

2. Geneticists investigated the mode of inheritance of a rare disorder that alters glucose metabolism and first shows symptoms in adulthood. The geneticists studied a family in which some individuals of generations II and III are known to have the disorder. Based on the pedigree (Figure 1), the geneticists concluded that the disorder arose in individual II–2 and was caused by a mutation in mitochondrial DNA.

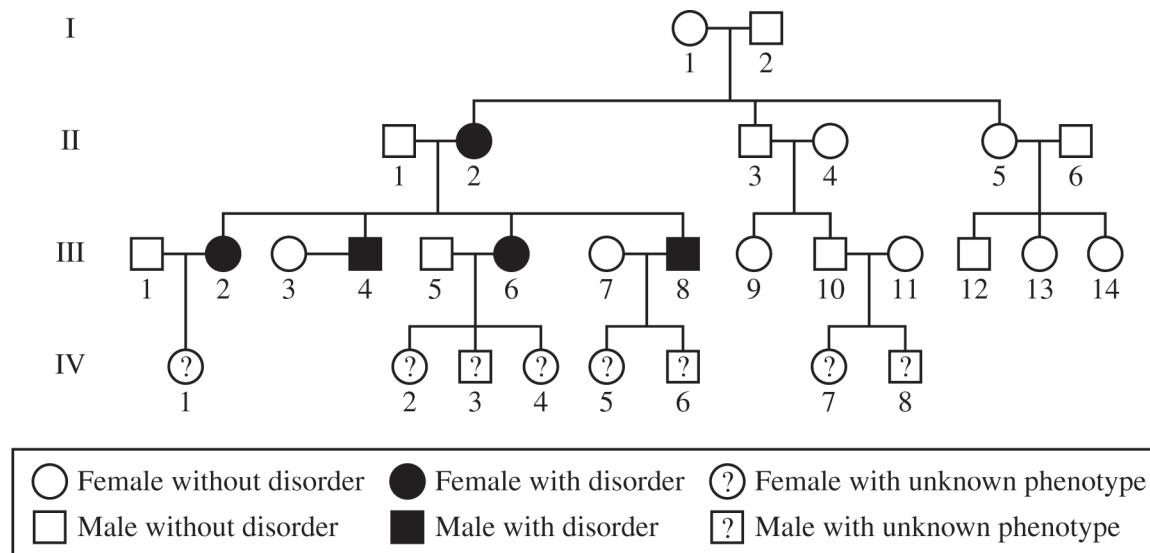


Figure 1. Pedigree of a family showing individuals with the glucose metabolism disorder. A question mark indicates that the phenotype is unknown.

TABLE 1. AVERAGE BLOOD GLUCOSE LEVELS OF INDIVIDUALS IN GENERATION IV

Individual	Average Blood Glucose Level (mg/dL \pm 2SE \bar{x})
IV–1	170 \pm 15
IV–2	190 \pm 10
IV–3	145 \pm 5
IV–4	165 \pm 15
IV–5	110 \pm 15
IV–6	125 \pm 5
IV–7	105 \pm 15
IV–8	120 \pm 10

TABLE 2. PHENOTYPIC CLASSIFICATIONS BASED ON BLOOD GLUCOSE LEVELS

Phenotype	Blood Glucose Level (mg/dL)
Normal	< 140 mg/dL
At risk	140 – 199 mg/dL
Affected	≥ 200 mg/dL

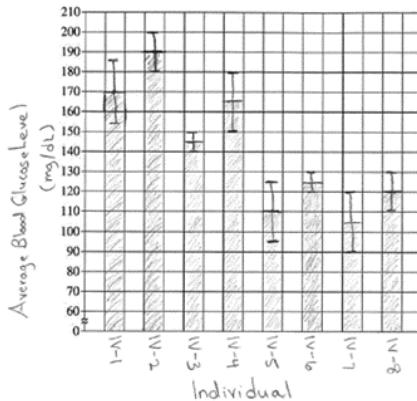
- (a) The disorder alters glucose metabolism. **Describe** the atoms AND types of bonds in a glucose molecule.
- (b) Using the template in the space provided for your response, **construct** an appropriately labeled graph based on the data in Table 1. **Determine** one individual who is both at risk of developing the disorder and has a significantly different blood glucose level from that of individual IV – 1.
- (c) Based on the pedigree, **identify** all individuals in generation IV who can pass on the mutation to their children.
- (d) Based on the fact that individual II – 2 is affected, a student claims that the disorder is inherited in an X-linked recessive pattern. Based on the student’s claim, **predict** which individuals of generation III will be affected by the disorder. Based on the pedigree, **justify** why the data do NOT support the student’s claim.

Write your responses to this question only on the designated pages in the separate Free Response booklet.

- (a) The disorder alters glucose metabolism. **Describe** the atoms AND types of bonds in a glucose molecule. **1 point**

- The atoms are carbon, hydrogen, and oxygen (C, H, and O) and are held together by covalent bonds.

- (b) Use the template provided to **construct** an appropriately labeled graph based on the data in **3 points** Table 1.



- Point distribution: Axis labels; plotting in a bar graph or modified bar graph; error bars

Determine one individual who is both at risk of developing the disorder and has a significantly different blood glucose level from that of individual IV-1. **1 point**

- IV-3

Total for part (b) **4 points**

- (c) Based on the pedigree, **identify** all individuals in generation IV who can pass on the mutation to their children. **1 point**

- IV-1, IV-2, IV-4

- (d) Based on the fact that individual II-2 is affected, a student claims that the disorder is inherited in an X-linked recessive pattern. Based on the student's claim, **predict** which individuals of generation III will be affected by the disorder. **1 point**

- III-4 and III-8

Based on the pedigree, **justify** why the data do NOT support the student's claim. **1 point**

Accept one of the following:

- The data do not support the claim because females III-2 and III-6 have the disorder and, if inheritance is X-linked recessive, they could only do so if their father II-1 had the disorder, which he does not.
- The data instead support mitochondrial inheritance, because all of the offspring of individual II-2 , not only the sons, have the disorder.

Total for part (d) **2 points**

Total for question 2 **8 points**