Human Systems - Circulation - Lesson 4: Regulation of Blood Flow

Cardiac Output

- Cardiac output is the amount of blood that flows from the heart per minute

- The left and right side of the heart pump the same amount of blood

- Two factors affect cardiac output

    1. **Stroke volume** - quantity of blood pumped with each heart beat

    2. **Heart rate** - number of heart beats *per minute*

Cardiac output = heart rate x stroke volume

- Stronger hearts can pump more blood with each beat

    - Average stroke volume for a 70 kg person is **70 mL** per beat

- People with better fitness have a higher stroke volume and a lower heart rate

- People of the same size have the same cardiac output

    - stroke volume and heart rate will be different if level of fitness differs

Table 1 Cardiac Output of Two People

Person	Stroke volume (mL/beat)	Heart rate (beats/min)	Cardiac output (stroke volume × heart rate)
Tom	50	100	5 L
Lee	100	50	5 L

+ stroke volume

- During exercise the heart rate increases to meet the increased demands for oxygen, nutrients and waste removal

    - ~~Stroke volume does not change~~

    - If heart rate increases then cardiac output increases

Blood Pressure

- Blood pressure is the force of the blood on the walls of the arteries

- Blood pressure is measured using a **sphygmomanometer**

    - A cuff with an air bladder is wrapped around the arm

    - A small pump is used to inflate the air bladder, thereby closing off blood flow through the brachial artery

    - A stethoscope is placed below the cuff and air is slowly released from the bladder until a low-pitched sound can be detected

        - The pressure when this occurs is generated by the ventricles contracting

        - This is the **systolic** pressure

    - The cuff is then deflated even more, until the sound disappears

        - This represents the pressure in arteries when the heart is relaxed

        - This is called the **diastolic** pressure

http://www.nelson.com/ABbio20-30/teacher/protect/otr/Bio2030OTR/attachments/i_AnimationSimulation/blood_pressure.html

- Your blood pressure is reported as two numbers: systolic / diastolic

    - Normal blood pressure is around **120 / 80**

- Blood pressure is measured in the units of **mm of Hg**

Table 2 Blood Pressure Categories (for 18 years and older)

	Blood Pressure (mmHg)	
Category	**Systolic**	**Diastolic**
normal	< 120	< 80
pre-hypertensive	120 to 139	80 to 89
hypertensive		
stage 1	140 to 159	90 to 99
stage 2	≥ 160	≥ 100

Regulation of Blood Pressure

- Regulation of blood pressure is necessary since both high and low blood pressure can be dangerous

- High pressure can weaken an artery and eventually result in its rupture

- blood pressure receptors are located in the walls of the aorta and the carotid arteries

- When blood pressure is too high

  - A stronger signal is sent from receptors to the brain
  - The brain (medulla oblongata) reduces the sympathetic nerve signals and increases the parasympathetic nervous signals
  - This slows the SA node, which makes the heart beat slower, and reduces cardiac output
  - Ex. After exercising

- When blood pressure is too low

  - A weaker signal is sent from receptors to the brain
  - The brain increases sympathetic nerve signals and reduces parasympathetic nervou signals
  - This speeds up the SA node, which makes the heart beat faster, and increases cardiac output
  - Ex. When you stand up after sitting for a long period of time

Read 'Response of the Circulatory System to Exercise' on pg 331

Regulating Body Temperature

- Thermoregulation is the maintenance of body temperature within a range in which cells can operate normally

- Response to overheating caused by exercise or high environmental temperatures:

  - Sensors in the brain detect rise in temperature
  - Hypothalamus (part of brain) sends signals to sweat glands to produce sweat
    - Heat is lost through evaporation of sweat
  - Hypothalamus sends signals to blood vessels in the skin to dilate
    - Heat is lost by the blood to air
  - As a result, body temperature drops and sweating stops and blood vessels constrict again

- Response to a drop in body temperature
  - Sensors detect a drop in temperature
  - Hypothalamus (part of brain) sends signals to skeletal muscles to contract causing shivering
    - Heat is generated
    - Only effective for short time periods
  - Hypothalamus sends signals to blood vessels in the skin to constrict
    - Less heat is lost by the blood to air

http://www.nelson.com/ABbio20-30/teacher/protect/otr/Bio2030OTR/attachments/i_AnimationSimulation/temp_regulation.html