# PA·CAT

## Physician Assistant ✔ College Admissions Test

# Study Guide

**How do I prepare for the PA-CAT exam?**

The goal of this study guide is to assist you with implementing regular study practice in the months leading up to your PA-CAT exam. Preparing for an exam can be stressful, but a little preparation can go a long way; you are more likely to do well when you have had ample time to practice and study the material. Being prepared and organized will help you reduce stress and test day anxiety.


**What is covered on the exam?**

The PA-CAT is a standardized assessment of 240 multiple-choice questions with an allotted time frame of 4.5 hours. This includes exam time, tutorials, and post-exam survey. The test is delivered electronically at Prometric testing centers across the US. The questions are designed to measure your knowledge and application in key prerequisite science subjects typically required for PA School.

Covered Subjects:
- Anatomy
- Physiology
- General Biology
- Biochemistry
- General and Organic Chemistry
- Microbiology
- Behavioral Sciences
- Genetics
- Statistics

Here are sample topics from Biochemistry*:
- Introduction to Biochemistry concepts
- Integration of Metabolism
- Proteins
- Specialized Metabolism of Tissues
- Cell Membranes and Cell Communication
- Enzymes
- Specific Functions of Proteins
- Lipids
- Nucleic Acids
- Vitamins
- Carbohydrates

*Note: Topics vary by exam form and are subject to change.*


**What is your baseline?**

Before you begin to study, it is important to understand your strengths and weaknesses.

- Review your syllabi from previous classes and any exams or quizzes you have taken. If you don't have any syllabi, search online to see what is publicly available.
- Take inventory of areas where you did not perform well, areas you are not sure you still remember, and areas you have a solid grasp on.
- We also highly recommend talking to your professors and TAs. They can help with your strengths and weaknesses analysis and point out other areas that may not be on your radar.

**Don't cram - Plan**

Now that you understand where your baseline is, fill in the remaining areas that you need to focus on and create a study outline. Then look over your schedule, take inventory of your responsibilities and what you need to accomplish for the PA-CAT, and start planning your study sessions.

Don't overschedule. Manage your time wisely and pace yourself. Studying for your PA-CAT exam is not a sprint; it's a marathon. By giving yourself ample time, you can break up your study goals into smaller, more manageable chunks to make the process less daunting.

- Schedule study sessions based on your study outline and commit to them. Ask a friend to hold you accountable, if necessary.
- Assign specific goals for each study session based on your strengths and weaknesses.
- Study in a quiet space and stay clear of distractions (TV, loud music)
- Leave your phone in a different room or turn it off. Log out of social media.
- During each study session, tackle the harder concepts that require your full attention and focus first. Finish up with easier, more fun subjects.
- Be sure that you are studying for *understanding* and not just recognition. Below is a breakdown of what you will be asked to do with the information you are studying (subject to change with each version of the exam).

| | |
|---|---|
| Knowledge | 12% |
| Comprehension | 25% |
| Application | 54% |
| Analysis | 9% |

  Yes, you will need to know the concepts and memorize appropriate terminology, but ensure that you are not just memorizing abstract concepts. Instead, take time to understand the content and how it can be applied.

  Below are some study strategies that will help determine if you understand the material or if you're only testing your memory:
  - Understand the broader concept before you memorize terminology.
  - Visualize the concepts you are studying and their application.
  - Rewrite the concepts in different words.
  - Discuss a concept with another person and explain it to them. This can be done as part of a study group or with a person who does not have a background in that field. As you talk your way through it, you'll quickly find areas that require more attention.
- Be sure to take regular, short study breaks. Studying in bursts with 5- to 10-minute breaks is more effective than studying nonstop. Breathe, move and stretch, have a nutritious snack, drink some water, then return and refocus.
- Sneak in study time whenever you can.

**Practice Test Taking**

The PA-CAT is a computer-based multiple-choice exam. It is important to put time aside to practice test taking on a computer. We recommend that you take advantage of Exam Master's free resources for your test prep:

- Review the Sample Questions to get an understanding of the type of questions you will be asked on the PA-CAT exam.
- After you register for the exam, you will receive an email with instructions on how to access additional free resources.
    - Take the *Practice Exam* to mimic the same conditions as the PA-CAT exam.
    - You will also have access to eight *Subject Review Practice Exams* and a *Review Course*.

**How to stay motivated**

Motivation is not constant. It needs to be nurtured as you prepare for your exam. Anticipate peaks and valleys in your progress, and put tools in place to overcome the low points. Below are some suggestions:

- Make a list of the reasons you want become a physician assistant and what it would mean to you to get into the PA Program of your choice. When you experience a motivational low in your PA-CAT preparation, revisit what you wrote down to remind yourself of your goals.
- Find a study buddy or group you can trust to hold you accountable. Working with a peer or in a study group can keep you engaged, and it allows you to test your knowledge through conversation and interaction.
- Visualize yourself taking the PA-CAT exam successfully. You can mentally rehearse the task at hand, making it easier to find motivation to study.
- Focus on the subject you are working on and not the other areas you still need to tackle. Break it up into smaller chunks. Once you have completed one of those chunks, celebrate and reward yourself before moving on to the next.
- Remind yourself that this is a process that has an end date, especially if you are feeling overwhelmed or unmotivated. You started studying early and put a plan in place to get you there. There is a level of urgency, and it is important to acknowledge that, but there is also a light at the end of that tunnel.

**Good luck from the Exam Master Team with your studies and on your PA-CAT exam!**

For more information on the PA-CAT, visit our Resources page.

# PA-CAT Sample Test Items

## Anatomy

What is the likely diagnosis for a child who reports increased back pain, an uneven gait, and favoritism to the left side?

**Answer Choices:**

    A. Kyphosis
    B. Lordosis
    **C. Scoliosis**
    D. Spina bifida

**Explanation:**

**Scoliosis** is the lateral bending of the vertebral column, often in the thoracic area.

**Kyphosis** is a curvature of the spine that produces a "humpback."

**Lordosis** is having a "hollow back," or being "bent backward." Some describe it as a sway back. It may be caused by poor posture.

**Spina bifida** is a defect of the vertebral column where L5 or S1 fails to develop normally, leaving a hole or dimple.

**References:**

1. Tortora, GJ, Derrickson BH. *Principles of Anatomy & Physiology*. 15th ed. Hoboken, NJ: Wiley: 2017:255-9.

---

A 42-year-old man with a history of anxiety and peptic ulcer disease develops severe back pain. An analysis reveals the presence of amylase, lipase, and peptidase in his stomach. This patient's condition is caused by erosion of a peptic ulcer in what structure?

**Answer Choices:**

    A. Left gastric artery
    **B. Pancreas**
    C. Peritoneal cavity
    D. Pleural cavity
    E. Splenic artery

**Explanation:**

This patient's sudden onset severe back pain suggests perforation of a peptic ulcer. The location of his pain along with the presence of pancreatic enzymes in the stomach suggest that the ulcer eroded into the **pancreas**. Since the pancreas is located directly posterior to the stomach, the ulcer would be located on the posterior wall of the stomach.

If the ulcer had eroded into the **peritoneal cavity**, the leakage of stomach contents into the peritoneal cavity would result in a generalized peritonitis, causing generalized severe abdominal pain and rebound tenderness, not focal back pain. If the ulcer had somehow eroded into the **pleural cavity**, we would expect to see pleuritic chest pain. If the ulcer had eroded into a blood vessel, we might see blood in the stomach or peritoneum instead of pancreatic enzymes, resulting in a much more serious clinical presentation. Two common blood vessels that a peptic ulcer can erode into are the **splenic artery**, which carries blood to the spleen, or the **left gastric artery**, which supplies blood to the lesser curvature of the stomach.

**References:**

1. Moore KL, Dalley AF, Agur AMR. *Clinically Oriented Anatomy.* 7th ed. Philadelphia, PA: Lippincott Williams & Wilkins; 2014:255-7.

## Physiology

*Question 1 of 2*

A patient sustains a myocardial infarction (heart attack) that damages the ventricular septum of the heart. What effect on the heart is most likely to be seen immediately after the heart attack?

**Answer Choices:**

    A. Blood flowing from the left side of the heart to the right
    **B. Changes in the electrical conduction of the heart**

C. Damage to the valves of the heart
D. Reduction in blood pressure

**Explanation:**

The septum contains fibers that coordinate the beating of the ventricles. These are sensitive and are damaged almost instantly in myocardial infarction. This damage can be seen via changes in the **conduction** of electricity through the heart.

**Damage** to valves, left to right **blood flow**, and dramatic **hypotension** are common late complications of myocardial infarction, generally occurring days to weeks following the initial event. This is in contrast to electrical changes, which present near instantly.

**References:**

1. OpenStax, Anatomy & Physiology. OpenStax CNX. Jul 31, 2018. https://cnx.org/contents/FPtK1zmh@11.1:Y5T_wVSC@5/Heart-Anatomy. Accessed September 5, 2018.

*Question 2 of 2*

If a patient ingests a poison that inhibits protein synthesis, what cellular organelle(s) is/are being targeted?

**Answer Choices:**

A. Lysosomes
B. Golgi apparatus
C. Plasma membrane
D. Mitochondria
E. **Ribosomes**

**Explanation:**

**Ribosomes** are responsible for the production of cellular proteins through the process of translation.

**Lysosomes** contain digestive enzymes and are involved in the breakdown of molecules and cellular maintenance.

The **Golgi apparatus** is responsible for sorting, packaging, and sending proteins throughout the cell.

The **plasma membrane** is a semi permeable boundary surrounding the cell.

**Mitochondria** are the energy-producing organelles within the cell. Mitochondria produce energy in the form of ATP via aerobic respiration in humans.

**References:**

1. Tortora GJ, Derrickson B, & Tortora GJ. *Principles of anatomy & physiology*. Hoboken, NJ: Wiley; 2014.

## General Biology

*Question 1 of 2*

**Case:**

Trace evidence retrieved in a crime scene revealed 2 distinct monosaccharides upon infrared spectroscopic analysis. The victim was a scientist who was working with an enzyme that cleaves disaccharides. The spectroscopic analysis from the crime lab exactly matched the last entry on the victim's electronic notebook. During their investigation, the forensics team analyzed carbohydrate samples from 4 suspects who had entered the crime scene in the past 24 hours. Each of the suspects had a unique carbohydrate sample that they needed to analyze.

**Stem:**

Based on this evidence, which of the following carbohydrates did the most likely suspect possess?

**Answer Choices:**

A. Fructose
B. Maltose
C. Starch
D. **Sucrose**

**Explanation:**

The victim was working with an enzyme that cleaves disaccharides into its constituent monosaccharides. The spectroscopic analysis revealed the presence of 2 different monosaccharides. The most likely suspect must have been the person who possessed a disaccharide made of 2 different monomers.

The suspect who possessed **sucrose** (glucose + fructose), is most likely to have seen the victim the last.

**Maltose** is a disaccharide made of 2 glucose monomers and could not have been the relevant disaccharide.

**Fructose** (a monosaccharide) and **starch** (a polysaccharide) cannot be cleaved by the enzyme in question.

**References:**

1. Simon EJ, Dickey JL, Hogan KA, Reece JB. Essential Chemistry for Biology. In: *Campbell Essential Biology with Physiology*. 5th ed. Harlow, UK: Pearson; 2016:22-35.

---

*Question 2 of 2*

**Case:**

A graduate student received organellar fractions from 4 different sources. The student was asked to extract DNA from each and was surprised to find 1 sample devoid of any genetic material.

**Stem:**

Given that the student was careful and there were no mistakes in the extraction procedure, what source would be devoid of genetic material?

**Answer Choices:**

A. Beetle leaf extract
B. Onion peel
C. **Red blood cells**
D. Semen sample

**Explanation:**

**Red blood cells (RBCs)** extracted from blood would be devoid of any genetic material. Typically, a blood sample would contain all cellular components (lymphocytes, RBCs, and platelets) from which DNA can be extracted, but RBCs specifically do not contain nuclei or any organelles (to make room for packaging hemoglobin).

**Beetle leaf extract** and **onion peel**, both plant sources, and **semen sample** (human source) would all contain DNA, as they contain nuclei and organelles (mitochondria and chloroplasts), which house various amounts of DNA.

**References:**

1. The Princeton Review: Molecular Biology. In: *Cracking the AP Biology Exam*. New York, NY: Penguin Random House; 2018:161-81.
2. The Princeton Review: Cells. In: *Cracking the AP Biology Exam*. New York, NY: Penguin Random House; 2018:111-8.

## General and Organic Chemistry

*Question 1 of 2*

What process occurs during the increase in water solubility of a compound containing functional groups with carboxylic acids as they undergo ionization?

**Answer Choices:**

A. Elongation of hydrocarbons
**B. Formation of salts**
C. Grouping of aromatic rings
D. Standardization of charge

**Explanation:**

One way in which carboxylic acids increase the water solubility of a compound is through reaction with a strong base to **form salts** (carboxylate anion salts). Salt formation can increase the water solubility of a compound due to the attraction of the area of the partial positive charge within the compound to the partial negative of water (area surrounding oxygen).

**Elongation of hydrocarbons**, **grouping of aromatic rings**, and **standardization of charge** (reduction of polarity) serve to reduce water solubility.

**References:**

1. Jonsson AL, Roberts MAJ, Kiappes JL, Scott KA. Essential chemistry for biochemists. *Essays Biochem*. 2017;61(4):401-27. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5869253/.

---

*Question 2 of 2*

The acetylation of 0.205 mol of p-aminophenol by acetic anhydride produced acetaminophen and acetic acid. A side reaction resulting from moisture in the reaction vessel hydrolyzed an unknown amount of acetic anhydride before the reaction was complete. After purification, only 29.47 g of acetaminophen was isolated. If 13.35 g of acetic acid was recovered from the products, how much acetic anhydride was consumed in the acetylation reaction and how much underwent hydrolysis?

**Answer Choices:**

A. Acetylation – 11.71 g and Hydrolysis – 1.39 g
**B. Acetylation – 19.91 g and Hydrolysis – 1.39 g**
C. Acetylation – 19.91 g and Hydrolysis – 1.64 g
D. Acetylation – 20.93 g and Hydrolysis – unknown
E. Acetylation – 19.91 g and Hydrolysis – unknown

**Explanation:**

The correct answer is **Acetylation – 19.91 g and Hydrolysis – 1.39 g**.

Since acetaminophen is the product of the acetylation reaction, the amount of acetaminophen produced from the reaction is used to determine how much of the acetic anhydride was consumed by the acetylation reaction. Using the molecular mass, we can determine that 0.195 mol of acetaminophen was produced through acetylation. This would require 19.91 g of acetic anhydride.

Calculate the amount of acetic acid produced as a side product of the acetylation reaction: 0.195 mol*60.05 g = 11.71 g. Now, subtract the mass of acetic acid produced as a result of acetylation from the mass recovered after reaction to get the mass of acetic acid produced through hydrolysis: 13.35 g – 11.71 g = 1.64 g acetic acid. The hydrolysis reaction proceeds as follows:

$(CH_3CO)_2O + H2O \rightarrow 2CH_3COH$

Therefore, 1.64 g of acetic acid is produced by 1.39 g of acetic anhydride.

**References:**

1. Zumdahl SS, Zumdahl SA. *Chemistry: An Atoms First Approach*. 2nd ed. Bellmont, CA: Cengage Learning; 2015:236.

## Biochemistry

*Question 1 of 2*

What generally results from a point mutation, deletion, or insertion in the promoter region of a proto-oncogene?

**Answer Choices:**

A. **Increased transcription of protein product**
B. Stimulation of cell mitosis
C. Transduction of continuous cell growth signals
D. Uncontrolled stimulation of kinase signaling pathway

**Explanation:**

A point mutation, deletion, or insertion in the promoter region of a proto-oncogene is an activation mechanism that generally causes **increased transcription**.

**Stimulation of cell mitosis** is an example of a general process involving proteins encoded by proto-oncogenes.

**Transduction of continuous cell growth signals** relates to a mutation within an oncogene rather than a mutation to the promoter region; specifically, this refers to the mutated *ras* oncogene, which causes a protein to remain in an active state and transduces continuous cell growth signals.

**Uncontrolled stimulation of kinase signaling pathway** similarly relates to a mutation within an oncogene rather than a mutation to the promoter region; specifically, this refers to the mutated *braf* oncogene, which encodes for a protein with a modified kinase domain.

**References:**

1. Lowdon R, Wang T. Epigenomic annotation of noncoding mutations identifies mutated pathways in primary liver cancer. *PLoS One.* 2017;12(3):e0174032. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5363827/.

Which hormone produced by the hypothalamus and secreted by the pituitary gland would you expect to be effective in improving social interactions in children with autism?

**Answer Choices:**

A. Human growth hormone
**B. Oxytocin**
C. Thyroid-stimulating hormone
D. Vasopressin

**Explanation:**

**Oxytocin** is involved in bonding and trust; low levels of this hormone are correlated with autism in children. **Human growth hormone** is involved with physical development of children. **Thyroid-stimulating hormone** activates production of thyroid hormones. **Vasopressin** helps regulate water and electrolyte homeostasis.

**References:**

1. Higashida H, Munesue T, Kosaka H, Yamasue H, Yokoyama S, Kikuchi M. Social Interaction Improved by Oxytocin in the Subclass of Autism with Comorbid Intellectual Disabilities. *Diseases*. 2019;7(1):24. doi:10.3390/diseases7010024.

## Microbiology

An 8-month-old boy who has never been vaccinated presents with a 3-day history of fever and watery non-bloody diarrhea. On physical examination, he appears dehydrated. What is the genome of the most likely infecting organism?

**Answer Choices:**

A. Double-stranded DNA
B. Non-segmented single-stranded positive-sense RNA
**C. Segmented double-stranded RNA**

D. Single-stranded DNA

**Explanation:**

Rotaviruses cause most of the watery diarrheal illness in infants and children worldwide. They are non-enveloped RNA viruses containing 11 segments of **double-stranded RNA genome** within a double-shelled capsid.

Rotaviruses, like the influenza viruses that have a segmented genome, can undergo genetic reassortment. Other viruses that cause gastroenteritis are Adenovirus, a **double-stranded DNA** virus, and Norovirus, a **non-segmented single-stranded positive-sense RNA**. **Single-stranded DNA** viruses do not cause gastroenteritis.

**References:**

1. Murray PR, Rosenthal KS, Pfaller MA. *Medical Microbiology*. 8th ed. Elsevier; 2016. pg. 505-508.
2. Johnson AG, Hawley L, Johnson AG, Ziegler RJ. *Microbiology and Immunology*: Wolters Kluwer/Lippincott Williams & Wilkins; 2010. pg.207

---

*Question 2 of 2*

**Case:**

A 13-year-old boy presents in the ED with fever, tender joints, and rapid heartbeat. His mother says he has been sick with a sore throat, which she thought was a cold; now she is concerned it may actually be the flu. Rapid strep test and flu test in the ED are both negative. The physician assistant finds a rash with pink rings and a clear center, orders an Antistreptolysin O antibody test and EKG, and gives the patient penicillin and a round of steroids. The lab test shows a high level of antibodies against *Streptococcus*.

**Stem:**

What organism is the most likely pathogen?

**Answer Choices:**

A. *Escherichia coli*
B. *Staphylococcus aureus*
C. **_Streptococcus pyogenes_**
D. *Streptococcus viridans*

**Explanation:**

*Streptococcus pyogenes* typically causes "strep throat" and would cause a positive rapid strep test. A rapid strep test looks for Group A strep, which causes beta-hemolysis or full hemolysis on blood agar after culture. Untreated strep throat can lead to rheumatic fever in children and adolescents, caused by the immune system's response from an earlier strep throat or scarlet fever infection; it is thought to be caused by a generalized inflammatory response.

*Escherichia coli* is a Gram-negative rod that does not typically cause pharyngitis. *E. coli* can grow on blood agar as a smooth round gray-white colony. Some strains are beta-hemolytic, or they show no hemolysis at all.

*Staphylococcus aureus* is a Gram-positive coccus seen in clusters that does not typically cause pharyngitis. On a culture, this organism grows as a medium-sized round creamy yellow colony and shows beta-hemolysis.

*Streptococcus viridans* is an alpha-hemolytic (green incomplete hemolysis) Gram-positive coccus seen in chains. *Streptococcus viridans* is part of the normal flora of a human mouth. On blood agar, it grows in small grayish alpha-hemolytic colonies.

**References:**

1. Group A Strep. *CDC*. https://www.cdc.gov/groupastrep/diseases-public/rheumatic-fever.html. Reviewed November 1, 2018. Accessed August 4, 2019.
2. Parker N, Schneegurt M, Tu A-HT, Forster BM, Lister P. *Microbiology*. Houston, TX: OpenStaxsity; 2017:177.

---

## Behavioral Sciences

*Question 1 of 2*

**Case:**

A young boy being observed at his daycare. The observer noted that he was quite relaxed and not very interested in his surroundings.

**Stem:**

According to the EAS Temperament Model, how would the child have scored?

**Answer Choices:**

**A. Low on emotionality**
B. Low on sociability
C. Low on activity
D. Low on affection

**Explanation:**

The **EAS Temperament Model** uses 3 dimensions of temperament: emotionality, activity, and sociability. Affection is not one of the 3 dimensions. The boy's relaxed and non-interested demeanor is part of the **emotionality** dimension, which measures the intensity of emotional reactions. **Activity** measures a person's energy level and **sociability** measures a person's ability to affiliate and interact with others.

**References:**

1. Chapter 3: Section 3: Temperament and Personality. AllPsych. Available at: https://allpsych.com/personalitysynopsis/temperament/. Accessed July 14, 2017.

*Question 2 of 2*

Which Gestalt principle describes the following example? **Refer to the image.**
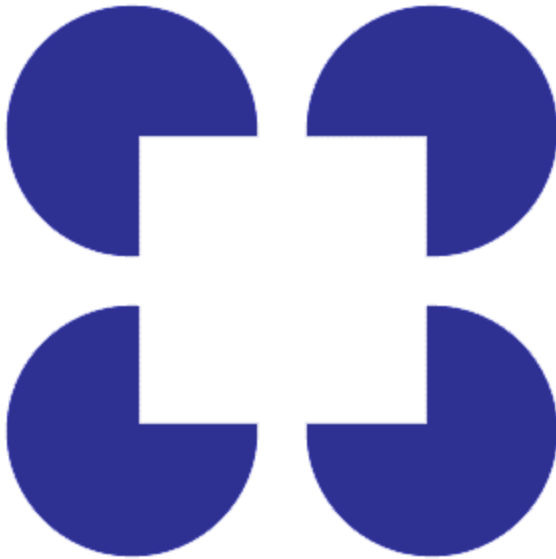
**Answer Choices:**

    A.  Similarity
    B.  Camouflage
    C.  Continuity
    **D.  Closure**

**Explanation:**

**Closure** is when we tend to see complete figures even when part of the information is missing. In this case, the square image in white is not really there, but rather, formed by the missing pieces of the surrounding circles.

**Similarity** is when things that share visual characteristics—such as shape, size, color, texture, or value—are seen as belonging together.

**Continuity** is when the edge of one shape continues into space and meets with other shapes or the edges of the picture plane; the viewer will follow the established pattern.

**Camouflage** is when the figure blends into the background, making the image visually disruptive.

**References:**

1. Gestalt Principles. Gestalt Principles. Available at:
   http://facweb.cs.depaul.edu/sgrais/gestalt_principles.htm. Accessed June 23, 2017.

## Genetics

*Question 1 of 2*

Which statement applies to the elongation stage of transcription?

**Answer Choices:**

    A. RNA polymerase binds to a sequence of DNA known as a promoter.
    **B. RNA polymerase builds an RNA molecule, making a chain.**
    C. RNA polymerase separates the DNA strands, creating a single-strand template.
    D. Sequences send signals that release the transcript from the RNA polymerase.

**Explanation:**

During the elongation stage of transcription, the RNA polymerase decodes the template strand, **building an RNA molecule, creating a chain**. In the initiation stage of transcription RNA polymerase is bound to a sequence of DNA referred to as the **promoter**. Once bound, the polymerase separates the DNA strands, creating the **template** strand. In the termination stage, sequences called terminators signal completion of the RNA transcript. This causes the transcript to be **released** from the RNA.

**References:**

1. Griffiths A, Wessler S, Carol S, Doebley J. *An Introduction to Genetic Analysis*. 11th ed. New York, NY: WH Freeman & Company; 2015:356-9.

A couple expecting a child have different blood types; the mother is AO and the father is BO. Which blood type in the infant would be an example of codominance?

**Answer Choices:**

**A. AB**
B. AO
C. BO
D. O

**Explanation:**

The blood type **AB is an example of codominance**. The A and B allele are both fully dominant, and the phenotype has both traits expressed equally. AO and BO blood types are examples of simple dominance, where either the A or B allele is the dominant trait and the O allele is a recessive trait. With type O blood, the offspring has received 2 copies of the recessive trait, one from each parent.

**References:**

1. Lashley F, Casper C, Schneidereith T. *Lashley's Essentials of Clinical Genetics.* 2nd ed. New York, NY: Springer; 2016:43-4.
2. Klug W, Cummings M, Spencer C, Palladino M. *Concepts of Genetics.* 11th ed. Edinburgh Gate, Harlow, Essex CM20 21E, England: Pearson; 2015:107-8.

## Statistics

What is the standard deviation calculated for the following 10 fasting blood sugar levels of patients with diabetes?

84, 87, 93, 99, 103, 116, 126, 129, 130, 133

**Answer Choices:**

A. 0
B. 2.86
**C. 18.02**
D. 18.99

**Explanation:**

A standard deviation is the square root of a variance, so the variance must be calculated first.

Variance is the squared difference from the mean (average).

First, calculate the mean of the values.

$84 + 87 + 93 + 99 + 103 + 116 + 126 + 129 + 130 + 133 = 1100$

$1100 \div 10 = 110$

For each value, subtract the mean and square the result (the squared difference).

For example,

$84 - 110 = -26$

$-26^2 = 676$

After completing all the calculations, take the average of the squared difference to find the variance.

$3246/10 = 324.6$ Therefore, the variance is 324.6.

The standard deviation (the square root of the variance) is $\sqrt{324.6} = 18.02$ 324.6=18.02
**2.86** would result from squaring the negative numbers and getting negative numbers instead of positive numbers. **0** would result from forgetting to square the differences. **18.99** would result from dividing the squared difference sum by 9 instead of by 10.

**References:**

1. OpenStax, Introductory Statistics. OpenStax CNX. Jun 17, 2019.
   https://cnx.org/contents/MBiUQmmY@23.31:gp5Hz9v3@17/2-7-Measures-of-the-Spread-of-the-Data.

Researchers often wish to reduce their sample size to save money in conducting studies.

What factor might make a study's sample size smaller?

**Answer Choices:**

    A. Measure central tendency and dispersion.
    B. Reduce statistical power and use chi-squared models for analysis.
    **C. Reduce the nonresponse rate and stratify the population.**
    D. Use inferential statistics rather than descriptive statistics.

**Explanation:**

A study that has a nonresponse bias of 50% will need a large sample size in comparison to one with a nonresponse rate of 1%. Putting resources into follow-up can **reduce the nonresponse rate** and reduce sample size. **Stratifying** the population reduces variation within groups, allowing a smaller sample size to adequately represent a population.

**Measuring central tendency and dispersion** would not affect the sample size. This is synonymous with analyzing mean and standard deviation, so these calculations would not affect the experimental setup. Similar to the case of central tendency and dispersion, our method of analysis would not affect our experimental design.

**Reducing statistical power** would allow us to reduce our sample size, but using **chi-squared models** for analysis would not.

Using **inferential statistics** rather than **descriptive statistics** is another mode of analysis, and would not achieve the desired reduction in sample size.

**References:**

1. Amatya A, Bhaumik DK. Sample size determination for multilevel hierarchical designs using generalized linear mixed models. *Biom.* 2018;74:673-84. doi:https://doi.org/10.1111/biom.12764.