the body's control of temperature and respiratory rate.
- To look at the anatomy and physiology relevant to temperature maintenance and respiration.
- To discuss the normal values of temperature, respiratory rate and pulse oximetry.
- To discuss factors that affect these normal values

Thermoregulation

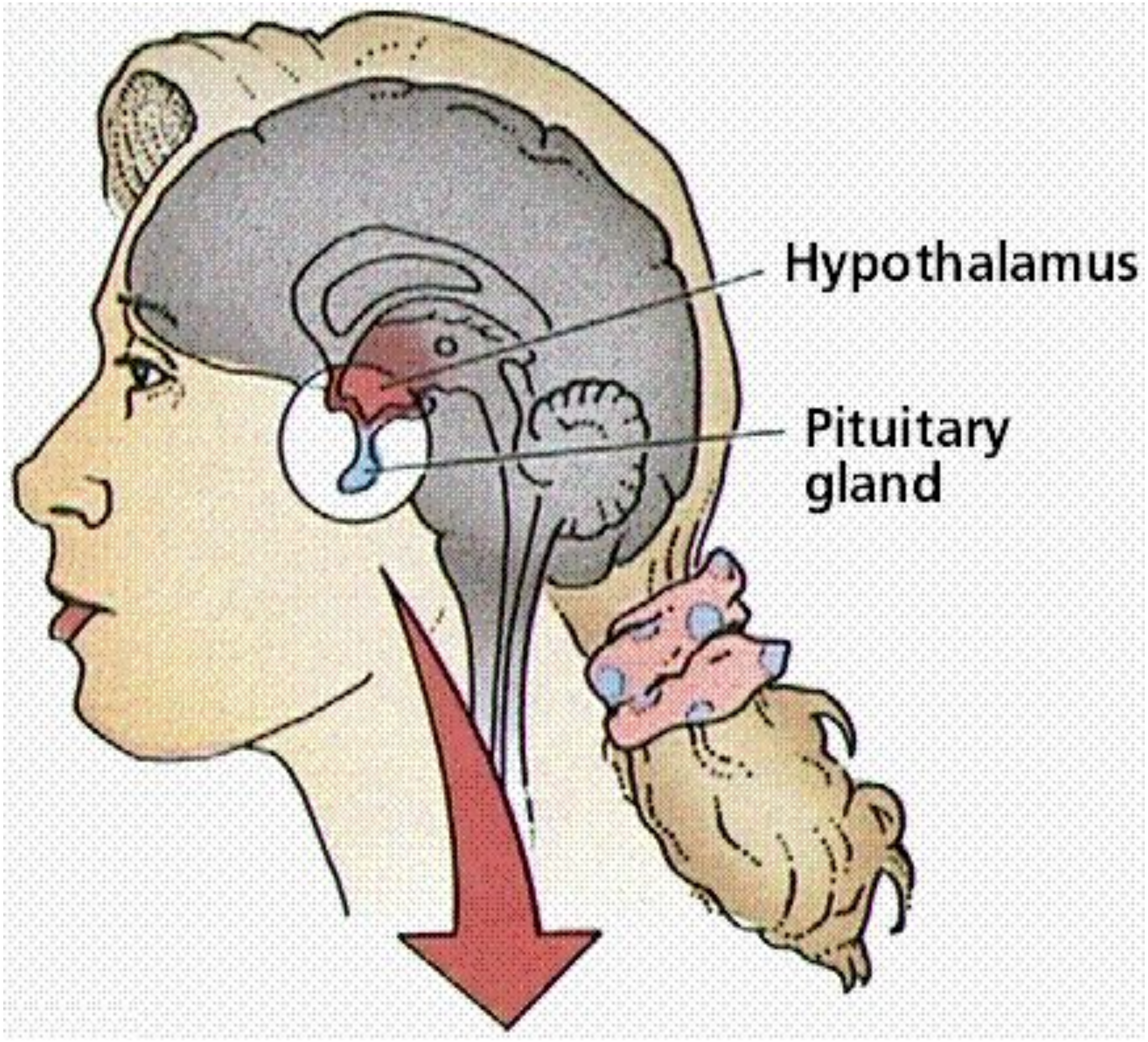
The ability to keep the body temperature within its limitations even when the surrounding temperature is different.

Temperature control

- **Temperature control** is the process of keeping the body at a **constant** temperature of 37°C.
- Our body can only stay at a constant temperature if the heat we generate is balanced and equal to the heat we lose.
- Although our core temperature **must be 37°C**, our fingers and toes can be colder. This is because energy is transferred from the blood as it travels to our fingers and toes.

Hypothalamus

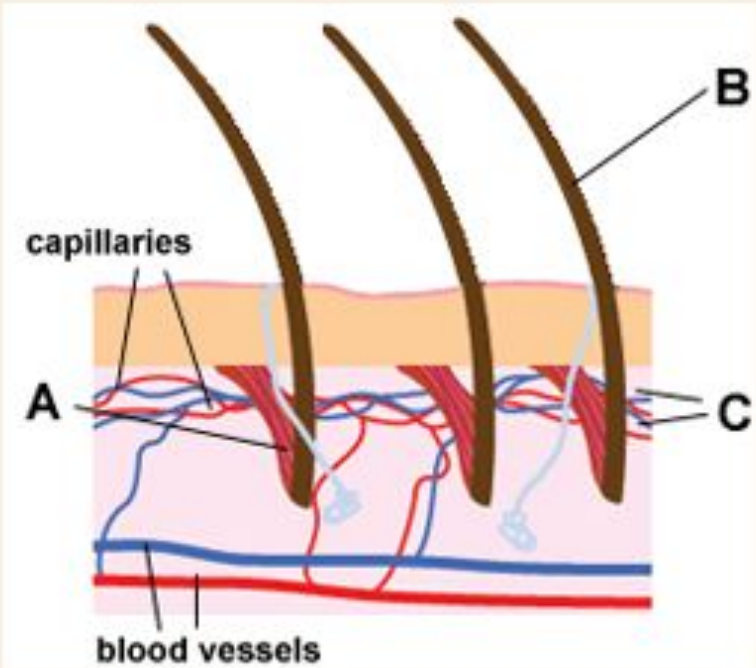
- Temperature **receptors** in the skin detect changes in the external temperature. They pass this information to the processing centre in the brain, called the **hypothalamus**.
- The hypothalamus has temperature receptors to detect changes in the temperature of the blood.
- the hypothalamus automatically triggers changes to **effectors** to ensure our body temperature remains constant, at 37°C.
- The effectors are **sweat glands and muscles**.


Hypothalamus
Pituitary gland

- If we are too hot or too cold, the processing centre sends nerve impulses to the skin, which has two ways to either increase or decrease heat loss from the body's surface.
- Tiny muscles in the skin can quickly pull the hairs upright to reduce heat loss, or lay them down flat to increase heat loss.
- Hairs on the skin trap more warmth if they are standing up, and less if they are lying flat. Tiny muscles in the skin can quickly pull the hairs upright to reduce heat loss, or lay them down flat to increase heat loss.
- If the body is too hot, glands in the skin secrete sweat onto the surface to increase heat loss by evaporation. This cools the body. Sweat secretion slows when the body temperature returns to normal.

Controlling temperature

Too cold

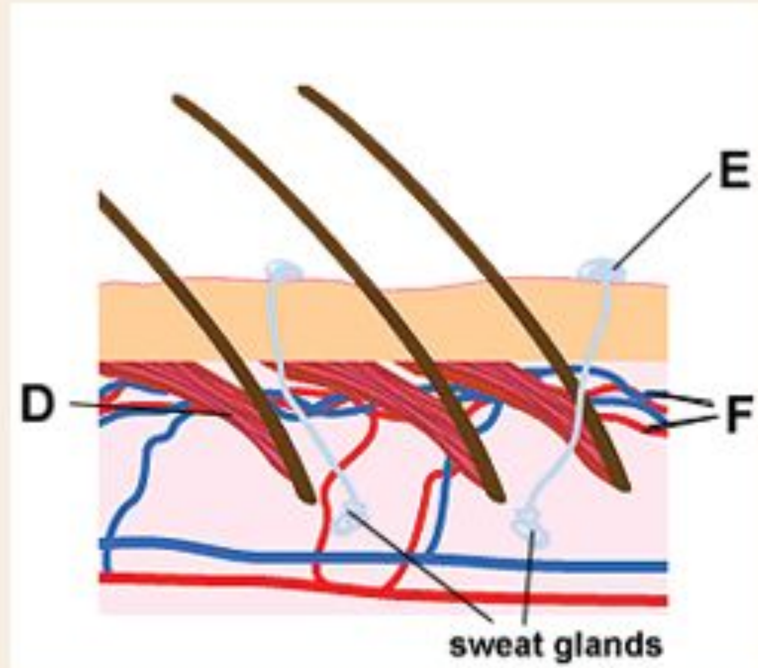


A - Hair muscles pull hairs on end.

B - Erect hairs trap air.

C - Blood flow in capillaries decreases.

Too hot

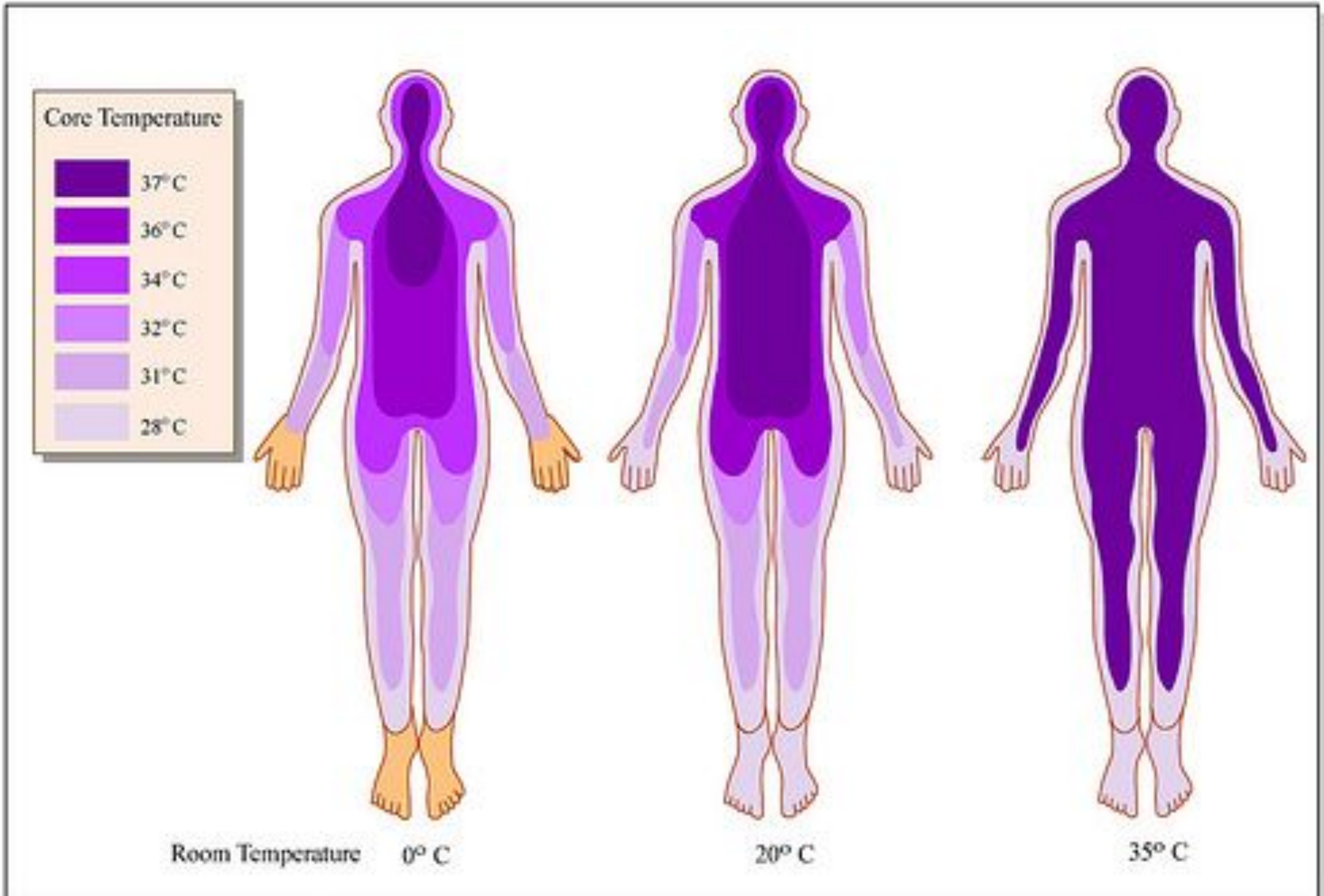


D - Hair muscles relax. Hairs lie flat so heat can escape.

E - Sweat secreted by sweat glands. Cools skin by evaporation.

F - Blood flow in capillaries increases.

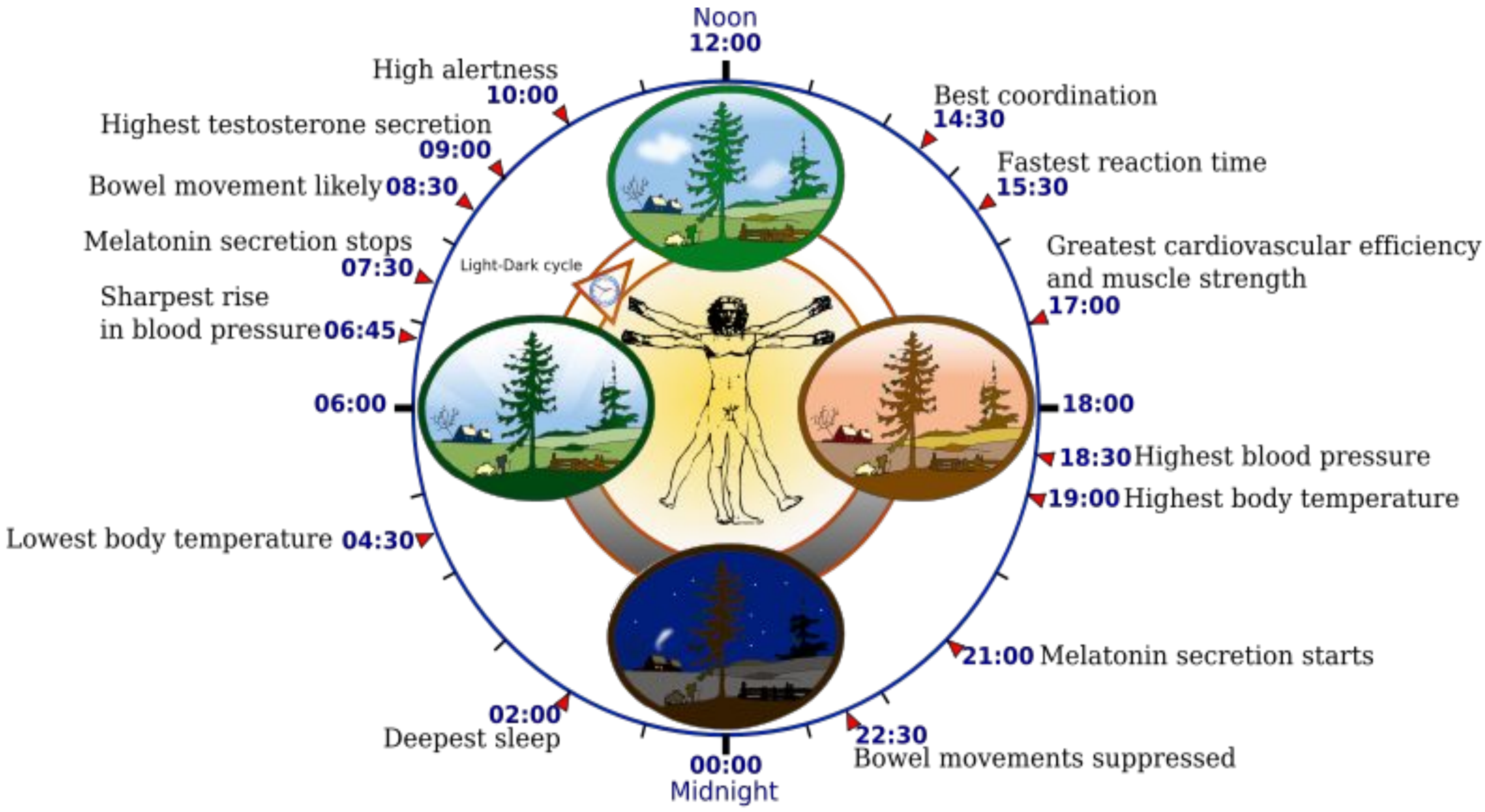
Core temperature maintained despite of environmental changes



normal body temperature?

- Normal body temperature can vary slightly
- It is influenced by factors such as exercise, eating, sleeping and the time of the day & time of the month.
- The lowest temperature is usually recorded at around 4am, the highest at 6 - 7pm.

normal body rhythms



Normothermia/euthermia

The average normal body temperature taken in the mouth is 37ºC (98.6ºF), but anywhere between 36.5ºC and 37.2ºC (97.7ºF and 99ºF) may be normal.

The accepted range of "normal" temperature is from 97F (36.1C) to 99F (37.2C)
For

- Rectal = 34.4–37.8 °C (94–100 °F)
- Tympanic cavity = 35.4–37.8 °C (96–100 °F)
- Auxiliary = 35.5–37.0 °C (96–99 °F)

Causes of temperature variation

- Environmental
- Exercise
- Food/drink
- Dehydration (vomiting & diarrhoea)
- Drugs
- Infection
- Inflammation
- Disease

An increase in body temperature can occur;

- Infective conditions
- Inflammation
- Immunological diseases
  - Lupus
  - Sarcoidosis
  - Inflammatory bowel disease
- Drugs
  - Adverse reaction to drugs/immunisation
  - Chemotherapy
  - Recreational drug withdrawal
- Metabolic disorders
  - Gout (local)
  - hyperthyroidism

Considerations when taking a temperature

- Room temperature
- How is the patient dressed
- Temperature site
- The equipment
- Is the equipment in working order
- Why are you taking the temperature
- Any medical history

Hyperthermia (heat stroke)

- Occurs when the body produces or absorbs more heat the it can dissipate.
- The most common cause is heat stroke and adverse reactions to drugs (cancer treatment eg radiotherapy)
- The body's set temperature remains the same

fever

- Fever occurs when the core temperature is set higher
- Usually in response to bacterial or viral infections
- Certain cells in the blood release pyrogens (a substance that induces fever) which have a direct effect on the hypothalamus causing body temperature to raise

hypothermia

- Happens when the body temperature falls below 35c
- Hypothermia can quickly become life threatening and treated as a medical emergency
- Usually triggered by being in a cold environment
- The elderly, the ill and those who are unable to move around easily to generate heat are most at risk
- Babies are also prone to hypothermia because their ability to control temperature isn't fully developed

Any questions?

Respiratory system

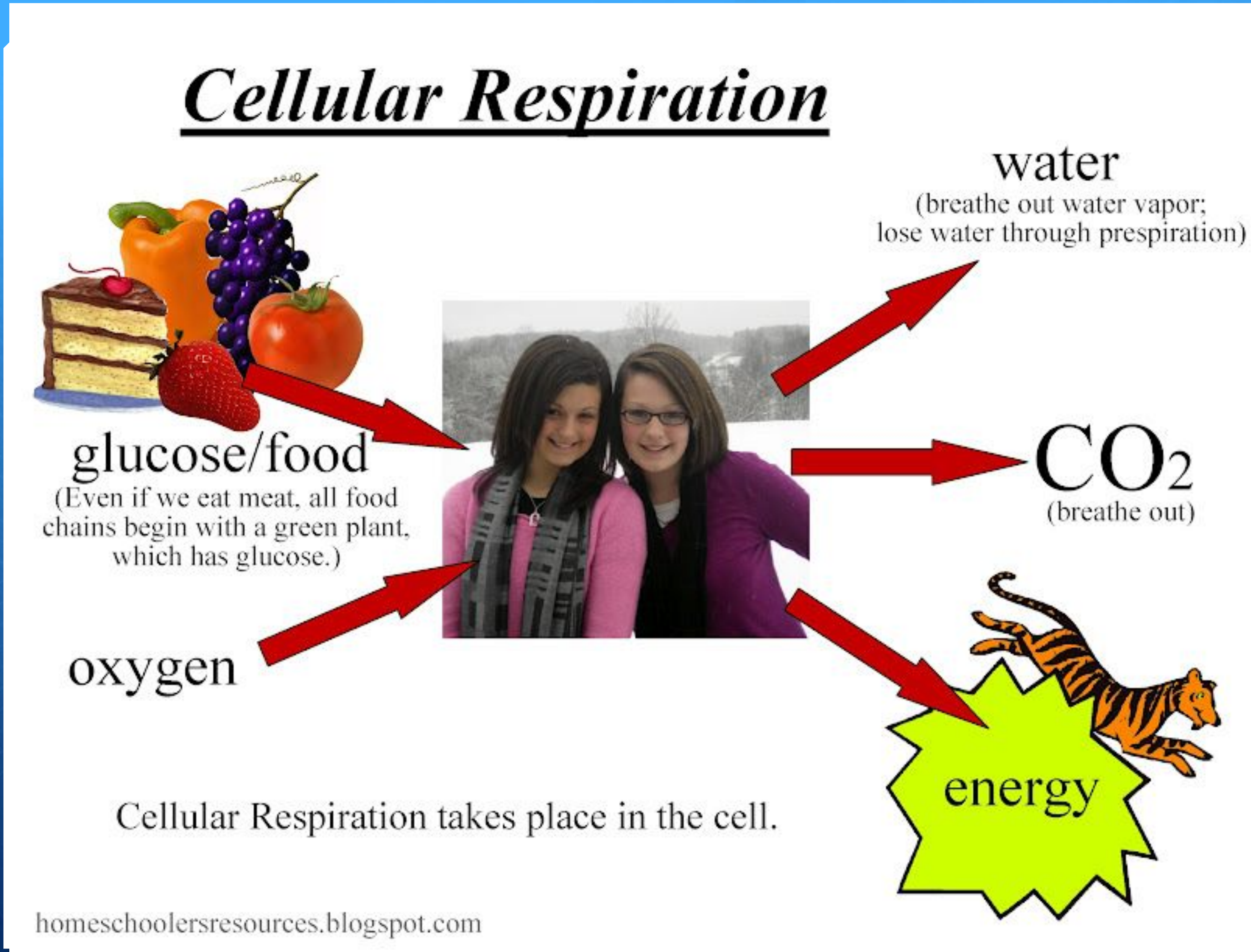
Lynne Powell

Respiration is defined as;

The transport of oxygen from the outside air to the cells within tissues and the transport of carbon dioxide in the other direction

Respiration v. ventilation

- Respiration is a chemical reaction that happens in all living cells. It is the way that energy is released from glucose, for our cells to use to keep us functioning.
- Remember that respiration is not the same as breathing (which is properly called ventilation).
- Breathing includes inspiration (breathing in) and exhalation (breathing out)

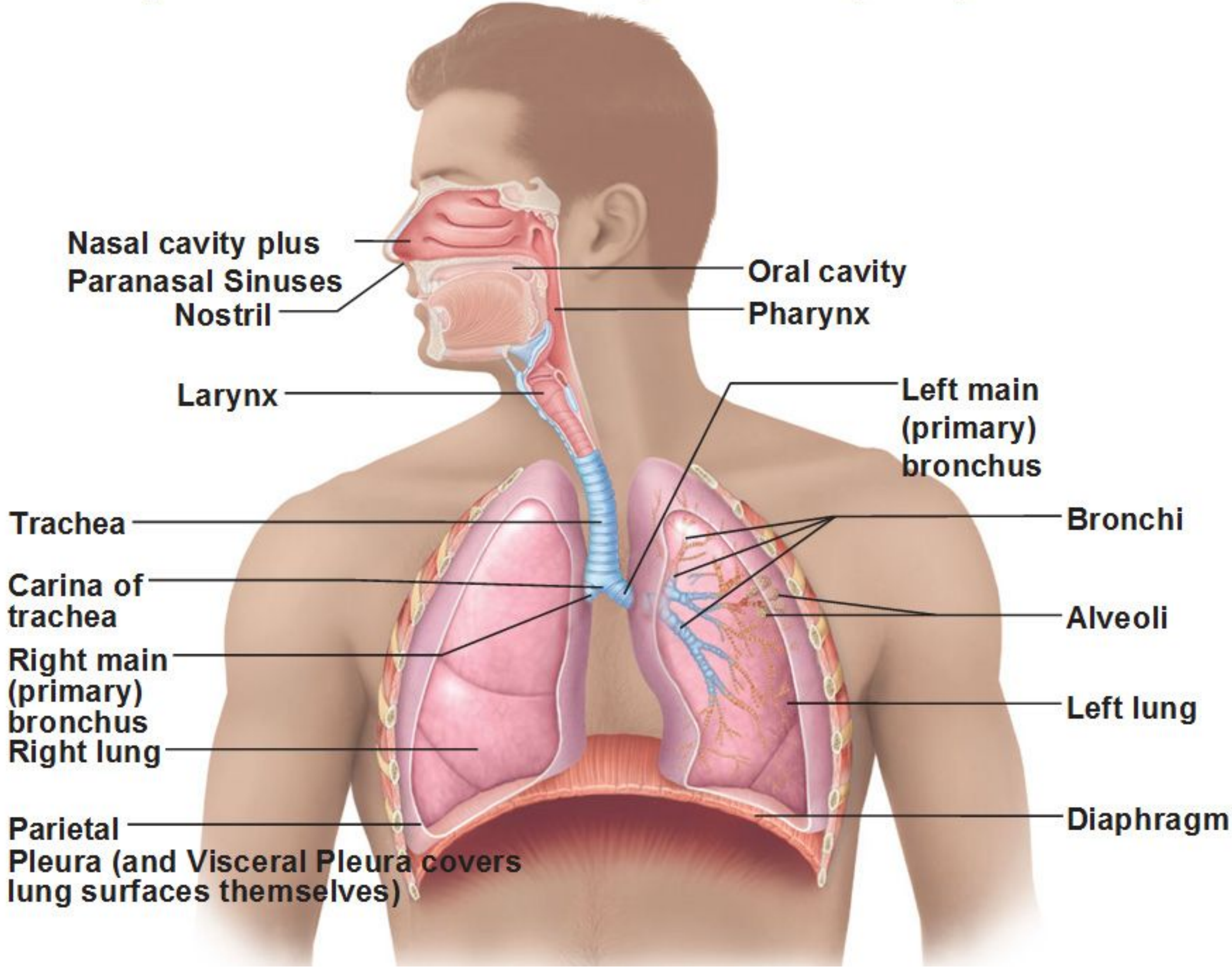

Cellular Respiration
water
(breathe out water vapor;
lose water through prespiration)
glucose/food
(Even if we eat meat, all food
chains begin with a green plant,
which has glucose.)
CO2
(breathe out)
oxygen
energy
Cellular Respiration takes place in the cell.
homeschoolersresources.blogspot.com

The respiratory system

The human respiratory system contains the organs that allow us to get the oxygen we need and to remove the waste carbon dioxide we don't need. It contains these parts:

- lungs
- tubes leading from the lungs to the mouth and nose
- various structures in the chest that allow air to move in and out of the lungs. The diaphragm, ribs,

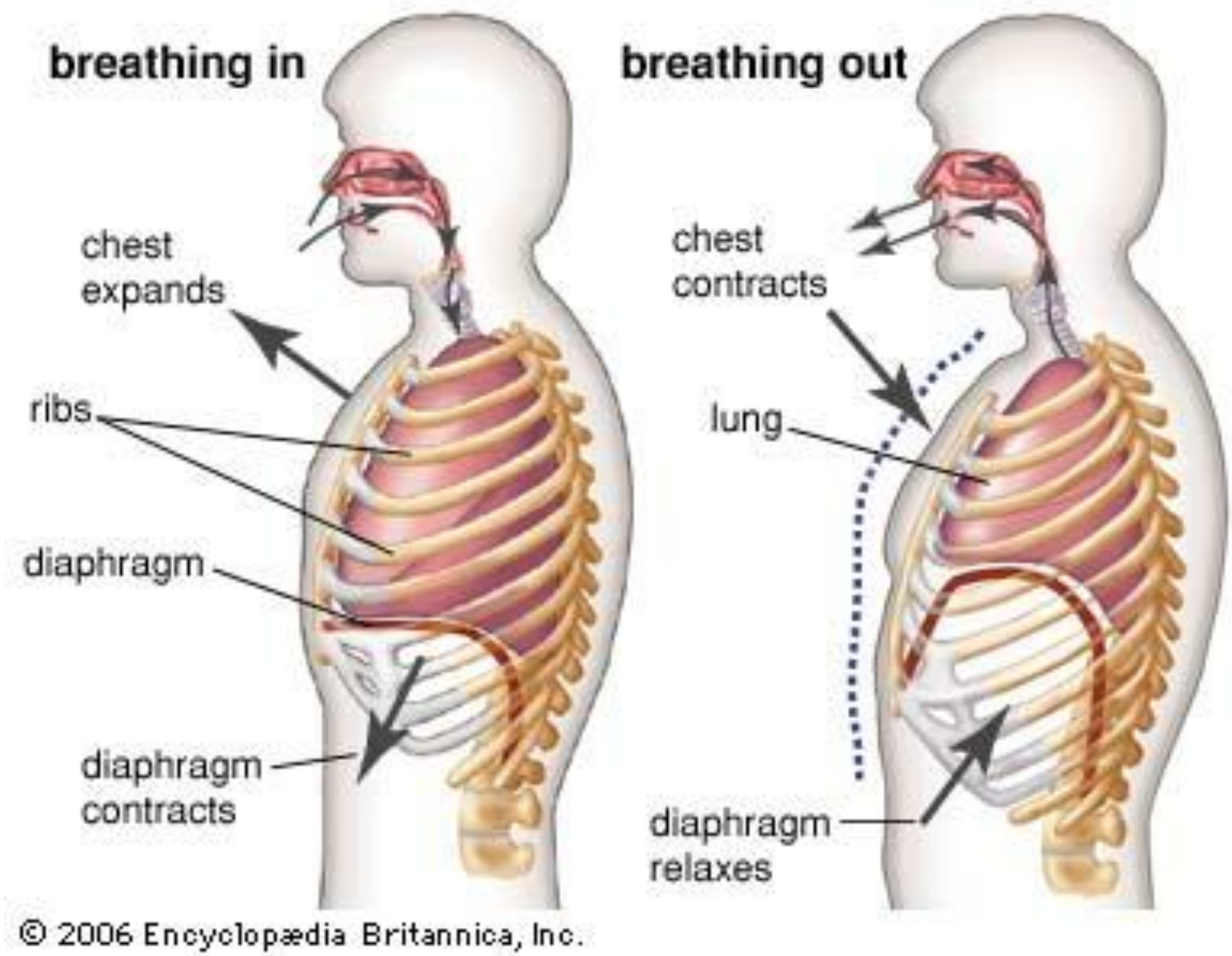
Organs of the Respiratory System



Ventilation

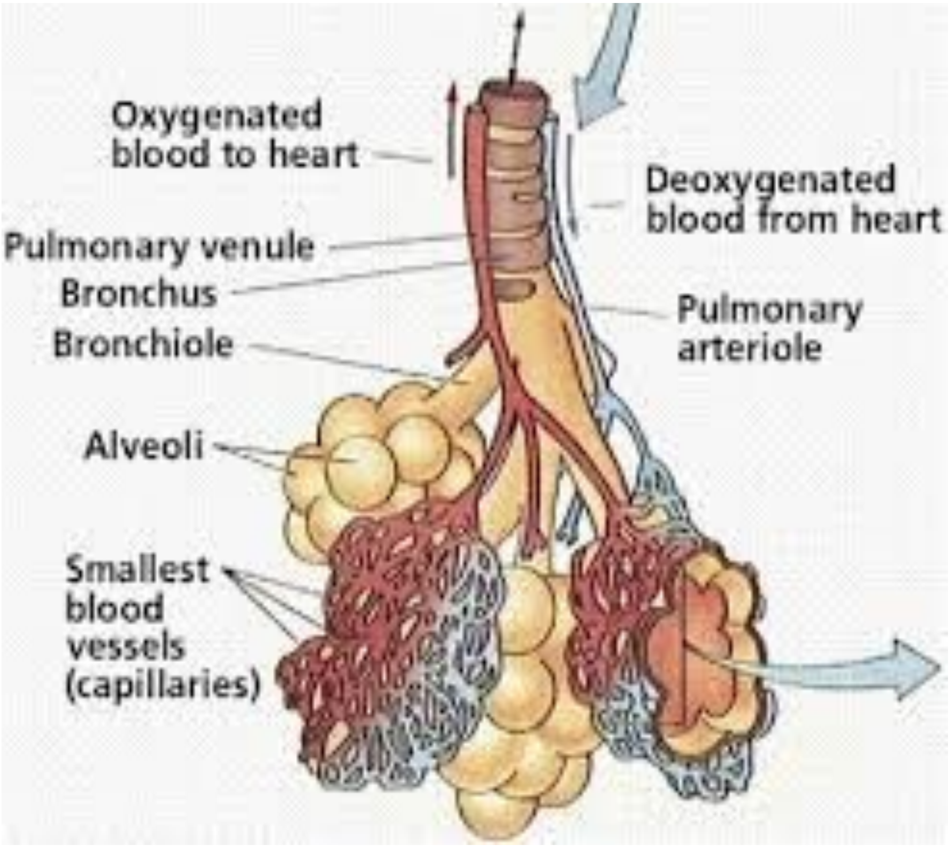
- Movements of the ribs, rib muscles and diaphragm allow air into and out of the lungs.
- this is called **breathing** or **ventilation**, not respiration.
- Air passes between the lungs and the outside of the body through the **trachea**
- The trachea divides into two bronchi, with one bronchus for each lung.
- Each bronchus divides further in the lungs into smaller tubes called bronchioles.
- At the end of each bronchiole, there is a group of tiny air sacs. These air sacs have bulges called **alveoli**

Ventilation

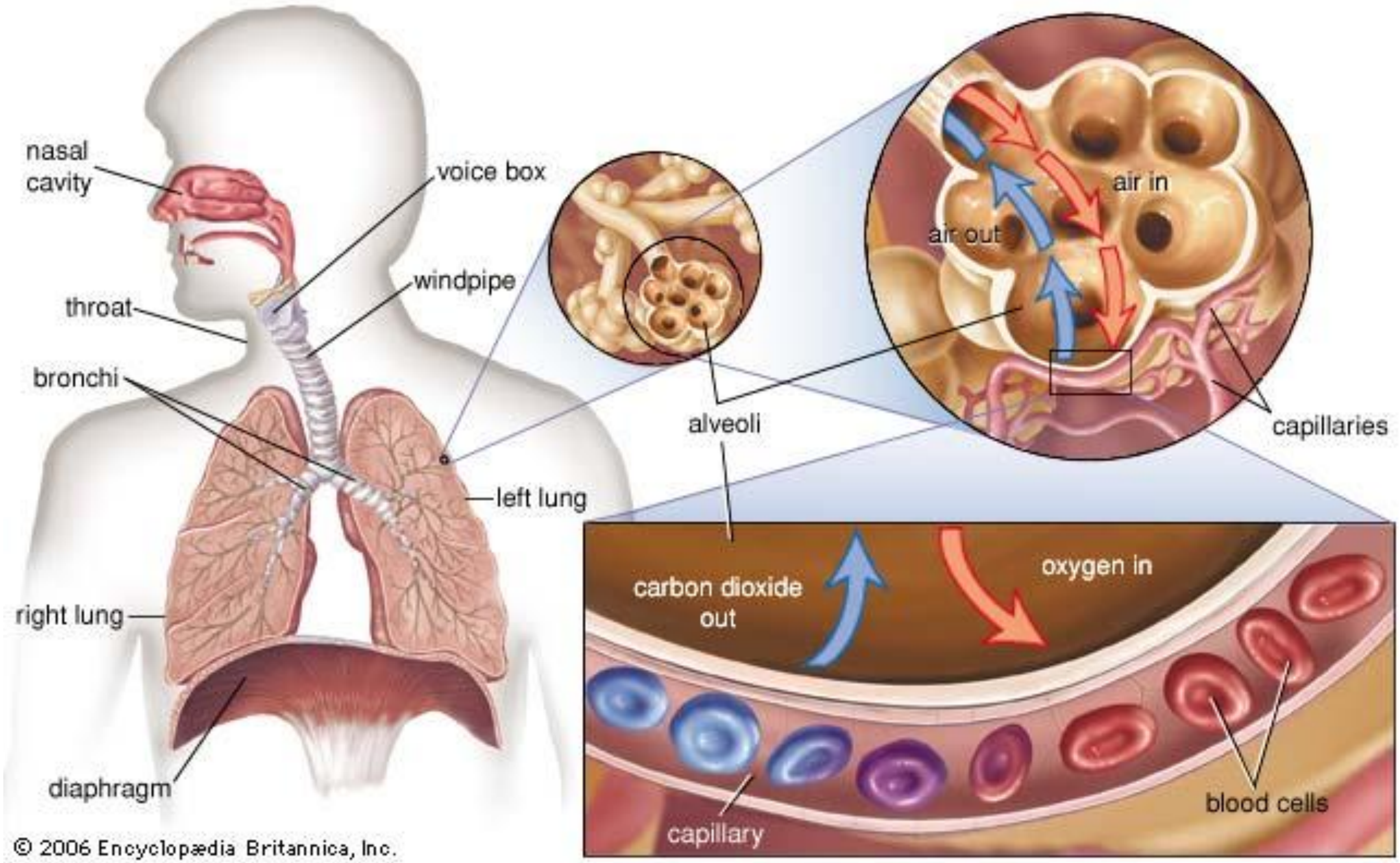


Gas exchange

- We need to move oxygen from the air into the blood and waste carbon dioxide from the blood into the air
- alveoli are adapted to make gas exchange in lungs happen easily and efficiently



Gaseous exchange



Respirations are recorded for a number of reasons:

- To acquire a baseline.
- To monitor a patient with breathing problems.
- To aid in the diagnosis of disease.
- To evaluate the response to medication that affects the respiratory system.

When measuring and recording breathing, the **rate** and pattern of breathing should be recorded.

- The rate should be regular with equal pause between each breath. The rate can be irregular with disease of the respiratory system. Any irregularities should be noted and reported.

- When observing the respiratory rate, noting the colour of the patient□s lips is important. They may be cyanosed (blue) or discoloured if the patient has respiratory problems. Cyanosis can also be observed in the nail bed, tip of the nose and ear lobes.

- The patient’s oxygen saturation (SaO_2) may be recorded using a pulse oximeter.

- Pulse oximetry provides a reading oxygenation in the red blood cells. Using a pulse oximeter may require the patient to have less arterial blood gases performed, by providing the medical team with a guide to the patient□s oxygenation level.

Observing breathing

is the patient;

- mouth breathing
- pursing the lips on expiration,
- using the abdominal muscles
- flaring the nostrils

Observe

- Lips
- Ear lobes
- Tip of the nose

Average respiratory rates, by age:

- Average adult 10-20 breaths/min
- Newborns: Average 44 breaths per minute
- Infants: 20–40 breaths per minute
- Preschool children: 20–30 breaths per minute
- Older children: 16–25 breaths per minute
- Adults during strenuous exercise 35–45 breaths per minute
- Athletes' peak 60–70 breaths per minute

Measuring respiratory rate

- The human respiration rate is usually measured when a person is at rest.
- Record the number of breaths for **one full minute** by counting how many times the chest rises.
- When checking respiration, it is important to also note whether a person has any difficulty breathing.
- The invasiveness of touch/observation is enough to sometimes make significant changes in breathing. .

PEAK FLOW MEASUREMENT

- Measurement of expiratory flow.
- Standard range peak flow meters are suitable for both adults and children.
- Low range peak flow meters are designed for adults and children with severely impaired function of the lungs.
- Readings will vary according to **age**, **height** and **gender** (male or female).
- Record children's height at every visit (at least annually).

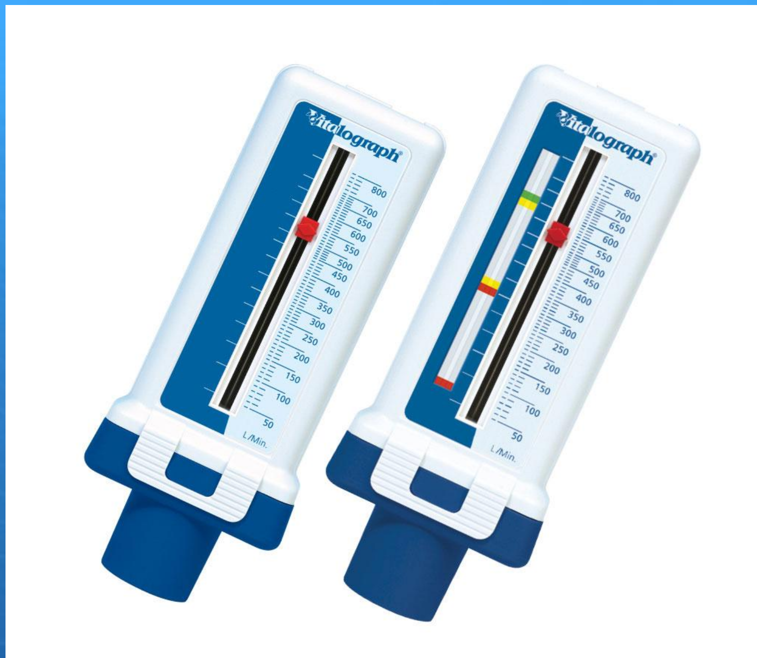
To take a peak flow reading you should:

- check that the pointer is at zero.
- preferably stand or sit in a comfortable, upright position.
- hold the peak flow meter level (horizontally) and keep your fingers away from the pointer.
- take a deep breath and close your lips firmly around the mouthpiece.
- then blow as hard as you can - as if you were blowing out candles on a birthday cake - remember it is the **speed** of your blow that is being measured.
- look at the pointer and check your reading.
- reset the pointer back to zero.
- do this three times and record the highest reading in your daily asthma diary.

Vitalograph

Mini-Wright™

PEAK FLOW METER



Infection control considerations

DISPOSABLE MOUTH PIECES

ACTION PLAN FOR PATIENTS with asthma

- **Green**: 80 to 100 percent of your personal best peak flow measurement; asthma is under control.

- **Yellow**: 50 to 79 percent of your personal best peak flow measurement; asthma is getting worse; you may need to use quick-relief medications or other medication, as directed by your doctor.

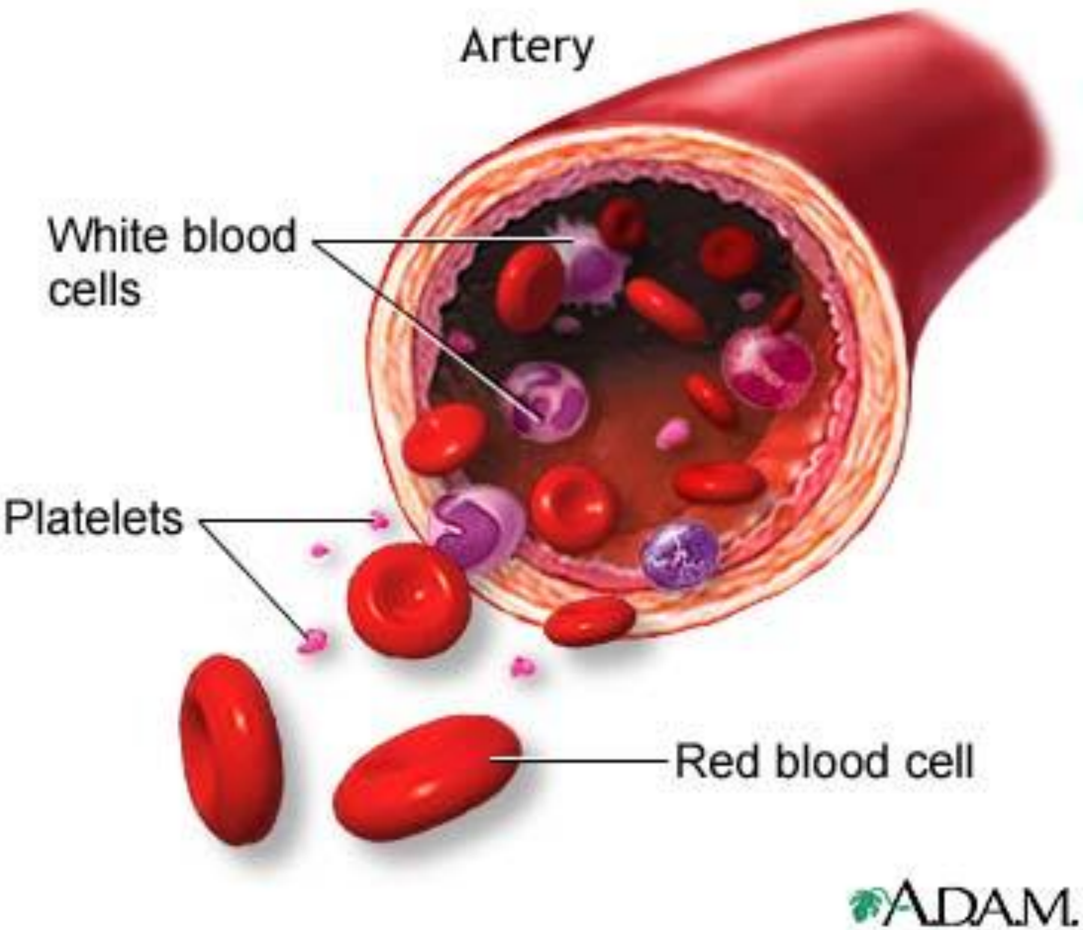
- **Red**: below 50 percent of your personal best peak flow measurement; medical alert, take quick-relief medication and seek medical help immediately.

Pulse oximetry

Pulse oximetry

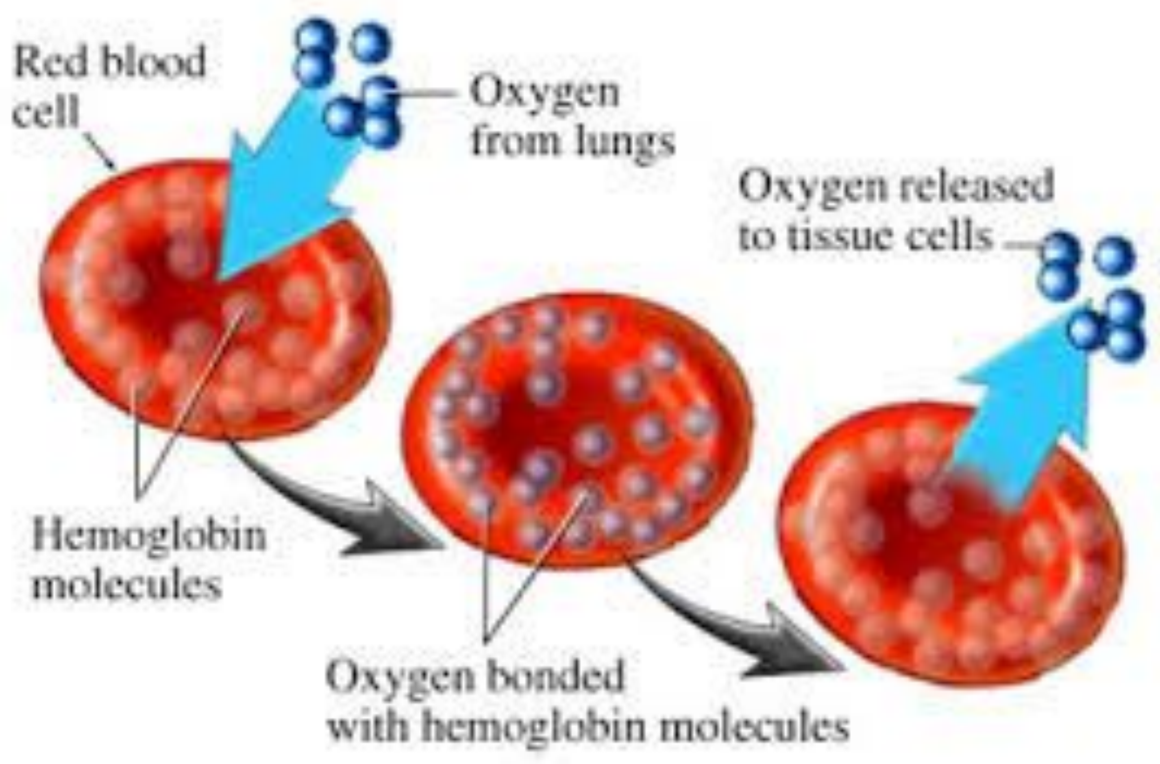
Non-invasive method of monitoring the % of **haemoglobin** (Hb) saturated with oxygen.

Blood



Red cells contain haemoglobin that have the ability to pick up and release oxygen under differing pressures

- Haemoglobin is the active oxygen carrying part of the erythrocyte (red blood cell)
- Blood carries oxygen in 2 ways – dissolved in plasma (approx 3%) & attached to haemoglobin



Most oxygen is carried by haemoglobin but 3 factors influence the amount of oxygen delivered to the tissue;

1. Tissue perfusion – blood supply to area
2. Amount of haemoglobin
3. Saturation of haemoglobin

How does a pulse oximeter work?

- Calibrated during manufacture.
- It emits two wavelengths which are partly absorbed by haemoglobin.
- It is able to distinguish between the types of blood vessels and pick up arterial flow (pulsitile).
- It absorbs the red and infrared light of the systolic component of the wavelength.
- It then computes the amount of haemoglobin that is saturated with oxygen.

Limitations of pulse oximetry

- Not reliable in patient's with poor circulation (e.g. peripheral vascular disease, anaemia, hypothermia, critically ill pts)
- Does not work through nail vanish, dyes or pigments.
- Not reliable in patients that have an irregular pulse rate.
- Shivering and movement give false readings.
- There have been reports of skin burns (earlier models).
- Not reliable in bright overhead lighting.
- Extremely misleading in cases of carbon monoxide poisoning (causes saturation levels toward 100%) CO-oximetry should be used.

Using an oximeter

- Resting readings should be taken for at least 5 mins
- The sensor is usually placed on a thin part of the patient’s body e.g. fingertip, earlobe
- The hand should be rested either on the chest at the level of the heart or on a flat surface.
- Ensure the digit is inserted fully as light should not reach the detector except through the tissue.
- Check that the displayed heart rate correlates to a manually checked rate

Results of pulse oximetry

- 95 - 100% = Acceptable normal ranges
- 92% or less = Refer for oxygen assessment
- 88 - 94% = Hypoxic drive problem
- 100% = may indicate carbon-monoxide poisoning or cyanide poisoning

Top tips for pulse oximetry

MHRA

Pulse oximetry is a non-invasive way to measure the oxygen saturation (SpO_2) of arterial blood. The value will vary between different devices and patients and can lead to errors of up to ± 4% in the range 70-100% SpO_2. Below 70% the accuracy falls. Although pulse oximetry will not give a precise value of oxygen saturation, it is useful for following trends. It does not measure carbon dioxide (CO_2) levels.

Attend to the patient if the oximeter shows low saturation; don't assume the equipment is faulty. If in doubt, check the arterial blood gases. Patients with a SpO_2 below 95% should cause concern and a reading below 90% requires immediate investigation.

%

SpO_2

To achieve optimum performance and precision users should consider the following points that affect the calculation of SpO_2.

- Use the appropriate probe and ensure it fits securely. Remember too tight causes constriction; too loose lets light in. Do not pull or stretch the cable and beware of motion artefacts when transporting patients.
- Nail coatings: where possible remove nail polish, check for false nails and consider an alternative site.
- Poor peripheral blood circulation may reduce the arterial pulsation, making it difficult to pick up a signal. Beware: hypovolaemia; cold; cardiac failure; arrhythmias; peripheral vascular disease, and the position of a non-invasive blood pressure cuff.
- Carboxyhaemoglobin (COHb) in cases of smoke inhalation absorbs similar wavelengths of light as oxyhaemoglobin; therefore COHb will lead to an overestimation of the actual oxygen saturation.
- Presence of Methaemoglobin (MetHb).
- Darker skin pigmentation may cause an overestimate of SpO_2 at saturations below 70%.
- The use of some dyes, such as methylene blue (used in surgery or to treat methaemoglobinaemia), may affect the absorption of light.

Other factors:

- Clean, maintain and regularly replace probes according to the manufacturer's recommendations.
- Have a spare probe to hand. Replace damaged probes immediately.
- Ensure that the probe is fully compatible with the pulse oximeter.
- Reduce the risk of tissue necrosis by following the manufacturer's advice on changing the sensor site and using the recommended fixation dressings.
- In an MRI environment only use probes designated MR CONDITIONAL or MR SAFE.

Report adverse incidents to the MHRA via our website www.mhra.gov.uk

This leaflet was produced in conjunction with the Association of Anaesthetists of Great Britain and Ireland

Medicines & healthcare products regulatory agency

Any questions?