MCAT-TEST Q&As

Medical College Admission Test: Verbal Reasoning, Biological Sciences, Physical Sciences, Writing Sample

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QUESTION 1

Historically, two different methods have been used to estimate the fluid pressure in capillary beds.

Method 1 A glass pipette is inserted into the capillary. The level of blood rising in the pipette is measured and used to calculate the pressure. Alternatively, an inert fluid of density can be placed in the pipette and its height h can be measured. The pressure in the capillary is given by gh, where g is the acceleration due to gravity.

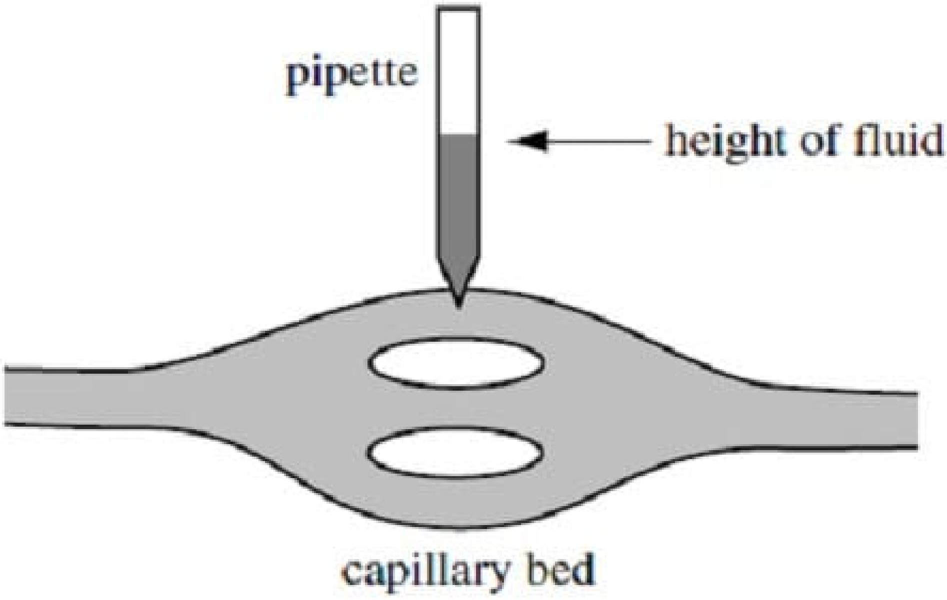


Figure 1 Method 2

The pressure can be measured indirectly in the following way. A section of gut tissue is removed from a specimen and placed on a beam balance. Blood is circulated through the tissue by a pump. The arterial pressure is then decreased. This leads to a decrease in the capillary hydrostatic pressure in the gut capillaries. The constant osmotic pressure of plasma proteins in the capillary causes absorption of fluid from the gut section which will decrease its weight. To prevent a change in the weight of the gut section, the venous pressure is increased. This tends to increase the capillary pressure, reducing the flow of fluid from the gut tissue into the capillaries. The capillary pressure is thus held constant (and the balance kept level) as the arterial pressure is decreased and the venous pressure increased. The arterial and venous pressures meet at the capillary pressure being measured.

(= MRT, where is the osmotic pressure, M the molarity of the solutes, R the universal gas constant, and T the temperature in Kelvin.)

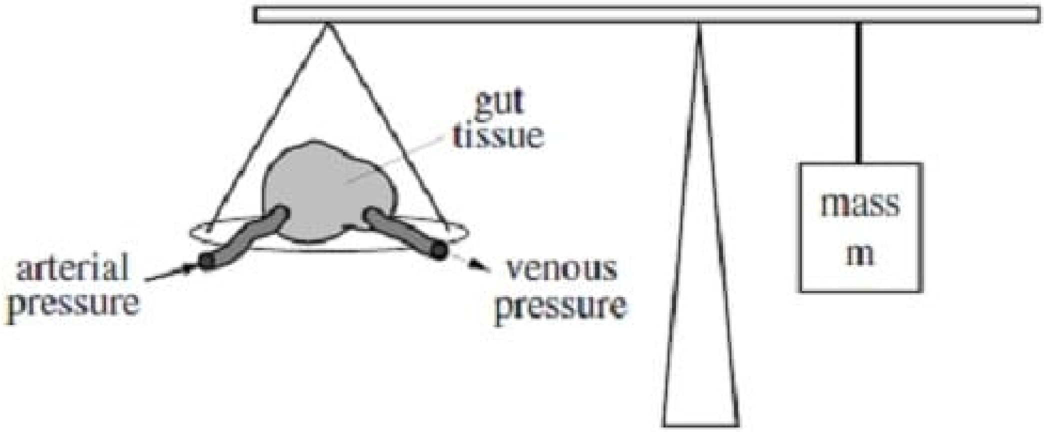


Figure 2

A researcher using Method 1 to determine the capillary pressure fills the pipette with an inert fluid less dense than blood. Compared to blood, the height of this fluid in the pipette will be:

A. higher because the fluid is less dense.

B. lower because the fluid is less dense.

C. the same because the pressure being measured is the same.

D. the same because the velocity of blood flow in the capillary bed is the same.

Correct Answer: A

The passage states that using Method 1, the capillary pressure is given by P = gh. We are measuring the same capillary, so the measured pressure is constant. If we use a less dense fluid, the column will rise higher for a given pressure. Choice B is incorrect for the reasons described above. Using a fluid more dense than blood would give a column with a lower height. Choice C is incorrect, although the pressure is the same, the height of the column changes with respect to the density of the fluid as described above. Choice D is a distractor choice that may have been tempting if you remembered that Bernoulli\\'s equation relates the velocity of fluid flow to the pressure. Again, if the velocity is the same, and the pressure is the same, then the height of the fluid will depend on its density.

QUESTION 2

Artificial kidneys have been used for almost 50 years to treat patients with different forms of renal failure. The artificial kidney (dialysis machine) removes unwanted substances from the blood by diffusion. A patient\\'s blood is passed through channels bounded by a porous, semi-permeable membrane that allows the free diffusion in both directions of all plasma constituents except the plasma proteins. Erythrocytes and other cellular components of blood cannot pass through the membrane. The other side of the membrane is exposed to the dialyzing fluid which carries away the unwanted materials. If the concentration of a material in the blood is greater than in the dialyzing fluid, there will be a net flow of the material from the plasma to the dialyzing fluid. If the concentration of a material in the blood is less than in the dialyzing fluid, there will be a net flow of the material from the dialyzing fluid into the blood. The composition of normal plasma, plasma in an individual suffering renal failure, and dialyzing fluid are shown in Table 1.

Constituent	Normal Plasma (mEq/L)	Plasma w/ renal failure (mEq/L)	Dialyzing Fluid (mEq/L)
Na^+	142	142	133
K^+	5	7	1.0
Cl^-	107	107	105
HCO_3^-	27	14	35.7
Urate	0.3	2	0
Constituent	**Normal Plasma (mg/dl)**	**Plasma w/ renal failure (mg/dl)**	**Dialyzing Fluid (mg/dl)**
Glucose	100	100	125
Urea	26	200	0
Creatinine	1	6	0

Table 1

Dialysis replaces some functions of the kidneys and attempts to correct the effects of renal failure. For example, patients with renal failure develop acidosis due to a buildup of metabolically produced acids in the circulation. Without dialysis,

the pH of the blood will drop and coma may occur. Dialyzing fluid contains a relatively high concentration of bicarbonate which diffuses into the circulation and neutralizes the acid.

In order to prevent the net movement of water between the blood and the dialyzing fluid, the dialyzing fluid:

A. is hypoosmotic to blood.

B. is isoosmotic to blood.

C. contains a higher concentration of solutes than blood.

D. contains hydrophilic proteins.

Correct Answer: B

If the dialyzing fluid is isoosmotic, it has the same concentration of particles and thus, the same osmotic pressure exists on either side of the membrane. There will be no net flow of water by osmosis between the blood and the dialyzing fluid. Choice A is incorrect because a hypoosmotic dialyzing fluid would lead to flow of water into the circulation from the dialyzing fluid. Choice C is incorrect because a solution with a higher concentration of solutes is hyperosmotic. A hyperosmotic dialyzing fluid would lead to flow of water out of the circulation from the dialyzing fluid. Choice D is incorrect because hydrophilicity has nothing to do with the net flow of water. A hydrophilic protein is "water-loving" because it contains polar amino acids.

QUESTION 3

What is the relationship between suicide rates and social change according to the sociologist Emile Durkheim?

A. A higher suicide rate leads to more social change.

B. A higher suicide rate leads to less social change.

C. Social change leads to suicide rates going up.

D. Social change leads to suicide rates going down.

Correct Answer: C

C is correct. In association with his observational study, Durkheim developed a typology of suicide that ascribed this behavior to the unsettling effects of social change. That is, for him, social change caused suicide. The greater social change was; the higher suicide rates were. A. This is incorrect. According to Durkheim, a change in suicide rates has no effect on social change. B. This is incorrect. According to Durkheim, suicide has no effect on social change. D. This is incorrect. According to Durkheim, social change leads to suicide rates going up, rather than going down.

QUESTION 4

All of the following are example of sensory, or neural, adaptation EXCEPT:

A. After putting on a shirt, you eventually no longer feel the sensation of the fabric on your back.

B. After first walking into a crowded room, you no longer are distracted by the buzz of conversation around you.

C. After first walking outside on a sunny day, you no longer are blinded by the initial brightness of the light.

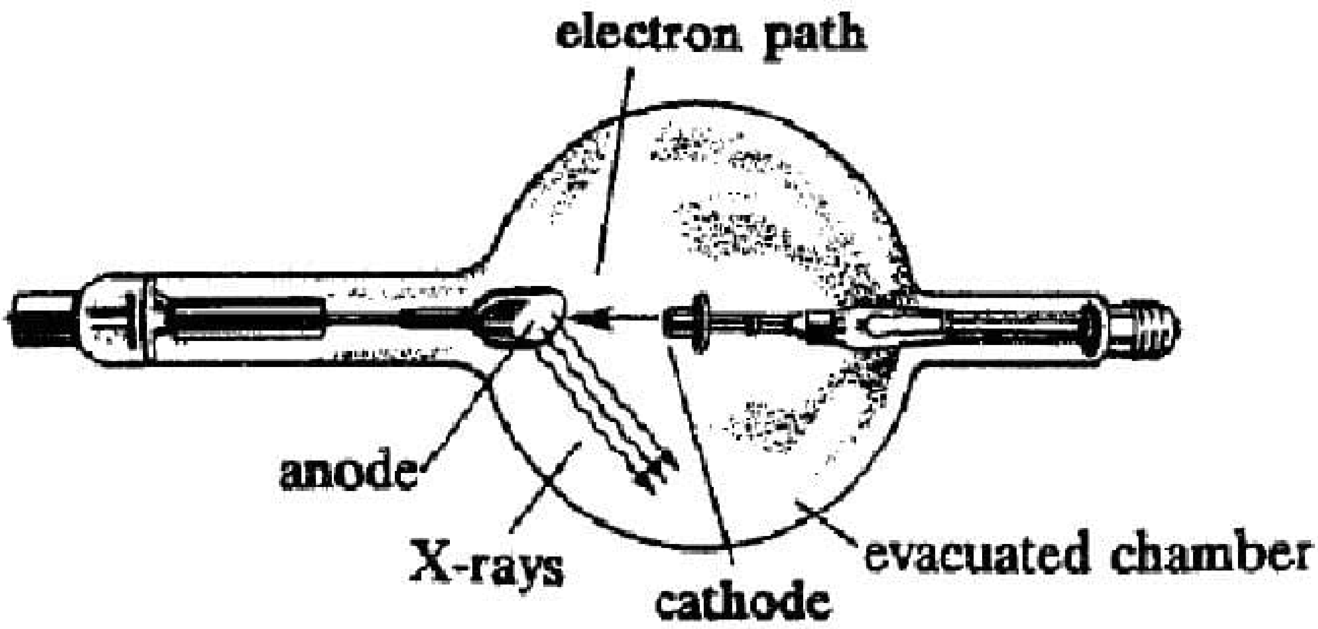
D. After first walking into an anatomy lab, you no longer notice the smell of formaldehyde.

Correct Answer: C

Choices A, B, and D are all examples of sensory adaptation occurring the due to the brain\\'s adaptation to a constant neural stimulus. Choice C, on the other hand, is due to the contraction of the iris, which in narrows the pupil and restricts the amount of light being received by our retina. It is therefore not an example of our brain\\'s adaptation to a constant neural stimulus, but a muscular contraction that changes the amount of stimulus.

QUESTION 5

X-rays are produced by a device which beams electrons with an energy between 103 and 106 eV at a metal plate. The electrons interact with the metal plate and are stopped by it. Much of the energy of the incoming electrons is released in the form of X-rays, which are high-energy photons of electromagnetic radiation. An example of such a device is shown below. Electrons are accelerated from the cathode towards the anode by an electric field.



There are two mechanisms by which the X-rays are produced within the metal. The first mechanism is called bremsstrahlung, which is German for "breaking radiation." X-rays are emitted by the electrons as they are brought to rest by

interactions with the positive nuclei of the anode.

The second mechanism occurs when an incoming electron knocks an inner electron out of one of the metal atoms of the anode. This electron is replaced by an electron from a higher energy level of the atom, and a photon making up the

energy difference is emitted.

X-rays are absorbed by a material when they pass through it. The amount of X-rays absorbed increases with the density of the material. In addition, lower energy X-rays are more likely to be absorbed than higher energy X-rays. (Note: 1 eV =

1.6 x 1019 J; Planck\\'s constant h = 4.1 x 10–15 eV•s; speed of light c = 3 x 108 m/s.)

An X-ray source produces X-rays with a maximum frequency of 6 x 108 Hz. If the cathode current is doubled so that twice as many electrons are emitted per unit time, what is the new maximum frequency of the X-rays produced?

A. 3 x 1018 Hz

B. 6 x 1018 Hz

C. 12 x 1018 Hz

D. 24 x 1018 Hz

Correct Answer: B

In the question we\\'re told that a cathode produces electrons. We are asked to determine what the new maximum frequency of the X-rays produced will be if the current is doubled, so that twice as many electrons are emitted per unit time. By doubling the current, we double the rate at which electrons are produced. However, the energy of each electron does not change. The energy is controlled by the potential difference through which the electrons are accelerated, and this remains constant. In addition, since the maximum frequency of an X-ray depends only on the electron\\'s energy, increasing the number of electrons produced will have no effect on the maximum frequency of the X-rays produced. The maximum frequency will remain 6 x 1018 Hz, and this is answer choice B.