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QUESTION 1

Hypoxia refers to a physiological condition in which the body lacks sufficient oxygen for normal cellular functioning. Prolonged hypoxia generally leads to an inhibition of mental capacity and a reduction in the work capacity of muscle. Severe cases of hypoxia can lead to coma or even death. Depending on the cause, hypoxia can be classified into four general types:

Hypoxic hypoxia is a type of hypoxia that occurs when the partial pressure of oxygen in the blood is too low. For example, climbers at high altitude, where the air contains less oxygen, might experience hypoxic hypoxia because the partial pressure of oxygen in the air inhaled is very low, leading to insufficient partial pressure of oxygen in the blood.

Anemic hypoxia describes a diminished ability of the blood to transport oxygen. Several factors can influence the oxygen-carrying capacity of the blood. Primary causes of anemic hypoxia include a lower than normal number of functional erythrocytes or an insufficient quantity of hemoglobin, the oxygen- carrying molecules of the blood. Abnormal hemoglobin can also decrease the blood/\'s capacity to carry oxygen and lead to anemic hypoxia.

Ischemic hypoxia is caused by a decreased delivery of blood to the tissues. Localized circulatory deficiencies, such as blood clots, and global circulatory deficiencies, such as heart failure, decrease the delivery of blood to the tissues, and can therefore cause ischemic hypoxia.

Histotoxic hypoxia results from the inability of cells to utilize the oxygen available in the blood. Causes of histotoxic hypoxia include the poisoning of cellular enzymes involved in aerobic respiration, as well as the decreased metabolic capacity of the oxidative enzymes due to vitamin deficiency. Cyanide poisoning causes histotoxic hypoxia by blocking the action of cytochrome oxidase in the electron transport chain so that tissues cannot use oxygen even though it is available.

Cigarette smoking causes emphysema, a condition in which the net surface area of the lungs is greatly decreased leading to a decrease in the diffusing capacity of the lungs.

Emphysema leads to which type of hypoxia?

- A. Hypoxic hypoxia
- B. Anemic hypoxia
- C. Ischemic hypoxia
- D. Histotoxic hypoxia

Correct Answer: A

The passage states that hypoxic hypoxia is caused by any factor that leads to a decreased plasma pO2. Since emphysema decreases the diffusing capacity of the lungs, less oxygen will diffuse into the blood, leading to a lower pO2. Choice B is incorrect because anemic hypoxia is caused by a decreased oxygen carrying capacity of the blood. Emphysema affects the amount of oxygen in the blood, not the ability of the blood to carry oxygen. Choice C is incorrect because ischemic hypoxia is caused by a decreased delivery of blood to the tissues. Emphysema has no effect on blood circulation. Choice D is incorrect because histotoxic hypoxia is caused by the inability of the tissues to utilize oxygen. Emphysema does not affect the ability of the tissues to use oxygen.

QUESTION 2

Saul Hoffman\\\'s scientific journal paper published in 2015 in Societies explores the relationship between two topics that at the surface are very distant from each other. As he goes on to state, "It is relatively easy, at least for an economist, to



see why economists would be attracted to issues like teen pregnancy and teen childbearing, despite their apparent distance from the core topics of economics. First, economics ?especially microeconomics ?is fundamentally the study of choices that individuals make, traditionally and most often in formal markets with monetary prices, but now more and more frequently outside that sphere. Viewed from that perspective, choices involving sexual and fertility behavior among teens are an incredibly challenging, but inviting, target. Is it possible to identify the role of economic incentives, including government policy, on these behaviors? Is it sensible to apply traditional models of rational choice decision-making to teens?

Second, the traditional concern about teen fertility was predicated on the notion that it was an economically catastrophic act. In a famous and oft-quoted 1968 article, Arthur Campbell wrote that \\'The girl who has an illegitimate child at the age of 16 suddenly has 90 percent of her life\\'s script written for her,\\' including reduced opportunities for schooling, the labor market, and marriage. But it doesn\\'t take too much reflection to appreciate that more may be going on in leading to these poor outcomes than just a teen birth. Disentangling the causal effect of teen childbearing on subsequent socio-economic outcomes from its correlational effect is another deliciously inviting and challenging target, this time well-suited for the applied economist or econometrician.

Just to make all this yet more inviting, the two research strands are closely related. Suppose it could be demonstrated that for some teens the socio-economic impact of a teen birth was negligible. For example, maybe future prospects for some teens were equally poor with or without a birth or perhaps government programs provided substantial benefits, so that the net impact on socio-economic well-being was consequently small or even positive. Then, it might well be \\'rational\\' in an economic sense to have a teen birth in the first place, thereby linking the research on the causal impact of a teen birth with the research on the choice determinants of a teen birth. So what came to be known as the teen birth `causes\\' literature and the teen birth `consequences\\' literature were clearly interrelated.

And then, to add yet another layer of challenge, the teen fertility rate in the U.S. has fallen at a rate that is totally unprecedented. Teen fertility was once widespread, with most of it occurring within early and sometimes not entirely voluntary marriage. In 1960, the teen fertility rate was approximately 90 births per 1000, which implied that more than 40% of women ever had a teen birth. When I published my first article on teen births 25 years ago, the teen fertility rate was 60 births per 1000, down one-third from 1960, but it had increased six years in a row in what turned out to be a deviation from the downward trend. Since then the rate has declined every single year, except for a short but puzzling uptick between 2005 and 2007. In 2014, the teen fertility rate was 24.2 births per 1000, the lowest teen fertility rate ever recorded in the U.S., though still shockingly high by European standards. Thus, the rate fell by more than 50% during my professional association with the topic and by 70% since 1960. Of course, at the same time teen marital births largely disappeared, falling from 85% of teen births to 12%.

This adds yet another focus for economic research. Why did the rate fall? Did it have anything to do with changes in the costs of teen childbearing or changes in policy? Is it a good thing or not?

In this article I try to make sense out of these various research strands by providing a personal narrative through the economics literature on teen childbearing, with a special emphasis on the three issues discussed above. My goal is to make the literature, including some reasonably technical content, accessible and valuable to a non-economist."

Hoffman, S. (2015). Teen Childbearing and Economics: A Short History of a 25-Year Research Love Affair. Societies, 5(3), 646-663. doi:10.3390/soc5030646

The author\\'s main point could be most strongly undermined by a sociological or economic study showing that:

A. statistics on teen birth make little apparent sense because even when there is an overall downward trend, the teen birth rate can unpredictably swing upward, and vice versa.

B. many teens who give birth do so not out of desire to be parents, but because they lack access to birth control and effective sex education.

C. in recent years, the economic and career results of teen pregnancy have been getting worse.

D. potential teenage mothers are minimally influenced by economic considerations like career and financial prospects, but make choices based on irrational factors like community beliefs about morality.



Correct Answer: D

This Reasoning-Beyond-the-Text question asks you to consider the effects of possible outside information on the passage. The author cites reasons to apply economic theory to teen pregnancy, writing "Viewed from that perspective, choices involving sexual and fertility behavior among teens are an incredibly challenging, but inviting, target. Is it possible to identify the role of economic incentives, including government policy, on these behaviors?" If such incentives had little or no effect on the behavior being studied, it would not make sense to apply the framework of economics to it. A ?incorrect. This would not undermine the author\\'s claim since he describes the data as in need of explanation and cites times when the birth rate rose during periods of overall decline. B. ?incorrect. The author does not suggest that desire to be a parent is a key motive in teen childbirth. C ?incorrect. The passage states teen birth has been declining. If the potential consequences have been getting worse, this would reinforce the author\\'s assumption that economic considerations influence behavior.

QUESTION 3

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. 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)
K ⁺	5	7	1.0
Cl-	107	107	105
HCO3-	27	14	35.7
Urate	0.3	2	0
Constituent	Normal Plasma	Plasma w/ renal	Dialyzing Fluid
	(mg/dl)	(mg/dl)	(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.

All of the following are removed from the plasma by dialysis EXCEPT:

A. Na+

B. K+

- C. Urea
- D. Glucose

Correct Answer: D

By comparing the concentration of a material in the dialyzing fluid with the concentration in plasma, we can determine the net flow by passive diffusion through the semi-permeable membrane. Of all of the choices, only glucose has a higher

concentration in the dialyzing fluid than in the plasma (with or without renal failure). Thus, glucose will not be removed from the plasma by dialysis. Choice A is incorrect because the concentration of Na+ in the dialyzing fluid is 133 mEq/L

which is less than the concentration in plasma (142 mEq/L). Sodium will be removed.

Choice B is incorrect because the concentration of K+ (1.0 mEq/L) is much lower than the concentration in the plasma.

Choice C is incorrect because there is no urea in the dialyzing fluid. One of the primary functions of dialysis is the removal of urea from the circulation.

QUESTION 4

There are two opposing theories of light: the particle theory and the wave theory. According to the particle theory, light is composed of a stream of tiny particles that are subject to the same physical laws as other types of elementary particles.

One consequence of this is that light particles should travel in a straight line unless an external force acts on them. According to the wave theory, light is a wave that shares the characteristics of other waves. Among other things, this means

that light waves should interfere with each other under certain conditions.

In support of the wave theory of light, Thomas Young\\'s double slit experiment proves that light does indeed exhibit interference. Figure 1 shows the essential features of the experiment. Parallel rays of monochromatic light pass through two

narrow slits and are projected onto a screen. Constructive interference occurs at certain points on the screen, producing bright areas of maximum light intensity. Between these maxima, destructive interference produces light intensity minima.

The positions of the maxima are given by the equation dsin = n, where d is the distance between the slits, is the angle shown in Figure 1, the integer n specifies the particular maxima, and is the wavelength of the incident light. (Note:



sin tan for small angles.)



Figure 1

θ

What is the angle for the third maximum (n = 3)?

A. 3×10^{-5} radians

B. 3×10^{-3} radians

C. 0.3 radians

D. 0.3 degrees

- A. Option A
- B. Option B
- C. Option C
- D. Option D

Correct Answer: B

To solve this problem, apply the formula given in the passage which quantifies the positions of the intensity maxima. The formula is dsin = n, where d is the distance between the slits, is the angle, and is the wavelength. The note in the passage says that sin when is small. You have to know that this approximation is only valid when is measured in radians. Making this approximation, we obtain d = n, and solving for we obtain n = n/d. Note that the distance units of and d can be anything as long as they



$$\theta = \frac{3(500 \times 10^{-9}m)}{5 \times 10^{-4}m} = 3 \times 10^{-3}$$
 radian

are the same. n is given in the question stem, and and d are given in Figure 1. Substituting, we obtain

which is choice B.

QUESTION 5

Which of the following cell types does NOT contain the diploid number of chromosomes?

- A. Spermatogonium
- B. Spermatid
- C. Zygote
- D. Primary oocyte
- Correct Answer: B

In males, diploid cells called spermatogonia undergo mitosis to produce diploid cells called primary spermatocytes. The primary spermatocytes undergo the first round of meiosis to yield secondary spermatocytes, which are haploid. The secondary spermatocytes undergo the second round of meiosis, resulting in four haploid cells called spermatids. The spermatids then mature into sperm -- the male gametes. So, choice A is incorrect because a spermatogonium is a diploid cell. And we\\'ve already found the correct answer -- choice B, spermatid, is NOT a diploid cell, it\\'s haploid. Let\\'s look at what happens in females anyway. In females, a diploid cell called a primary oocyte undergoes the first meiotic division to yield two haploid cells -- a polar body and a secondary oocyte. The secondary oocyte undergoes the second meiotic division to produce two more haploid cells -- a mature oocyte, or ovum, and another polar body. So, choice D, primary oocyte, is also incorrect because these are diploid cells. During fertilization, an ovum and a sperm fuse; two haploid cells fuse to form a single diploid cell called a zygote. Thus, choice C is also incorrect.

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