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**QUESTION 1**

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

According to passage information, a scholar interested in microeconomics might study all of the following EXCEPT:

A. which environmental factors make a city dweller more likely to litter.

B. the reasons behind college students\\' choices to spend their time studying vs. socializing.

C. how divorce influences real estate prices and choices.

D. how recent college graduates prioritize cost versus convenient location in choosing an apartment.

Correct Answer: C

This Reasoning-Beyond-the-Text question asks you to understand the passage definition of microeconomics. We are told it is "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." This option mentions choices, but is primarily focused on large-scale markets, (not on the reasons behind individual actions) and their relationship to the variable "divorce". A ?incorrect. This concerns individual choices and outside influence on them. B ?This is incorrect. This concerns a cost-benefit analysis over how to use a limited resource, in this case, time, and how this influences the choice that college students ultimately make. D ?incorrect. This is another example of studying how people with limited resources rank various priorities in order to arrive at an economic choice.

**QUESTION 2**

A solar-power collector has an area of 10 cm2 facing the sun. If the intensity of the sunlight incident upon this surface is 1.5 kW/m2, what is the maximum energy the device can supply in one hour?

A. 1500 J

B. 15000 J

C. 5400 J

D. 54000 J

Correct Answer: C

Explanation: We will calculate to determine the energy supplied by the sun to a 10 cm2 region during 1 hour, assuming that the device is 100% efficient.

$$10\ \text{cm}^2 \times 1.5\ \frac{\frac{\text{kJ}}{\text{s}}}{\text{m}^2} \times \frac{1\text{m}^2}{10000\ \text{cm}^2} \times 3600\text{s} = 5.4\ \text{kJ} = 5400\ \text{J}$$

**QUESTION 3**

Many nutrients required by plants exist in soil as basic cations:

$$\text{Mg}^{2+}, \text{Mn}^{2}, \text{and Ca}^{2}.$$

A soil\\'s cation-exchange capacity is a measure of its ability to adsorb these basic cations as well as exchangeable hydrogen and aluminum ions. The cation-exchange capacity of soil is derived from two sources: small clay particles called micelles consisting of alternating layers of alumina and silica crystals, and organic colloids.

$$\text{A1}^{3+}$$

Replacement of + and + by other cations of lower valence creates a net negative charge within the inner layers of the micelles. This is called the soil\\'s permanent charge. For example, replacement of an atom of aluminum by calcium within a section where the net charge was previously zero, as shown below, produces a net charge of ?, to which other cations can become adsorbed.

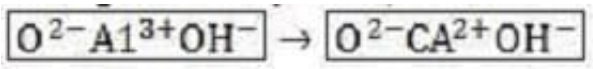



Figure 1

A pH-dependent charge develops when hydrogen dissociates from hydroxyl moieties on the outer surfaces of the clay micelles. This leaves negatively-charged oxygen atoms to which basic cations may adsorb. Likewise, a large pH-

dependent charge develops when hydrogen dissociates from carboxylic acids and phenols in organic matter.

In most clays, permanent charges brought about by substitution account for anywhere from half to nearly all of the total cation-exchange capacity. Soils very high in organic matter contain primarily pH-dependent charges. In a research study,

three samples of soil were leached with a 1 N solution of neutral KCl, and the displaced A13+ and basic cations measured. The sample was then leached again with a buffered solution of BaCl2 and triethanolamine at pH 8.2, and the

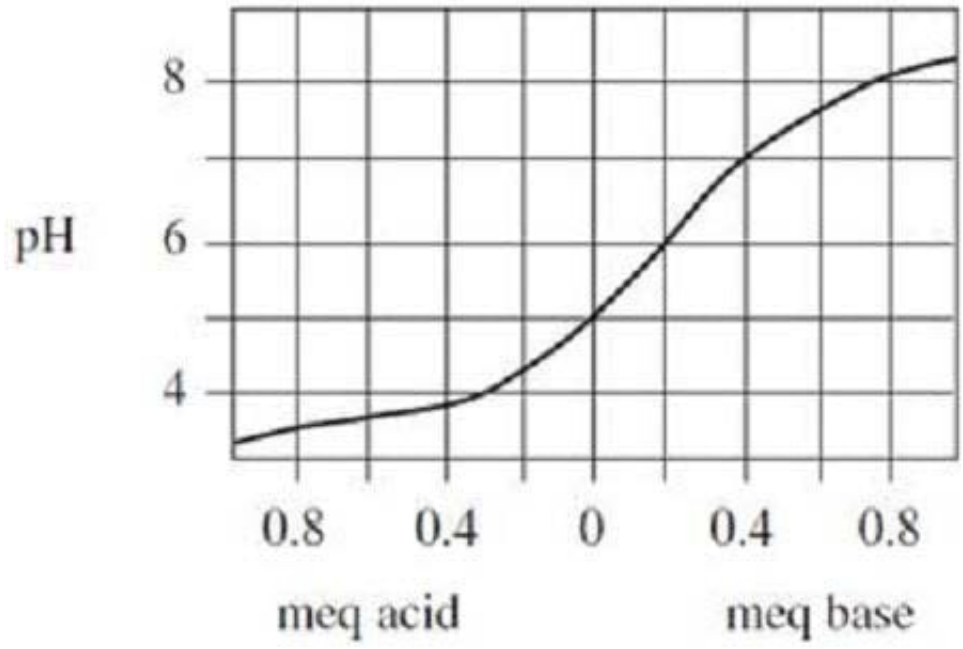
displaced H+ measured. Table 1 gives results for three soils tested by this method.

Table 1

| | (meq/100 g) | | | | Total Cation Exchange Capacity |
|---|---|---|---|---|---|
| | pH | $Al^{3+}$ | Basic Cations | $H^+$ | |
| Sample I | 4.5 | 11.7 | 1.9 | 34.0 | 47.6 |
| Sample II | 5.3 | 1.6 | 16.3 | 19.5 | 37.4 |
| Sample III | 6.0 | 0.5 | 9.8 | 7.8 | 18.1 |

Due to the buffering effect of the soil\\'s cationexchange capacity, just measuring the soil solution\\'s pH will not indicate how much base is needed to change the soil pH. In another experiment, measured amounts of acid and base were added to 10-gram samples of well-mixed soil that had been collected from various locations in a field. The volumes of the samples were equalized by adding water. The results were recorded in Figure 2.

Figure 2.




**A1³**

Which of the following would probably NOT displace + in soil micelles?

A. $A1^{3+}$
B. $H^{+}$
C. $A1^{3+}$ and Basic Cations
D. $A1^{3+}$ and H+

A. Option A

B. Option B

C. Option C

D. Option D

Correct Answer: C

The passage tells you that in soil micelles, cations like A13 and Si4+ are replaced by cations with lower valences. That is what gives the micelles their negative charge. When an A13 cation is displaced by a cation with a +2 charge, the micelle gains a ? charge. So the leaching of these actions as depicted in Table 1 gives an indication of the permanent charge as we saw in the earlier questions. Knowing this, it is easy to see that Si4+, with a valence of +4, is the cation that could not displace the A13+, since Na+, Mg2+, and Cr2+ all have lower valences than the aluminum\\'s +3 and would give a net negative charge to the micelle.

**QUESTION 4**

Aerobic respiration is the major process used by oxygen- requiring organisms to generate energy. During respiration, glucose is metabolized to generate chemical energy in the form of ATP:

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + 36ATP$$

The biochemical machinery necessary for cellular respiration is found in the mitochondria, small organelles scattered throughout the cytoplasm of most eukaryotic cells. The number of mitochondria per cell varies by tissue type and cell

function.

Mitochondria are unusual in that they have their own genetic systems that are entirely separate from the cell\\'s genetic material. However, mitochondrial replication is still dependent upon the cell\\'s nuclear DNA to encode essential proteins

required for replication. Despite this fact, mitochondria seem to replicate randomly, out of phase with both the cell cycle and other mitochondria.

The nature of the mitochondrial genome and protein synthesizing machinery has led many researchers to postulate that mitochondria may have arisen as the result of the ingestion of a bacterium by a primitive cell millions of years ago. It is

postulated that the two may have entered into a symbiotic relationship and eventually became dependent on each another; the cell sustained the bacterium, while the bacterium provided energy for the cell. Gradually, the two evolved into the

present-day eukaryotic cell, with the mitochondrion retaining some of its own DNA. This is known as the endosymbiotic hypothesis. Because mitochondrial DNA is inherited in a non-Mendelian fashion (mitochondria are inherited from the

maternal parent, who supplies most of the cytoplasm to the fertilized egg), it has been used to look at evolutionary relationships among different organisms.

A mating type of a wild-type strain of the algae C. reinhardii is crossed with the opposite mating type of a mutant strain of the algae, which has lost all mitochondrial functions due to deletions in their mitochondrial genome. All of the offspring

from this cross also lack mitochondrial functions. Based on information in the passage, this can best be explained by the:

A. endosymbiotic hypothesis.

B. non-Mendelian inheritance of mitochondrial DNA.

C. recombination of mitochondrial DNA during organelle replication.

D. presence of genetic material in the mitochondria that is distinct from nuclear DNA.

Correct Answer: B

In this question you are presented with a cross between two strains of the algae C. reinhardii. You do not need to know anything about this species of algae to answer the question. From the question stem you know that the mating type of a wild-type strain, which has normal mitochondrial DNA, is crossed with the opposite mating type of a strain that lacks functional mitochondria due to deletions in the mitochondrial genome. This whole thing about "mating types" is another way of saying male and female in species that do not technically have opposite genders, such as algae and yeast. In addition, you\\'re told that the offspring of this cross do not have functional mito- chondria either. What does this mean? Somehow the offspring have the same deleted mitochondrial genome as the mutant strain. Now all you have to do is

find the choice that best accounts for this occurrence. Choice A is incorrect because the endosymbiotic theory attempts to explain the derivation of mitochondria in eukaryotic cells, not the inheritance of mitochondria. Choice B is correct. Since you\\'re told that the offspring lack mitochondrial functions, this implies that they inherited their mitochondria from the mutant strain mating type. In other words, the mutant strain was the organelle-donating parent -- the female -- in this cross. Therefore, the non-Mendelian inheritance pattern of mitochondria, as explained in the passage, best accounts for these experimental observations. If the mating type of the wild-type strain had been the organelle-donating parent, then all of the offspring would have normal mitochondrial function. Choice C is wrong because the word recombination implies the formation of new gene combinations due to crossing over events that occur during reproduction. If recombinations did occur, you would expect some of the offspring to regain mitochondrial functions since wild-type mitochondrial DNA would replace the deleted segments of DNA in some offspring. Although choice D is a true statement, it does not explain the inheritance patterns observed in this cross, thus choice D is incorrect.

**QUESTION 5**

Agonistic behavior, or aggression, is exhibited by most of the more than three million species of animals on this planet. Animal behaviorists still disagree on a comprehensive definition of the term, but aggressive behavior can be loosely described as any action that harms an adversary or compels it to retreat. Aggression may serve many purposes, such as food gathering, establishing territory, and enforcing social hierarchy. In a general Darwinian sense, however, the purpose of aggressive behavior is to increase the individual animal\\'s -- and thus, the species\\' -- chance of survival. Aggressive behavior may be directed at animals of other species, or it may be conspecific -- that is, directed at members of an animal\\'s own species. One of the most common examples of conspecific aggression occurs in the establishment and maintenance of social hierarchies. In a hierarchy, social dominance is usually established according to physical superiority; the classic example is that of a pecking order among domestic fowl. The dominance hierarchy may be viewed as a means of social control that reduces the incidence of attack within a group. Once established, the hierarchy is rarely threatened by disputes because the inferior animal immediately submits when confronted by a superior. Two basic types of aggressive behavior are common to most species: attack and defensive threat. Each type involves a particular pattern of physiological and behavioral responses, which tends not to vary regardless of the stimulus that provokes it. For example, the pattern of attack behavior in cats involves a series of movements, such as stalking, biting, seizing with the forepaws and scratching with the hind legs, that changes very little regardless of the stimulus -- that is, regardless of who or what the cat is attacking. The cat\\'s defensive threat response offers another set of closely linked physiological and behavioral patterns. The cardiovascular system begins to pump blood at a faster rate, in preparation for sudden physical activity. The eyes narrow and the ears flatten against the side of the cat\\'s head for protection, and other vulnerable areas of the body such as the stomach and throat are similarly contracted. Growling or hissing noises and erect fur also signal defensive threat. As with the attack response, this pattern of responses is generated with little variation regardless of the nature of the stimulus. Are these aggressive patterns of attack and defensive threat innate, genetically programmed, or are they learned? The answer seems to be a combination of both. A mouse is helpless at birth, but by its 12th day of life can assume a defensive threat position by backing up on its hind legs. By the time it is one month old, the mouse begins to exhibit the attack response. Nonetheless, copious evidence suggests that animals learn and practice aggressive behavior; one need look no further than the sight of a kitten playing with a ball of string. All the elements of attack -- stalking, pouncing, biting and shaking -- are part of the game which prepares the kitten for more serious situations later in life.

The author suggests that the question of whether agonistic behavior is genetically programmed or learned:

A. still generates considerable controversy among animal behaviorists.

B. was first investigated through experiments on mice.

C. is outdated since most scientists now believe the genetic element to be most important.

D. has been the subject of extensive clinical study.

Correct Answer: D

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