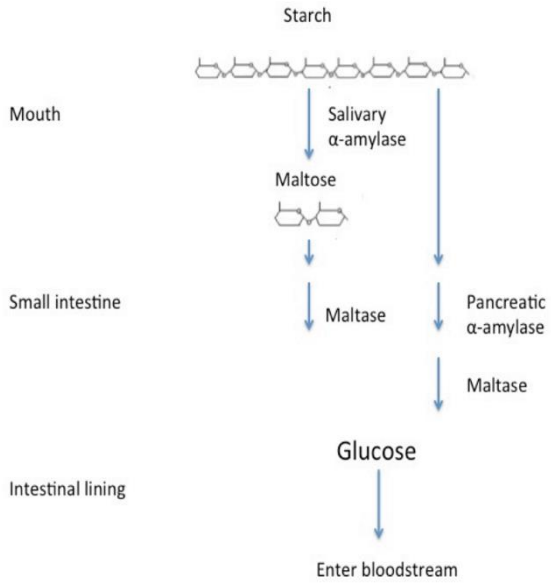
NAME: DATE: AP BIOLOGY: SALIVARY AMYLASE LAB

[1]Salivary Amylase Lab

Background

Over the 200,000 years or so that modern humans have existed, human populations have adapted to a wide range of environments, including different foods. The availability of new energy-rich foods has resulted in different selection pressures affecting human evolution. For example, when some human populations started consuming milk as adults, the ability to digest lactose, the sugar in milk, provided a survival advantage to individuals with the trait. Over time, the lactose tolerance trait increased in frequency in some human populations. Another example of an evolutionarily important change in diet was the increased availability of starch-rich foods, beginning with the agricultural revolution about 10,000 years ago. Once starch-rich foods became common staples in the human diet, people who were able to effectively digest starch may have had a survival advantage. Starch is a plant polysaccharide composed of many building blocks of glucose, which is a monosaccharide. Starch cannot be dissolved in water or in stomach acid so an enzyme is needed to break it up. Starch digestion begins in the mouth with the enzyme amylase. Salivary amylase breaks the covalent bonds between glucose units in starch by adding a water molecule; this chemical reaction is called hydrolysis. The reaction produces maltose, a glucose-glucose disaccharide. Maltose is further broken down into glucose in the small intestine by the enzyme maltase.

Figure 1 to the right shows the steps in carbohydrate digestion. Carbohydrate digestion begins in the mouth, where salivary α-amylase attacks the α-glycosidic linkages in starch, the main carbohydrate ingested by humans, to produce maltose. The enzyme α-amylase is also produced in the pancreas (pancreatic α-amylase) and dispensed to the small intestine, where it converts any remaining starch molecules to maltose. Maltose is then cleaved into two glucose molecules by maltase. Monosaccharides, such as glucose, are absorbed through the wall of the small intestine into the bloodstream.



In humans, the AMY1 gene on chromosome 1 produces salivary amylase. Humans are diploid organisms, meaning that, except for the genes on the X and Y chromosomes, they have two copies of most genes—one copy inherited from each parent. However, genetic studies show that people can have anywhere from two to 15 diploid copies of the AMY1 gene on each chromosome 1, suggesting that the gene has been duplicated during human evolution. Why would this be?

Researcher George Perry and his colleagues hypothesized that as some groups of people started consuming more starch, individuals with more copies of the AMY1 gene would have had a survival advantage (G. H. Perry et al., *Nature Genet*. 2007).

To test their hypothesis, Perry and colleagues analyzed DNA collected from two groups. The first group consisted of populations that have historically consumed a diet rich in protein and low in starch, such as hunter-gatherers living in tropical rainforests or near the Arctic Circle. The other group consisted of populations from agricultural societies and hunter-gatherers living in arid environments, which traditionally eat high-starch foods. The researchers measured the number of copies of the AMY1 gene in individuals from these different populations. In this lab, you will analyze some of the data collected by Perry and colleagues.

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Data and Results

1. The data in Table 1 show the number of AMY1 gene copies and milligrams of amylase protein per milliliter of saliva in 25 adults. These measurements were taken in 25 adult Americans of European descent. Construct and label a graph that shows the relationship between these two variables.
2. Table 2 shows some of the data Perry and colleagues collected on AMY1 gene copy numbers from different populations. The first group of individuals studied included 11 adult Americans of European descent, six Hadza (Tanzania), and eight Japanese, all of whom eat a high-starch diet. The second group of individuals studied included nine Biaka (Central African Republic), six Mbuti (Democratic Republic of Congo), eight Yakut (Siberia), and two Datog (Tanzania), all of whom eat a low-starch diet. For each diet-profile group (i.e., high starch or low starch), determine the sample size and then calculate the mean, standard deviation, and 95% confidence interval. Enter this data into a table.
3. Construct and label a graph that represents the difference in number of AMY1 gene copies between populations with a high-starch diet and populations with a low-starch diet. Include standard error bars on the graph.

Discussion:

Respond to the guiding question in 2-3 paragraphs: **How does a historically high-starch diet affect the number of copies of AMY1 gene in a population?** Use the following prompts to guide your write-up.

- State the alternative and null hypotheses. Indicate whether the hypotheses were rejected or failed to reject based on the data.
- Describe the graphs from both datasets.
- Explain the relationship between copies of the AMY1 gene and amount of salivary amylase.
- Explain the relationship between historic quantities of starch in diet and copies of the AMY1 gene.
- Explain one real-world application of this type of study.

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