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QUESTION 1

Four major blood types exist in the human ABO blood system: types A, B, AB, and O; and there are three alleles that code for them. The A and B alleles are codominant, and the O allele is recessive. Blood types are derived from the presence of specific polysaccharide antigens that lie on the outer surface of the red blood cell membrane. The A allele codes for the production of the A antigen; the B allele codes for the production of the B antigen; the O allele does not code for any antigen. While there are many other antigens found on red blood cell membranes, the second most important antigen is the Rh antigen. Rh is an autosomally dominant trait coded for by 2 alleles. If this antigen is present, an individual is Rh+; if it is absent, an individual is Rh-. For example, a person with type AB blood with the Rh antigen is said to be AB+.

These antigens become most important when an individual comes into contact with foreign blood. Because of the presence of naturally occurring substances that closely mimic the A and B antigens, individuals who do not have these antigens on their red blood cells will form antibodies against them. This is inconsequential until situations such as blood transfusion, organ transplant, or pregnancy occur.

Erythroblastosis fetalis is a condition in which the red blood cells of an Rh+ fetus are attached by antibodies produced by its Rh- mother. Unlike ABO incompatibility, in which there are naturally occurring antibodies to foreign antigens, the Rh system requires prior sensitization to the Rh antigen before antibodies are produced. This sensitization usually occurs during the delivery of an Rh+ baby. So while the first baby will not be harmed, any further Rh+ fetuses are at risk. The Coombs tests provide a method for determining whether a mother has mounted an immune response again her baby\\'s blood. The tests are based on whether or not agglutination occurs when Coombs reagent is added to a sample. Coombs reagent contains antibodies against the anti-Rh antibodies produced by the mother. The indirect Coombs test takes the mother\\'s serum, which contains her antibodies but no red blood cells, and mixes it with Rh+ red blood cells. Coombs reagent is then added. If agglutination occurs, the test is positive, and the mother must be producing anti-Rh antibodies. The direct Coombs test mixes the baby\\'s red blood cells with Coombs reagent. If agglutination occurs, the test is positive, and the baby\\'s red blood cells must have been attacked by its mother\\'s anti-Rh antibodies.

A medical student suggested giving Rh- mothers of Rh+ fetuses a specific exogenous substance prior to delivery to prevent an immune response. Which of the following substances would likely be the safest and most effective?

A. Rh antigen

B. An immunosuppressive drug

C. Anti-Rh antibody

D. Iron pills

Correct Answer: C

It is, in fact, true that a medical student was responsible for the treatment currently used to prevent Rh incompatibility reactions. The exogenous substance is called RhoGAM, and is derived from Rh immunoglobulin. RhoGAM is anti-Rh antibody. The theory behind it is that if given prior to delivery -- the time at which exposure occurs -- rhoGAM will attack and coat the fetal Rh positive red blood cells. By coating the fetal cells, the Rh antigen is no longer accessible to the mother\\'s system; it is effectively "hidden." The mother therefore does not produce anti-Rh antibody of her own, the baby\\'s coated red blood cells are removed and destroyed by the mother\\'s immune system, and sensitization has been prevented. So choice C is correct. In practice, however, rhoGAM is usually administered during the postpartum period, specifically within the first 72 hours following birth. Choice A, Rh antigen, would only enhance the mother\\'s immune response if given prior to delivery. Exposing her to the antigen would lead to the production of anti-Rh antibody, which would increase the risk of erythroblastosis fetalis for future children. The whole idea of the treatment is to prevent the mother from producing her own anti-Rh antibodies, and thereby prevent sensitization, NOT enhance it. So, choice A is wrong. Choice B, an immunosuppressive drug, might be an effective way to suppress the immune response, but it would certainly not be safe. An immunosuppressive drug has a broad action, rather than a specific one, and would affect many aspects of the mother\\'s immune system, not just her ability to produce anti-Rh antibodies in response to

the Rh antigen on her baby\\'s red blood cells. In fact, immunosuppressive drugs would make the mother more susceptible to infection and would have adverse side effects. So choice B is also incorrect. Choice D, iron pills, are often given to pregnant women as an iron supplement to combat the anemia associated with pregnancy. The anemia is due to the excessive circulatory demands exacted by the fetus and the placenta. Iron pills, however, in no way affect the immune system and would therefore not be effective in preventing an immune response of any sort; thus choice D is incorrect.

QUESTION 2

...[TV Guide\\'s] immediate concern was the television quiz show scandal, which had reached its climax two weeks earlier when Charles Van Doren, the appealing young man who\\'d taught viewers the value of learning while winning big on MCA\\'s Twenty-one, stood before a House committee and admitted he was a fraud. But the issue went well beyond rigged quiz shows. The charge was that through their stranglehold on talent, MCA and William Morris monopolized the medium to the detriment of their clients, the industry, and the public at large. This was why the Justice Department had launched a secret investigation of both agencies more than two years before. The Morris Agency had started the quiz show vogue in 1955, when it packaged The $64,000 Question for Revlon and sold it to CBS. While the show won praise for its "educational" nature, the real source of its appeal was in its crapshoot format -- the idea that once contestants\\' winnings hit the $32,000 mark, they had to decide whether to go double or nothing on the final, $64,000 question, or play it safe and go home. The response was tremendous. Within weeks, the show knocked I Love Lucy out of the number-one slot in the ratings. Casinos in Vegas emptied out when it went on the air. Bookies took odds on whether the first contestant to go for the big one -- a marine captain whose specialty was cooking -would get the answer right. (He did.) Revlon sold so much Living Lipstick that its factory was unable to meet the demand. The $64,000 Question quickly inspired imitators, among them an MCA package called Twenty-one. Based on the card game, more or less, Twenty-one was a dismal failure at first. "Do whatever you have to do," the sponsor ordered angrily, so the producers put the fix in. In December 1956, when Charles Van Doren, a boyishly attractive English instructor at Columbia University, beat Herb Stempel, a short, squat, nerdy grad at City College, Van Doren became the first intellectual hero of the television age. Honors and acclaim poured in--the covers of Time, letters by the hundreds, offers of movie roles and tenured professorships and a regular guest spot on The Today Show. But Herb Stempel didn\\'t like being told to lose, especially to some Ivy League snot. He went to the press. The DA\\'s office started to investigate. The walls began to close in. Meanwhile, the show\\'s producers agreed to sell the rights to NBC for $2 million. One of them started to feel queasy about selling the show without letting the network know the score, so he went to Sonny Werblin, MCA\\'s top man in New York, and asked his advice. Werblin, the man behind such hits as The Ed Sullivan Show and The Jackie Gleason Show, ran the television department as if it were a football team coached by Attila the Hun. "Dan," he asked the producer, "have I ever asked you whether the show was rigged?" No, he hadn\\'t. "And has NBC ever asked you whether the show is rigged?" No, they hadn\\'t either. "Well," Werblin concluded, "the reason that none of us has asked is because we don\\'t want to know." And with good reason. Not only was Twenty-one an MCA package and Van Doren himself an MCA client; Werblin had a special relationship with NBC\\'s president, Robert Kintner. Kintner had been president of ABC until...ABC\\'s chairman forced him out in his determination to move the network out of third place. MCA used its influence to place him at NBC, where he proved an extremely pliant customer. In the spring of 1957, when the networks were putting together their schedules for the next season, Werblin went to a meeting of NBC programming executives led by Kintner and his boss, RCA chairman Robert Sarnoff. "Sonny, look at the schedule for next season," Kintner said when he walked in, "here are the empty slots, you fill them."

According to the passage, which of the following are true statements?

I. A correlation between successful contestants and successful sponsors exists in the television industry.

II. Most game shows in the 1950s were rigged.

III.

Van Doren\\'s quiz-show success provided him with further opportunity in his academic career.

A.

I only

B.

II only

C.

III only

D.

None of the above

Correct Answer: C

Statements I and II are general claims that cannot be concluded based solely on the incidents cited in the passage. Statement III is supported by information found in the third paragraph.

QUESTION 3

Sugars are carbohydrates, that is, molecules usually with the empirical formula C(H2O), and structural formulas made up of polyhydroxy aldehydes or ketones. Because of their polyfunctional nature, sugars can undergo a wide variety of

transformations upon treatment with acids, bases, or heat, and upon reaction with other simple reagents and enzymes. While many sugars occur in nature and are thus readily available, the synthesis and modification of simple sugars is a

necessary step in studies of enzymatic processes.

Higher sugars can be synthesized from the simple carbohydrate D-glyceraldehyde with the following procedure:

D-glyceraldehyde (Compound A) is reacted with HCN to produce a cyanohydrin (Compound B). Compound B is then treated with hydrogen gas and a modified palladium catalyst (similar to the Lindlar reagent) to give Compound C.

Compound C is hydrolyzed to give the higher sugars in Mixture D. This reaction is summarized in Figure 1. Mixture D contains two compounds, which can be separated by crystallization. Two doublets near 9.5 (, ppm) are observed in the 1H

NMR spectrum of mixture D, with each doublet corresponding to one of the two products present in the mixture. IR spectroscopy shows broad absorptions for both products around 3300 cm?.

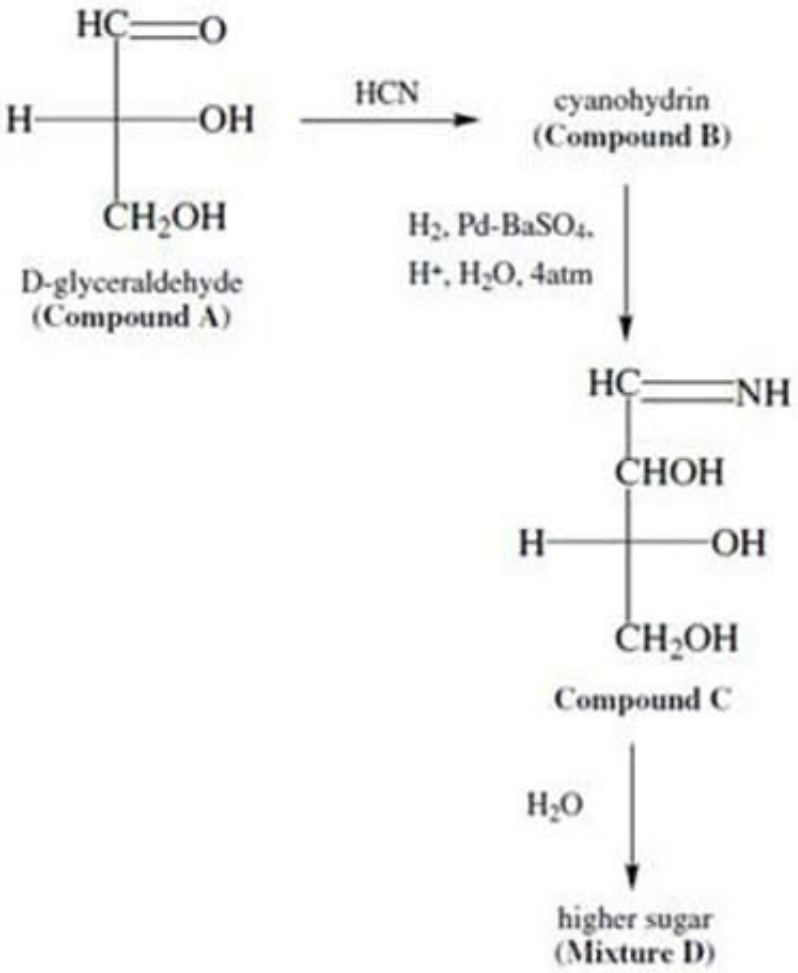


Figure 1 Synthesis of higher sugar

The hydroxyl groups of carbohydrates can also participate in reactions. For example, D-glyceraldehyde can react with chloromethane under basic conditions to yield a completely methylated product. This SN2 reaction is shown in Figure 2.

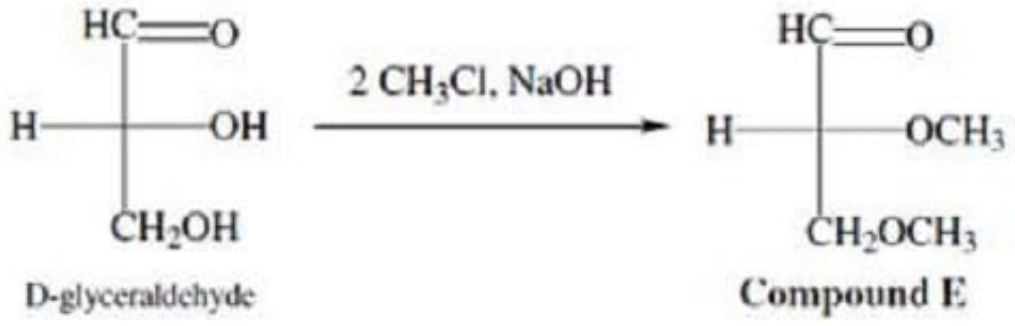


Figure 2 Methylation of D-glyceraldehyde

In glucose, the carbonyl carbon can be attacked, intramolecularly, by the hydroxyl oxygen of carbon-5 to form:

A. glucofuranose.

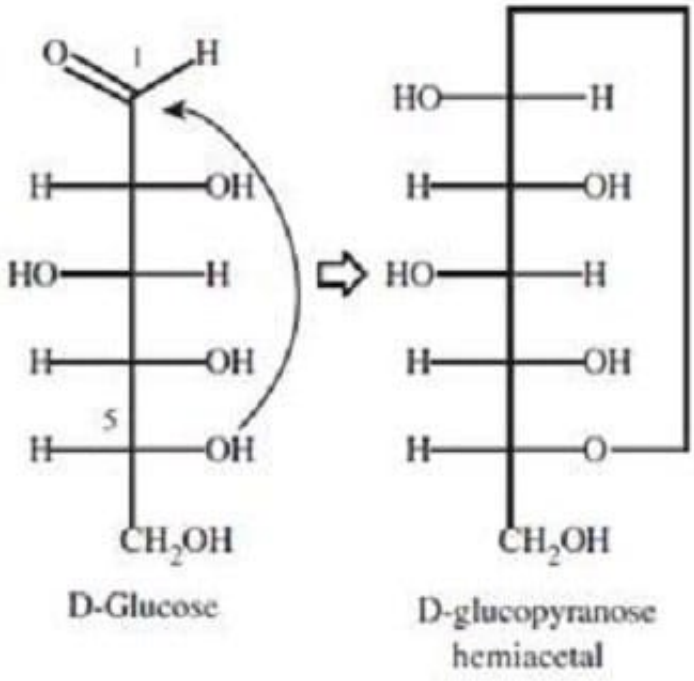
B. a hemiacetal.

C. a lactone.

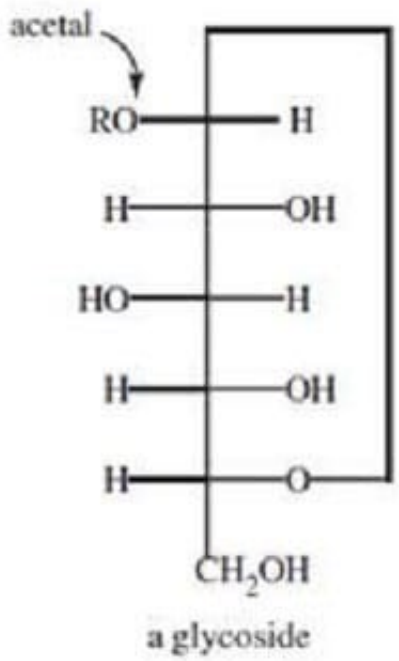
D. a glycoside.

Correct Answer: B

A hemiacetal is formed through reaction of a carbonyl group and a hydroxyl group. In this question, these two groups occur on the same molecule of glucose.



Choice A is incorrect because glucofuranose is the five-membered ring that is formed through attack by the hydroxyl oxygen of carbon-4, not carbon-5 as the question stem states. Furanose refers to a five- membered ring while pyranose refers to the more energetically favorable six-membered ring. Choice C is incorrect because a lactone is a cyclic ester. No ester linkage is formed in this case. Choice D is incorrect because a glycoside is a sugar acetal. These acetals are formed during polysaccharide formation. They can also be formed by exposing a sugar like D-glucose to another alcohol in an acidic environment.



QUESTION 4

A continuous spectrum of light, sometimes called blackbody radiation, is emitted from a region of the Sun called the photosphere. Although the continuous spectrum contains light of all wavelengths, the intensity of the emitted light is much greater at some wavelengths than at others. The relationship between the most intense wavelength of blackbody radiation and the temperature of the emitting body is given by Wien\\'s law, ? = 2.9 x 106/T, where ? is the wavelength in nanometers and T is the temperature in kelvins.

As the blackbody radiation from the Sun passes through the cooler gases in the Sun\\'s atmosphere, some of the photons are absorbed by the atoms in these gases. A photon will be absorbed if it has just enough energy to excite an electron from a lower energy state to a higher one. The absorbed photon will have an energy equal to the energy difference between these two states. The energy of a photon is given by E = hf = hc/? where h = 6.63 x 10-34 J•s, Planck\\'s constant, and c = 3 x 108 m/s, the speed of light in a vacuum.

The Sun is composed primarily of hydrogen. Electron transitions in the hydrogen atom from energy state n = 2 to higher energy states are listed below along with the energy of the absorbed photon:

Final Energy State Energy (x 10-19 J) n = 3

3.02

n = 4

4.08

n = 5

4.57 n = 6

4.84 n = ?

5.44

Based on the data in the table, what is the approximate wavelength of a photon emitted in the electron transition from energy state n = 4 to energy state n = 3?

A. 5 nm

B. 30 nm

C. 100 nm

D. 2,000 nm

Correct Answer: D

QUESTION 5

Before birth, the rodent brain is sexually undifferentiated. It is only in the first few days following birth, during a period referred to as the critical period, that the rodent brain differentiates along male or female lines. The hormone testosterone plays a critical role in this development. Specifically, sexual differentiation is determined by the presence of estradiol, an estrogen derivative of testosterone, in certain areas of the brain. Testosterone is converted to estradiol in critical brain cells that contain the enzyme aromatase. To study the effects of testosterone on the neonatal rodent brain, the following experiments were conducted:

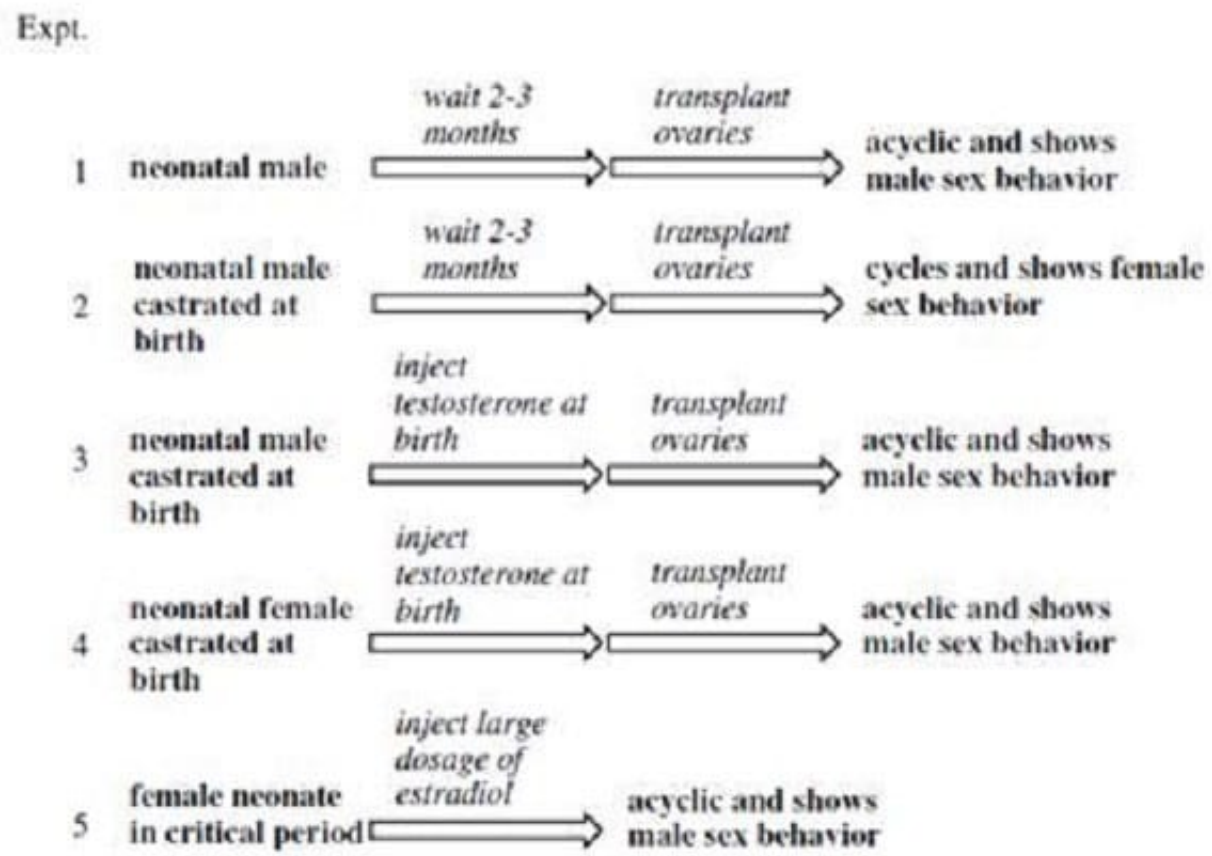


Figure 1

The above research, combined with additional studies, concluded that testosterone has two "organizational" effects on the male rodent brain: Defeminization Moderate levels of testosterone-derived estradiol during the critical period are sufficient for defeminization of the brain. Defeminization of the rodent brain results in loss of estrogen positive feedback on LH and FSH secretion and the ensuing loss of cyclicity, as well as loss of female sex behavior. Masculinization High levels of estradiol due to high levels of testosterone during the critical period results in masculinization of the brain. Masculinization leads to the induction of male sex behavior including antagonism towards other males and the mounting of females.

A normal female rat injected with estradiol will respond by:

A. decreasing secretion of LH from the anterior pituitary.

B. increasing secretion of LH from the anterior pituitary.

C. decreasing secretion of GnRH from the hypothalamus.

D. increasing secretion of progesterone from the follicle.

Correct Answer: B

Estradiol has a positive feedback effect on the pituitary, causing it to secrete LH and FSH. Estradiol also has a positive feedback effect on the hypothalamus, causing it to secrete GnRH. Estradiol injection will lead to an LH surge in rodents

capable of cycling.

Choice A is incorrect because LH secretion increases.

Choice C is incorrect because GnRH secretion increases.

Choice D is incorrect because progesterone is not secreted by the follicle. It is secreted by the corpus luteum or placenta.