Unit 19 · Circulatory System

ANSWER KEY · FOR TEACHERS

Full marks 32

Give the marks for the points in the marking scheme; an answer in other words that says the same is right.

1 Key words

1. myocardium
2. musculi pectinati
3. fossa ovalis
4. SA node
5. Purkinje fibers
6. Thebesian
7. sphygmomanometer
8. portal

K · 4

Each carries 0.5 mark.

2 Label the diagram

1. superior vena cava
2. right atrium
3. pulmonary trunk
4. left atrium
5. aortic valve
6. bicuspid valve

K · 3

Each carries 0.5 mark.

3 Multiple choice

i. **d.** Thebesian — K · 1

The opening of the coronary sinus into the right atrium is guarded by the **Thebesian** (coronary) valve. The **Eustachian** valve is at the opening of the inferior vena cava. (Some printings of this question list "tricuspid" twice and leave out the Thebesian valve: then none of the options is right.)

ii. **b.** to let the atria finish emptying before the ventricles contract — U · 1

The impulse waits about **0.1 s** at the **AV node**, so blood has time to pass from the atria into the ventricles before they squeeze. The beat is **started** by the **SA node**.

iii. **a.** it carries blood away from the heart — U · 1

Vessels are named by **direction**: **arteries** carry blood **away** from the heart, **veins** towards it, whatever blood they carry. So the **pulmonary artery** (deoxygenated, to the lungs) is an artery, and the **pulmonary veins** (oxygenated, to the left atrium) are veins.

iv. **b.** group B, with anti-A — A · 1

Clumping with **anti-B** means her cells carry **antigen B**; no clumping with anti-A means they lack A. So she is **group B**, and her plasma has **anti-A** (a).

v. **d.** blood group O — A · 1

Group **O** red cells carry **no A or B antigen**, so they can be given to a person of any ABO group: the **universal donor**. (In a real emergency, **O negative** is used, to be safe for the Rh factor too.)

4 Short answers

a. MARKING SCHEME — K · 2

- ✓ Lubb: first sound, closing of the tricuspid and bicuspid valves.
- ✓ Dub: second sound, closing of the semilunar valves.

b. MARKING SCHEME — U · 2

- ✓ The left ventricle pumps to the whole body against high resistance (high pressure).
- ✓ The right pumps only to the nearby lungs at low pressure.

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c. MARKING SCHEME A · 2

- ✓ Both parents heterozygous, I^Ai.
- ✓ The cross showing ii (group O) in one in four.

d. MARKING SCHEME U · 3

- ✓ Hepatic portal vein carries blood from the gut, pancreas and spleen to the liver's capillaries, then hepatic veins.
- ✓ A first significance (e.g. nutrients processed and stored first).
- ✓ A second significance (e.g. detoxification, or germs destroyed by Kupffer cells).

5 Numerical problem

ANSWER A · 4

Cardiac output = heart rate × stroke volume.

- At rest: 72 × 70 ml = **5040 ml/min** (about 5 L/min).
- During the run: 180 × 110 ml = **19 800 ml/min** (19.8 L/min).
- 19 800 ÷ 5040 ≈ **3.9**, about 4 times.
- One cycle at rest = 60 ÷ 72 ≈ **0.83 s** (about 0.8 s).

MARKING SCHEME

- ✓ Resting output 5040 ml/min.
- ✓ Output during the run 19 800 ml/min.
- ✓ About 4 times (3.9).
- ✓ Cycle about 0.8 s (60 ÷ 72).

6 Long answer

ANSWER U · 4

The human heart is **myogenic**: each beat starts in its own specialized cardiac muscle (nodal tissue), not in a nerve.

1. The **SA node** (pacemaker), in the wall of the right atrium near the opening of the superior vena cava, fires on its own about 72 times a minute; the impulse spreads over both **atria**, which contract.
2. It reaches the **AV node**, low in the right atrium near the interatrial septum, the only way to the ventricles; it **delays** the impulse about **0.1 s**, so the atria finish emptying.
3. It then races down the **bundle of His**, its **right and left branches** and the **Purkinje fibers** to the whole ventricle wall.
4. Both **ventricles** contract together, from the apex upwards.

MARKING SCHEME

- ✓ Myogenic: the beat starts in the heart's own nodal muscle; the SA node is the pacemaker and the atria contract.
- ✓ The AV node delays the impulse about 0.1 s so the atria empty.
- ✓ Bundle of His, its branches and the Purkinje fibers carry it to the ventricles.
- ✓ The ventricles contract together from the apex upwards.

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7 Think

ANSWER HA · 3

Anti-Rh antibodies are **not present from birth**; an Rh-negative person makes them only **after** Rh-positive blood enters her body.
So the first transfusion did little harm at once, but it **sensitized** her: she began making **anti-Rh (anti-D) antibodies**.
At the second transfusion these antibodies **clump (agglutinate)** the Rh-positive red cells, which burst; this can be serious, even fatal. She should get Rh-negative blood.

MARKING SCHEME

- ✓ Anti-Rh antibodies are not present from birth.
- ✓ The first transfusion sensitized her to make anti-Rh antibodies.
- ✓ The second transfusion's Rh-positive cells are agglutinated and destroyed, a dangerous reaction.

8 Activity: Your pulse

(not marked)

WHAT STUDENTS SHOULD FIND

At rest about **60–80** beats a minute (about 72); much higher just after running; back near the resting rate within a few minutes. The pulse at the wrist is the **radial artery**. Working muscles need more oxygen and glucose, so the **sympathetic nerves and adrenaline** speed up the heart and raise the cardiac output.

Marks by level	Knowledge	Understanding	Application	Higher ability	Total
Marks	10	11	8	3	**32**

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