***Circulatory System***

**Closed System:** Blood **contained within vessels**

**Heart → arteries → arterioles → capillaries → venules → veins → heart**

Blood is moved through veins by muscles squeezing the veins and forcing blood along

|  |  |  |
| --- | --- | --- |
| **Arteries** | **Veins** | **Capillaries** |
| **Small Lumen** | **Large lumen** | Very narrow |
| **Thick layer** of muscle and elastic tissue | **Thin layer** of muscle and elastic tissue | Walls **one cell thick** |
| **Valves absent** | **Valves present** to **prevent backflow** | **Porous** walls allow exchange |
| Carries blood **away from heart** | One way flow of blood **towards heart** | **Very close to all cells** |
| **High pressure - pulse** | **Low pressure** – **no pulse** | Link arterioles and venules |

**Functions of Blood**

***Blood Smear***

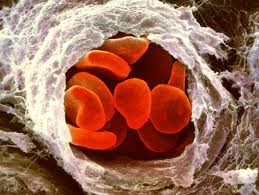
* **Transport - food, wastes, hormones, oxygen** etc.
* **Protection - antibodies, white blood cells, clotting**
* **Homeostasis - distributes heat around body**  
   **- Keeps pH steady 7.4**

**Composition**

**Plasma (~55%) : Cells (~45%)**

**1. Plasma**

* **Water 90%**
* **Proteins 8%**
* **Nutrients**

**

***Capillary***



***Red Blood Cells***

* Gases
* Ions
* **Waste materials**

**2. Red Blood Cells** [**erythrocytes**]

* Made in red **bone marrow**
* **Biconcave discs**
* Survive **120 days**
* Contain **Haemoglobin** [dark red] which picks up oxygen to form **oxyhaemoglobin** [bright red]. **Carries O2** from lungs to all parts of body. Oxygen set free when blood reaches a location where oxygen is needed.
* **No nucleus** and **No mitochondria**
* **Transport CO2** [20% of all CO2 carried in red blood cells]
* **Lack of iron** leads to a lack of red blood cells which **causes anaemia**
* **Destroyed** in **liver** and **spleen** [form **bilirubin** and **biliverdin** which are **bile pigments**]

**3. White Blood Cells**

**Functions** produce **antibodies** and **engulf cells (phagocytosis)**

* **Lymphocytes** 
  + **T-cells attack** cells infected by **viruses** or have turned **cancerous**
  + **B-cells** make **antibodies** that attack bacteria
* **Monocytes** 
  + **Engulf cells** by **phagocytosis**
  + **Present antigens to T-Cells** so that they can respond to them

Produced in red **bone marrow**

Move in blood to all parts of the body

Some take up residence in organs e.g. liver, spleen, lymph nodes and tonsils

**4. Platelets**

* **Cell fragments**
* Involved in **clotting**
* Plug tears in blood vessels to **prevent blood loss** and **entry of pathogens**

**Blood Groups**

Based on surface chemistry of red blood cells i.e. **antigens on cell surface**

* **A**  – antigen A on surface,
* **B**  – antigen B on surface,
* **AB**  – antigens A and B on surface, [**universal recipient**]
* **O**  – no antigens on surface so not recognised as foreign [**universal donor**]

**Rhesus+ and Rhesus–**

* **­­Rhesus+** has **rhesus antigen on surface** of red blood cells
* **Rhesus-** has **no rhesus antigen** on surface of red blood cells
  + **Rh- mother can attack Rh+ baby in womb causing problems**

**Double Circulation**

* **Pulmonary** circulation: heart → **lungs** → heart
* **Systemic** circulation: heart → **body** → heart

**Heart Internal Structure and Blood Flow**

**Heart**

* Located **in thoracic cavity**
* Strong double pump
* Made of special muscle

– **does not tire**

– **branched**

* Get oxygenated blood through **coronary arteries**
* Comes **from aorta** just after semi-lunar valves
* Blood returns through **coronary veins**

**Hepatic Portal System**

Carries **glucose**

***N.B. The direction of blood flow in all three vessels***

**amino acids**

**minerals** from **intestine to liver**

**Cardiac Cycle**

* **Diastole** the **filling** phase **heart relaxed**
* **Systole** the **emptying** phase **muscles contracting**

**Sequence**: heart relaxed / blood flows into atria from veins / bicuspid and tricuspid valves relax / blood flows into ventricles / atria contract pushing more blood into ventricles / ventricles contract / forces blood into arteries / bicuspid and tricuspid valves slam shut / “lub” sound / ventricles relax / blood tries to flow back from arteries into heart / semilunar valves slam shut / “dub” sound

**Dissect, Display and Identify a Sheep’s Heart.**

* **Identify right** and left – **left side thicker** or firmer [ pumps blood further]
* Place **ventral side up**
* On **dissecting board**
* **Note coronary artery** emerging from start of aorta and running over front of heart
* Using **a scalpel**
* Make **cut from centre of left atrium to left ventricle** – not on septum
* **Repeat on right side**
* **Identify and flag label** atria and ventricles, bicuspid and tricuspid valves
* **Cut down pulmonary artery** and aorta to **show semi-lunar valves**
* **Safety precautions** – wear **rubber gloves** and wash and sterilise equipment after use

**Control of Heart Rate**

Heart muscle beats by itself

Heart muscle is **contractile** ***i.e. it can shorten***

**Pacemakers**

* **Sinoatrial Node** on the upper wall of right atrium
* **Atrioventricular Node** in the bottom of the right atrium near the septum.
* Average rate **75 beats per minute**.

**Rate affected by**

* **Nerve** signals
* **Hormones** e.g. adrenalin released when one is excited or frightened speeds it up.

**Pulse** ***wave of pressure along arteries caused by ventricles contracting***

**Blood Pressure** ***force exerted by blood on artery walls***

* **Highest at aorta** as it leaves the heart and lowest at the right atrium.
* **Measured on the upper arm**

|  |  |
| --- | --- |
| **Action** | **Result** |
| **Smoking** | **High blood pressure**, hardening of arteries, more risk of heart attack and stroke |
| **Diet**  High salt intake  Overeating | **High blood pressure** – danger of stroke  **Blocked coronary arteries** – heart attack |
| **Exercise** | **Heart stronger**, greater oxygen carrying capacity, lower resting heart rate |

**Investigate the Effect of Exercise on the Pulse [or Breathing Rate] of a Human.**

* **Record pulse at rest** using first and second fingers on wrist [or breathing rate]
* **Count** number of **pulse in 15 seconds** and **multiply by four** to get rate per minute

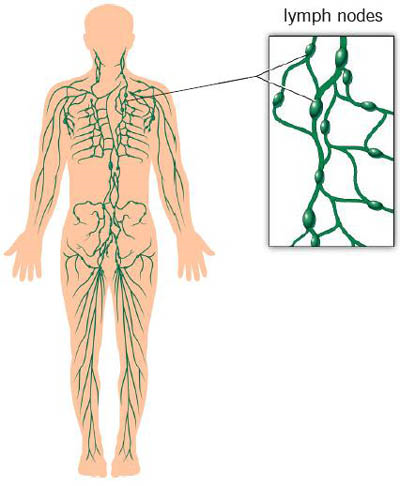
***Taking a Pulse***

* **Repeat 3 times – calculate average**
* Do **gentle exercise**
* **Calculate average** heart rate as before
* Note time taken for pulse to return to resting rate
* Do **vigorous exercise**
* **Calculate average** heart rate as before
* Note time taken for pulse to return to resting rate

**Results**

* **More strenuous exercise** causes **greater increase in heart rate**.
* **Fitter** one is **faster heart rate returns to normal** and the slower resting heart rate is
* Similar results for breathing rate

**Lymphatic System**

**

***Lymphatic System***

**Lymph**:

* All cells are bathed in **tissue fluid** which is plasma that has leaked from capillaries
* This flows into **lymphatic capillaries** and is called **lymph**, these capillaries merge to form **lymph vessels**.
* Along the lymph vessels there are swelling called **lymph nodes** which contain large numbers of **phagocytic** white blood cells that clean blood of **debris, bacteria and cancer cells.**
* Nodes are concentrated in neck, armpits and groin
* Vessels flow into the **thoracic duct** which drains into the blood at the **subclavian vein**
* **One way** flow – **valves** – muscle pressure moves lymph [similar to blood in veins]

**Functions** *[any three]*

**Defence**

* Nodes **filter plasma** removing pathogens and cell debris
* **Produce lymphocytes** [B and T cells]
* Lymphocytes **produce antibodies**

**Transport**

* **Fats absorbed** into the **lacteals** in **villi**
* **Fats from lacteals** taken **by lymph** and enter the blood at the **subclavian vein**
* **Tissue fluid** leaked from capillaries is **returned into blood** at **subclavian vein**
* **Returns plasma proteins** that have leaked from blood

**Defence System**

**Pathogen** ***Disease causing organism***

**Immunity** ***Ability of body to defend itself from pathogens, cancer cells and toxins***

**General Defence System**

* **Targets any intruder harmful and beneficial**

1. **Skin**

* **Physical barrier** – dead cells on surface fall off
* **Sweat and sebum** contain antibacterial and antifungal chemicals
* **Sebum** keeps **skin supple** to prevent cracking
* **Mutualistic bacterial** prevent other micro-organisms getting a foothold

1. **Mucous Membranes**

Lining cells that produce a sticky slime called **mucus**

**Breathing** **System**

* **Mucus** in breathing tract **traps pathogens**
* **Cilia** beat in unison to **move mucus from lungs** to throat where it is swallowed,
* **Hairs** in nose also **trap pathogens** and toxins

**Reproductive System**

* **Mucus traps pathogens**
* **pH in vagina** is **acidic** to **kill bacteria** and fungi

**Digestive** **System**

* **Mucus lubricates** the passage of food **preventing damage** and traps bacteria and fungi
* **Hydrochloric acid** in **stomach kills bacteria**
* **Mutualistic bacteria** in **large intestine prevent pathogens establishing** by **outcompeting** them.

1. **Phagocytic White Blood Cells [Monocytes]**

* **Roam at large** and **engulf** large numbers of bacteria in an **amoeba like fashion**.
* Pus is a collection of (dead) phagocytic white blood cells.

**Specific Defence System** **(Immune System)**

* **Targets particular pathogens or substances**

|  |  |  |  |
| --- | --- | --- | --- |
| **Antigen:** | | | ***a molecule (usually on cell surface) that stimulates the formation of antibodies.*** |
| **Antibody** | | | ***a protein made by lymphocytes in response to an antigen***  They **attach to the antigen** and **destroy** the antigen or the cell to which it is attached |
| **Induced Immunity** | | | ***is the defence response involving the production of a specific antibody following the introduction and detection of an antigen***. |
| **Active Immunity** | | | ***person produces their own antibodies in response to an antigen****.*  **Memory cells** give **long lasting** protection. |
| **Passive Immunity** | | | ***person does not produce their own antibodies but gets them from another source*** |
|  | * **Natural** - **mother passes antibodies across the placenta** and also in colostrum to her baby. * **Artificial** - **another animal makes the antibody** and it is given to the patient e.g. horse and tetanus | | |
| **Immunisation** | | medical ***protection against pathogens or toxins by vaccination or injection of antibodies*** | |
| **Vaccination** | | **administration of a pathogen** that is   * **dead** [whooping cough], * **weakened** [rubella] or a * **harmless relative** [cowpox for smallpox]   to **produce antibodies** and **memory cells**. | |

**Role of Lymphocytes**

* White blood cells **made in foetal bone marrow**.
* **B cells mature in bone marrow** and then enter the blood.
* Most of them take up residence in lymphoid tissue e.g. lymph nodes, spleen, tonsils and adenoids.
* **T cells mature in the thymus**