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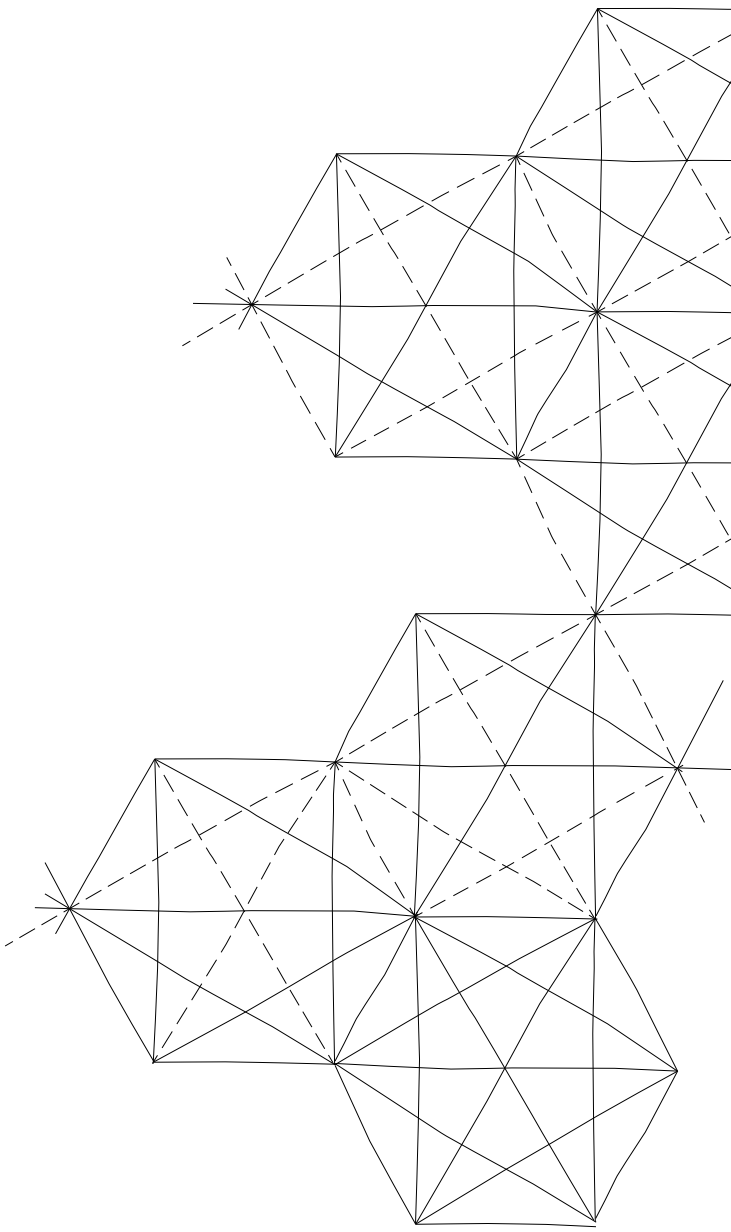

edited by

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Heart – Circulation – Respiration

Solutions

Ernst Klett Verlag
Stuttgart · Leipzig

1. Auflage 1 5 4 3 2 1 | 15 14 13 12

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Gestaltung: Normaldesign GbR, Schwäbisch Gmünd

Printed in Germany
A15150-044304

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1.1 The Heart

The most powerful muscle (page 10)

T1 Without physical load the heart beats about 70 times a minute, thereby pumping circa 6 liters blood through the whole body – all life long.

T2 The heart is situated in the left upper torso. It is protected by the ribcage and surrounded by the lungs. The diaphragm separates the upper half of the torso from the lower half, which contains the digestive organs.

T3 A pacemaker sends an electronic pulse that stimulates the heart muscle so that it contracts. An artificial pacemaker has a battery, which has to be replaced every few years.

T4 The heart contains the same things in both halves but the muscle layer is bigger on the left side. The reason for this is that the left side has to pump the blood into the whole body and thus needs a lot of power to get the blood to the toes (for example). The right side only has to pump the blood to the lung, which is right next to the heart, so this does not require as much power.

The most powerful muscle (page 11)

T5/T6

Structure of the heart	Function
right atrium	The blood with no oxygen flows back to the heart from the body.
valves (all of them)	The valves stop the blood from flowing backwards and mixing with other blood.
right ventricle	The blood flows into the right ventricle through the open valve. The right ventricle contracts and the blood is pumped into the pulmonary artery.
pulmonary artery	The pulmonary artery transports the blood to the lungs, where it picks up oxygen.
pulmonary veins	The pulmonary veins transport the oxygen-enriched blood back to the heart.
left atrium	The blood is collected in the left atrium.
left ventricle	The blood flows into the left ventricle through the open valve. The left ventricle contracts and the oxygen-enriched blood is pumped into the aorta.
aorta	The aorta transports the oxygen-enriched blood through the whole body.

T7 **Arteries:** Arteries are the vessels which transport blood away from the heart.
Veins: Veins are the vessels which transport blood back to the heart.
Capillaries: Capillaries are vessels that run between the arteries and the veins and are located all over the body.

T8 **Arteries:** Arteries have a thick muscle layer because of the pressure of the blood, which flows through them with great force.
Veins: Veins have valves in them to stop the blood from flowing backwards.
Capillaries: Capillaries are very thin and also have thin walls (oxygen and carbon-dioxide can pass through the walls).

T9 If you find a vein and you push the blood towards the wrist the blood will flow back, but not all the way because of the valves in the vein.

Systemic and pulmonary circulation (page 12)

T1 See pages 10 – 11.

T2 See pages 38 and 39.

T3 **Systemic circulation:** Oxygen-enriched blood enters into the heart through the left atrium, from there it flows through the valve into the left ventricle. The blood then enters the aorta through a valve. The aorta transports the blood to the organs in the body.

Experiments: Preparation of a pig heart (page 14)

T1 **Ventricles**: pump the blood through the aorta into the body or through the pulmonary artery to the lung → the ventricles have thick walls (the left side of the heart is bigger / has thicker muscles).
Blood vessels: These transport the blood to various parts of the body → the arteries have very strong walls and are very difficult to cut through with the scalpel; the veins are easier to cut through and if the ones on the heart are long enough you might see the valves.
Blood vessels around the heart: The capillaries surrounding the heart are very small and have very thin walls, you can fill the vessels with water if you inject it through a small glass tube.

T2 **Left atrium:** Is a small space surrounded by muscles.
Right atrium: Is the smaller opening on the right side.
Left ventricle: Has very thickly muscled walls and it is bigger than the right side.
Right ventricle: Its walls are quite thick, but it is smaller than the left side.

T3 **Pulmonary artery:** Its diameter is not as big as that of the aorta.
Aorta: It has quite thick walls and is about as thick as a finger.

T4 The valves are white thin strings that have very thin skin between them.

T5 **Left side:** approx. 5 mm (this muscle has to pump the blood through the whole body).
Right side: approx. 2 – 3 mm (this muscle only has to transport the blood to the lung).

T6 There are three different vessels: small veins (which may have valves), arteries (which are a bit bigger than the capillaries), capillaries (very thin blood vessels).

In depth: Circulation in various classes of animals (page 15)

T1

animal class	animal	circulatory system
fish	carp	– no lungs, but gills – oxygen dissolved in the water goes into the blood, it moves through the whole body, blood without oxygen goes back to the heart – heart pumps blood back to the gills
amphibia	common frog	– ½ the oxygen absorbed through skin – circulatory system like mammals, but three chambers – two atria, but only one ventricle → blood is mixed and then pumped through the body
reptilia		– circulatory system like mammals, but the ventricles are not completely separated – the blood that is mixed is pumped through the body
invertebrates	grapevine snail	– no capillaries – the blood is pumped through the whole body

Blood pressure and pulse (page 16)

T1 The blood flows into the right ventricle when it returns to the heart from the lungs.

T2 **Systole:** The systole is made up of 2 different parts, first the atria contract, then the ventricles – this causes the blood to move from the atrium to the ventricle and then from the ventricle to the body / lungs.
Diastole: The heart muscles relax and the blood flows into the atria and the ventricles.

T3 A heartbeat is made up of 2 sounds: the systolic pressure and the diastolic pressure. The heart relaxes and the blood flows into the atria and the ventricles. Then the blood is pumped into the ventricles by the contracting atria. Now the valves at the top open, so the blood gets pushed into the body and lungs. The valves at the bottom are closed, so the blood doesn't flow back.

Experiments: How to listen to a heartbeat (page 17)

T1 The blood pressure is about 120/80. The first value is the systolic pressure, which is when the ventricles contract, the second value is the diastolic pressure, which ist when the heart muscles relax. The third is the pulse, which rises when you do sports.
The blood pressure stays the same or sinks a bit when you do sports.

T2 –

T3 The systolic pressure is the spike and the diastolic pressure is the level in the graph.

T4 For example:
– When you are in love.
– When you are stressed or angry.

Illnesses of the circulatory system (page 18)

T1 They can occur when you are stressed, when you work too much, eat unhealthy food (fast-food), smoke or don't do sports.

Illnesses of the circulatory system (page 19)

T2

illness	how does it occur
arteriosclerosis	Arteries get blocked and lose their elasticity.
heart attack	Blood vessels around the heart get blocked and this leads to a part of the heart muscle not getting any blood, so it dies.
stroke	A blood clot gets stuck in a blood vessel leading to the brain. The part of the brain doesn't get enough blood and dies.
defective valves	The blood with and without oxygen gets mixed and the organs don't get enough oxygen, so they get damaged or die.

T3 When a blood clot comes loose, it can cause a heart attack or a stroke.

Prevention of illnesses in the circulatory system (page 20)

T1 You can prevent illnesses of the circulatory system by leading a healthy lifestyle, eating healthy food and not smoking or drinking too much alcohol.

T2 Between 50 and 80 g.

T3 The heart rate and the blood pressure are higher than normally and the skin temperature drops.

1.2 The Blood

The different blood cells and their functions (page 22)

T1 True – The red blood cells carry oxygen to all the organs.
False – Blood cleans the cells.
True – The red blood cells carry oxygen (which is food) to all the organs.
True – The white blood cells fight infections.
True – The platelets form a scab that stops the bleeding.

The different blood cells and their functions (page 23)

T2 –
T3

function of blood	cells
– to carry oxygen and carbon dioxide	red blood cells
– to transport of blood cells	plasma
– to fight infections	white blood cells
– to close wounds	platelets

T4 55 % of the blood is plasma → made up of over 90 % of water and proteins.
45 % are the blood cells: 93.9 % of these are red blood cells, 0.1 % white blood cells, and 6 % platelets.
page → They are produced in the bone marrow.

T5 The white blood cells fight infections and germs to help the body. When you are ill you need more white blood cells to fight the germs.

Experiments: Looking at blood (page 24)

T1 The blood with oxygen is a little lighter than the other blood.
The blood with carbon-dioxide is darker than the other blood.

T2 After a short time the blood would turn lighter again because the red blood cells can either carry carbon-dioxide or oxygen.

T3 Theoretically you can do this experiment as many times as you want, but the blood in the beaker is exposed to the air in the classroom, so it doesn't stay fresh forever.

Experiments: Looking at blood (page 25)

T4 You can see red blood cells, white blood cells, and if you have a good microscope you might also see the platelets.

Blood clotting and closure of wounds (page 26)

T1 After some time the wound stops bleeding. Some yellowish liquid may come out of the wound, and after a few days a scab forms.

T2 The blood comes out of the injured blood vessel, which contracts to stop the bleeding. In addition platelets collect at the wound, where they are held in by the fibrinogen net.

T3 There are several different forms of haemophilia, but in most cases there is something wrong with the production of the fibrinogen or the different stages that are in between.

Blood typs (page 28)

T1 **Antibodies of type B:** They look like a Y and have little arrows at the ends.
Antigen of type B: The red blood cells have the antigens on them; the opening is in the shape of a square.
Antibodies of type 0: They look like a Y and have little arrows and little squares at the end.
Antigen of type 0: No antigens.

T2 The red blood cells have no antigens, so there is no clotting.

T3

blood types you can receive	your blood type	blood types you can donate to
A, O	A	A, AB
B, O	B	B, AB
AB, A, B, O	AB	AB
O	O	O, A, B, AB

T4 You have blood type 0, because there are no antigens.

In depth: The discovery of blood types (page 29)

T1 Because AB has both antigens on the red blood cells and so it clots with both antibodies A and B.

T2 Landsteiner / Störk: 0 → their blood cells didn't clot with any serum (because they have no antigen); but their serum clots with all the others (because it has A and B antibodies)
Pletschnik / Zaritsch: they have the same blood type: A or B; because they clot with the serum of Sturli and Erdheim
Erdheim / Sturli: they have the same blood type, but a different one from Pletschnik and Zaritsch → so probably B

T3 A lot of people have illnesses and need regular blood transfusions, there are also a lot of accidents with cars or motorcycles, where the victims need blood afterwards.
Problems are: You need the blood, because you can't produce it. People have to donate blood.

Blood transfusions (page 30)

T1 Reasons are:
– Accidents that happen where the victims need blood transfusions.
– People need blood during operations.
– People with a blood disease.

T2 –

Blood transfusions (page 31)

T3 Because 500 ml of blood are taken out of your body, so the number of white blood cells is reduced for about 3 days. An unhealthy person may not have the bodily strength to fight an infection and make new blood at the same time.

T4 To donate blood you have to
- be at least 18 but not older than 69
- weigh at least 50 kg
- be healthy
- have a stable blood pressure
- have a temperature of 37.5 °C
- eat and drink enough before donating blood
- not have any alcohol in the last 12 hours
- not have consumed any drugs in the last 4 weeks
- not have had a tattoo or piercing in the last 5 months
- not have had an operation for the last 6 months

As a man you can donate blood up to 6 times a year, as a woman up to 4 times.

T5

pros:	cons:
– You help other people who need the blood. – Your blood gets checked for free by the Red Cross: you get information about your blood. – You get an international "Accident Aid and Blood Donation Pass".	– You might feel a bit tired / dizzy after the donation. – If the person taking your blood can't find the vein first time, it might be a bit painfull. – It takes about 1 – 1.5 hours.

T6 –

1.3 Respiration

The structure and function of the lung (page 32)

T1 The lungs are covered by the ribs, so they are protected by the ribcage / the ribs.

The structure and function of the lung (page 33)

T2

part	task
nose / mouth	The air enters the body here and is heated to body temperature. The first dirt particles are prevented from entering the body.
trachea	The cilia stop all the dirt (like dust and bacteria).
bronchia	This part divides the air between the two lungs.
bronchioles	These bring the air to the alveoli.
alveoli	Gaseous exchange takes place here → oxygen and carbon dioxide are exchanged.

T3 Air enters the body through the nose or mouth and is heated up to body temperature and moistened. Then the air goes through the trachea to the bronchia, which transport the air to each lung. In the lungs the air is transported through bronchioles, to the alveoli, where gaseous exchange takes place. The air then leaves the body again along the reverse path.

T4 The muscles between the ribs help to move the ribcage to make breathing in and out possible. When you laugh really hard, these muscles have to work harder and they get a little sore. The diaphragm, which moves the abdomen up and down, is also used a lot for breathing and for laughing, so this can be another reason for a pain in the stomach area when you laugh hard.

Gaseous exchange (page 34)

T1 Gaseous exchange:
Blood containing carbon dioxide arrives in the alveoli, where the level of fresh air containing oxygen is higher, so the carbon dioxide leaves the blood and goes into the alveoli in order to be exchanged for oxygen, which is picked up by the red blood cells. The oxygen-rich blood then leaves the alveoli to go back to the heart (and from there into the rest of the body).

T2 There may be more than one reason why gaseous exchange is disrupted:
- Not enough oxygen reaches the alveoli because the air is polluted and the filter systems (like the cilia) aren't working properly.
- The walls of the capillaries have lost their elasticity because of unhealthy eating habits or fat has formed plaque on the capillary walls.

Experiments: Proving gaseous exchange (page 35)

T1 The lime water changes colour when we breathe into it and also when we put CO_2 into it. This proves that the air we breathe out contains CO_2.
CO_2 is a gas that stops candles from burning, so the candles go out faster when the air in the glasses has more CO_2 in it.
The last experiment shows that there are lower/ higher amounts of CO_2 in the air when we breathe it out.

Smoking as a health risk (page 36)

T1 The poisonous substances found in cigarettes can also be found on the roads (tar), in cleaning products (like ammonia), and in rat poison (arsenic). Butane is found in lighters or gas burners (for camping or school experiments).

T2 About 15 – 20 % (research findings in 2009).

Experiments: Lungs and respiration (page 37)

T1 Reasons may be:
– the size of the person
– whether he or she does sports regularly
– whether he or she smokes

T2 You can hold your breath longest with full lungs, because only about 4% of the oxygen in the air is used during each phase of gaseous exchange, but the air contains about 21%, so this is an ideal combination.

T3 Our lungs have a capacity of about 3 to 8 liters. So you can blow them up to the size of a medium-sized balloon and the skin of the lung gets thinner.
When the oxygen in the air (21%) is all used up, we need to take a new breath. The muscles between the ribs and the diaphragm help when we breathe in or out.

T4 I think young people start smoking because there is a lot of pressure from friends / classmates. They want to be cool and have an identity in the eyes of other people. Another reason could be that they believe that smoking cigarettes will stop them from gaining weight and help them stay thin. Often young people also start smoking because their parents or relatives smoke, so they don't see any harm in it. In my opinion young people also smoke because it is forbidden by law, so they are attracted by the thrill of doing something forbidden.