AP Bio FRQ Fridays

2021 #2
Graphing, Pedigrees, & Genetics

FRQ Friday #12

2021 #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.

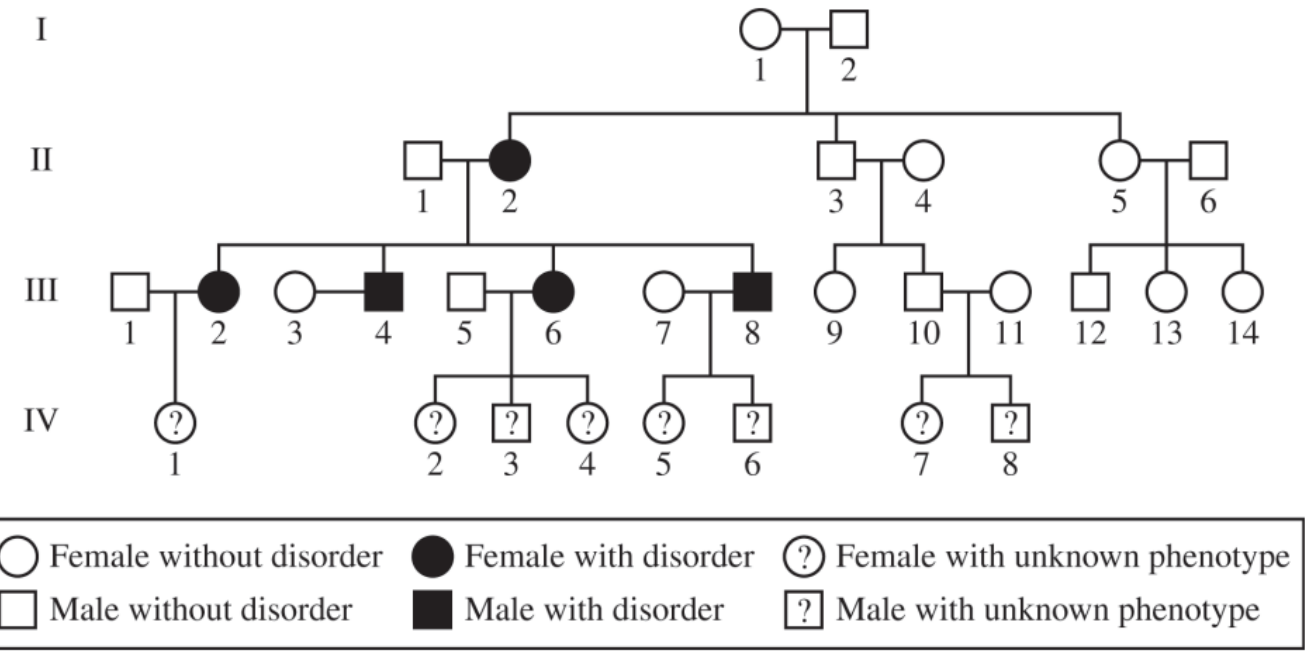

Figure 1. Pedigree of a family showing individuals with the glucose metabolism disorder. A question mark indicates that the phenotype is unknown.

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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 ± 15
IV–2	190 ± 10
IV–3	145 ± 5
IV–4	165 ± 15
IV–5	110 ± 15
IV–6	125 ± 5
IV–7	105 ± 15
IV–8	120 ± 10

PIC CLASSIFICATIONS BASED ON BLOOD G

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

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

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

2) Glucose is made of carbon, hydrogen, and oxygen
its formula is $C_6H_{12}O_6$, the bonds found between these atoms in a glucose molecule are covalent bonds.

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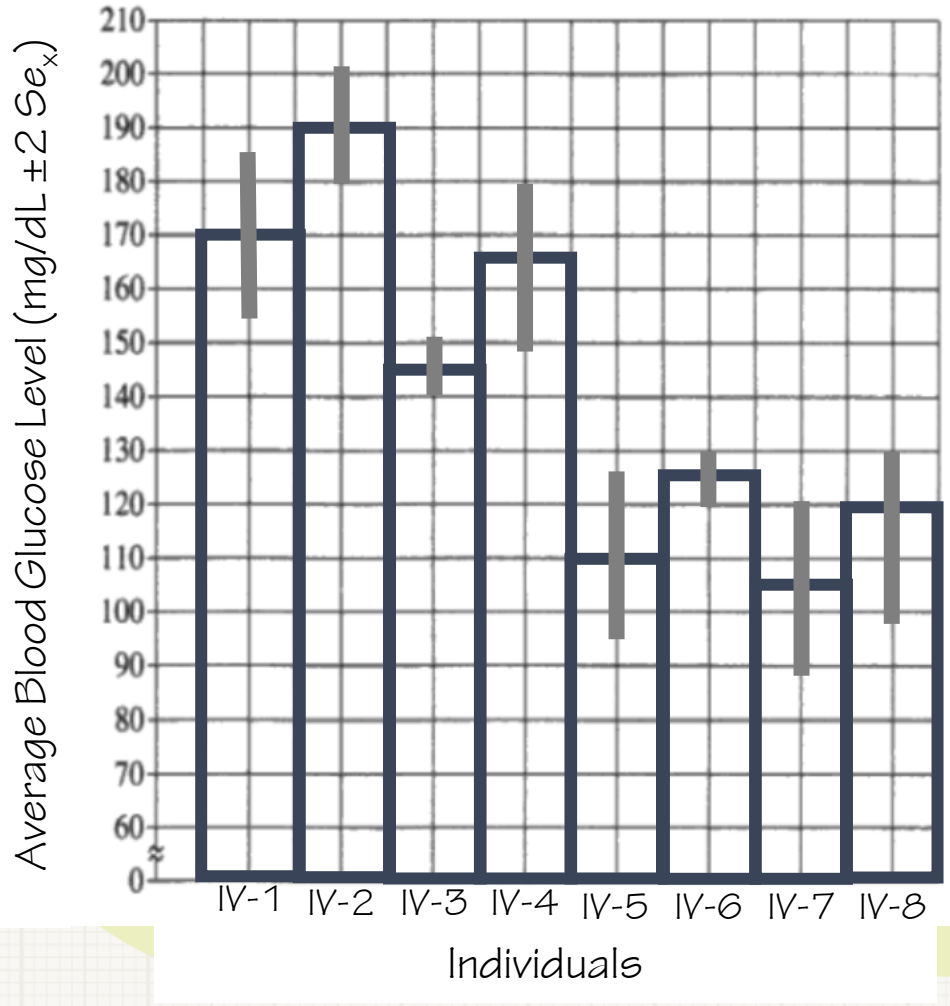
(b) Using the template in the space provided for your response, **construct** an appropriately labeled graph based on the data in Table 1. **Determine** one individual who is both at risk of developing the disorder and has a significantly different blood glucose level from that of individual IV–1.



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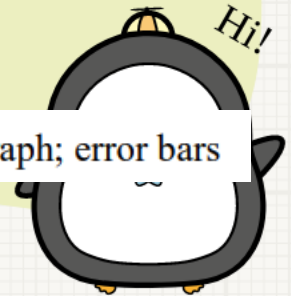

- Point distribution: Axis labels; plotting in a bar graph or modified bar graph; error bars

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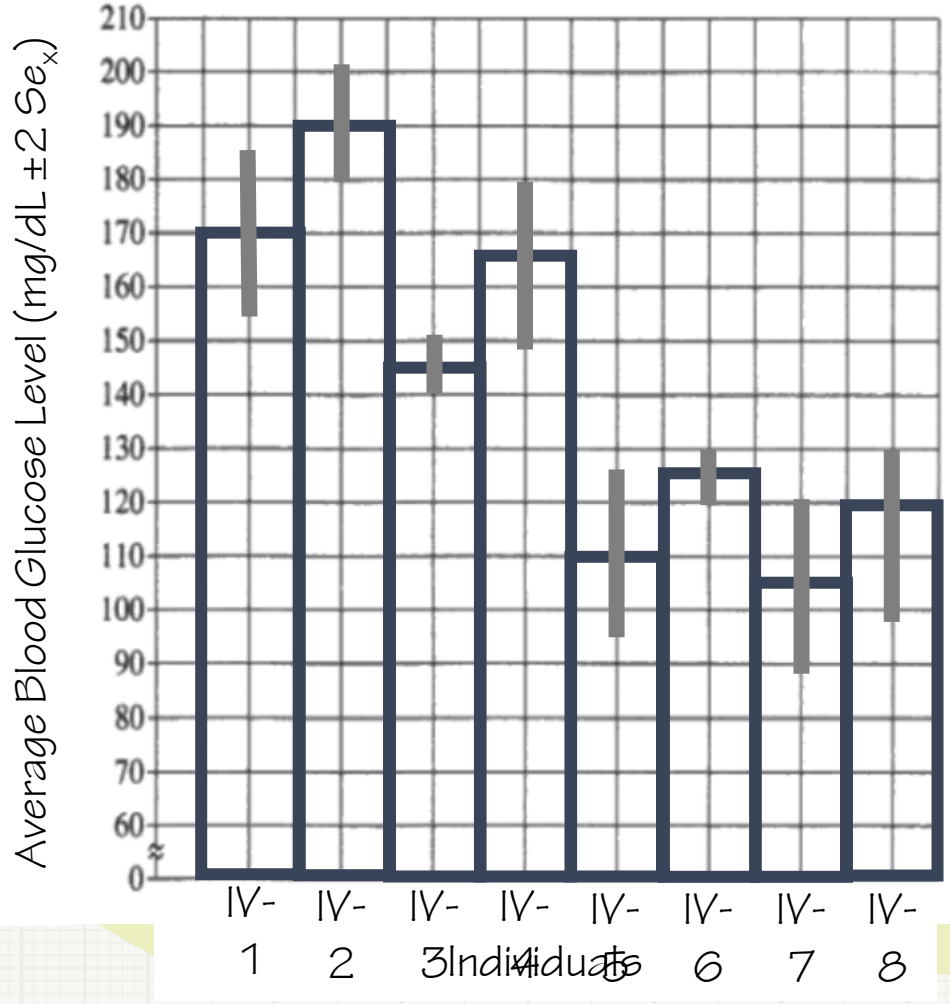

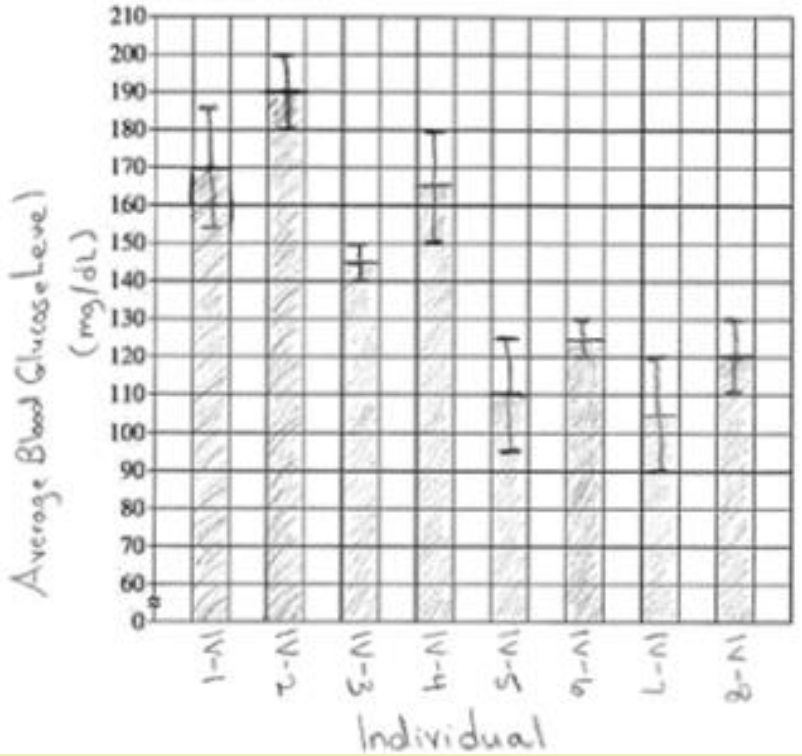

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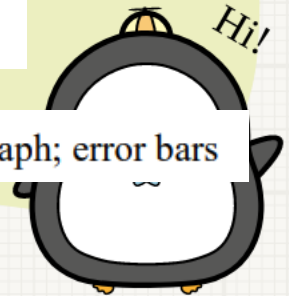

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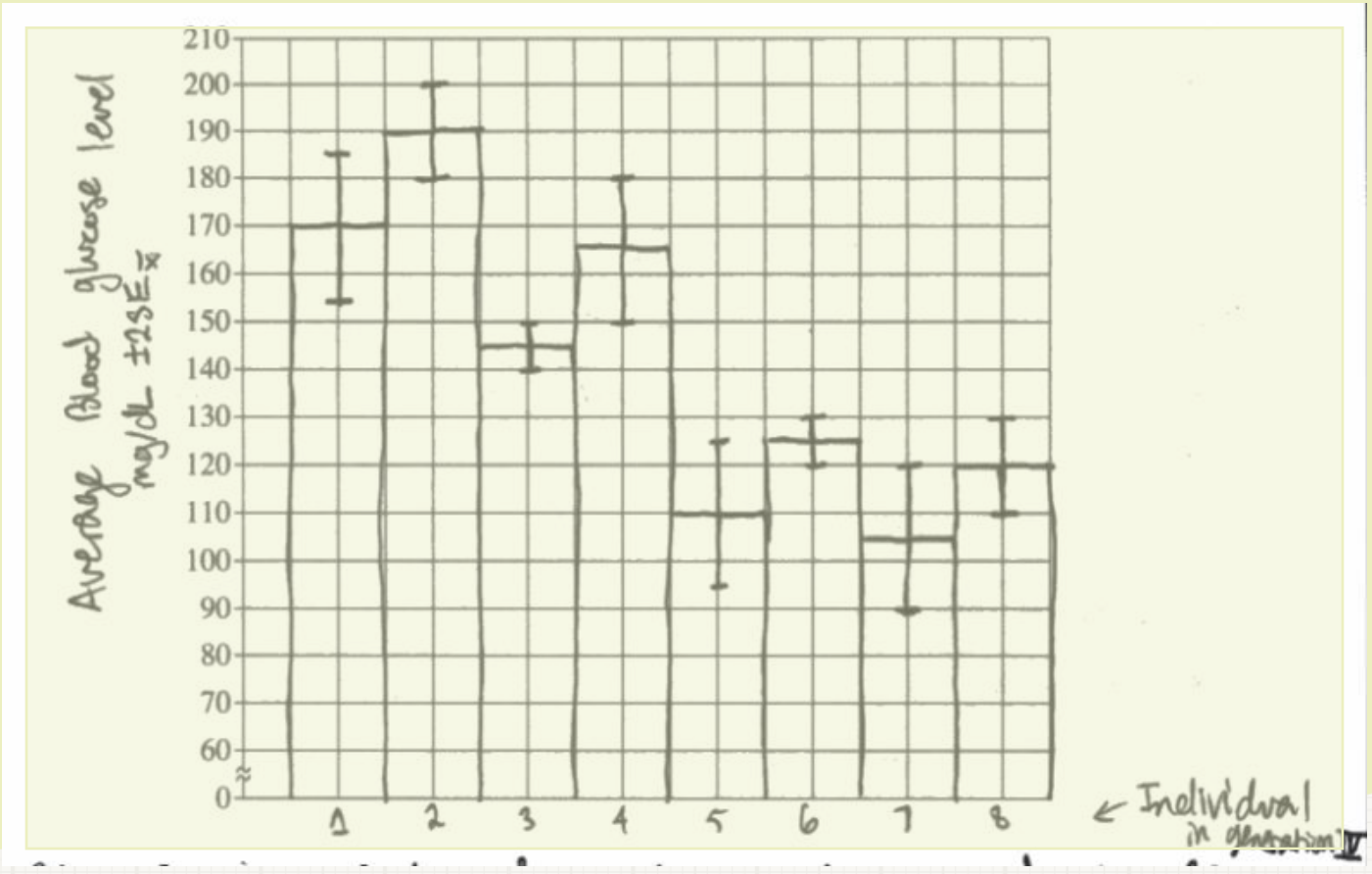

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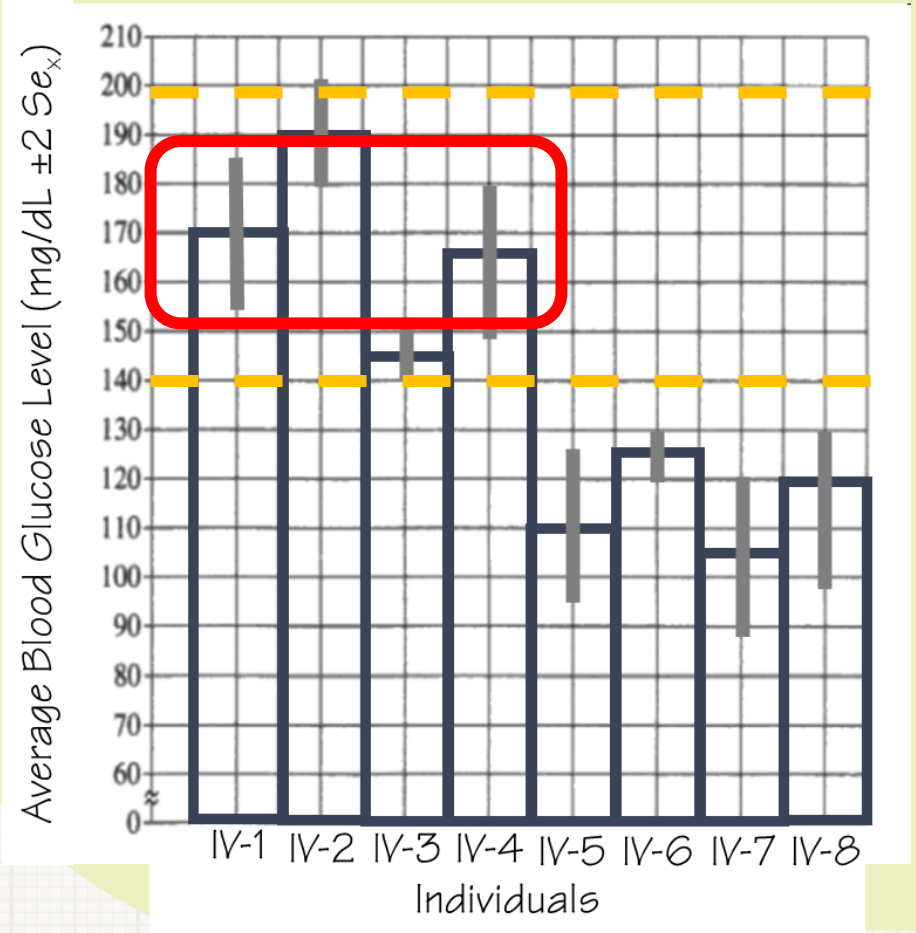

TABLE 2. PHENOTYPIC CLASSIFICATIONS BASED ON BLOOD GLUCOSE LEVELS

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

- IV-3

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(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.

- IV-3

b) one individual who is at risk of developing the disorder with a significantly different blood glucose level than IV-1 is IV-3. we know this because the error bars on the graph do not overlap making the difference in blood glucose level for IV-1 and IV-3 significantly different.

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

Prompt stated that it was MITOCHONDRIAL inheritance

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

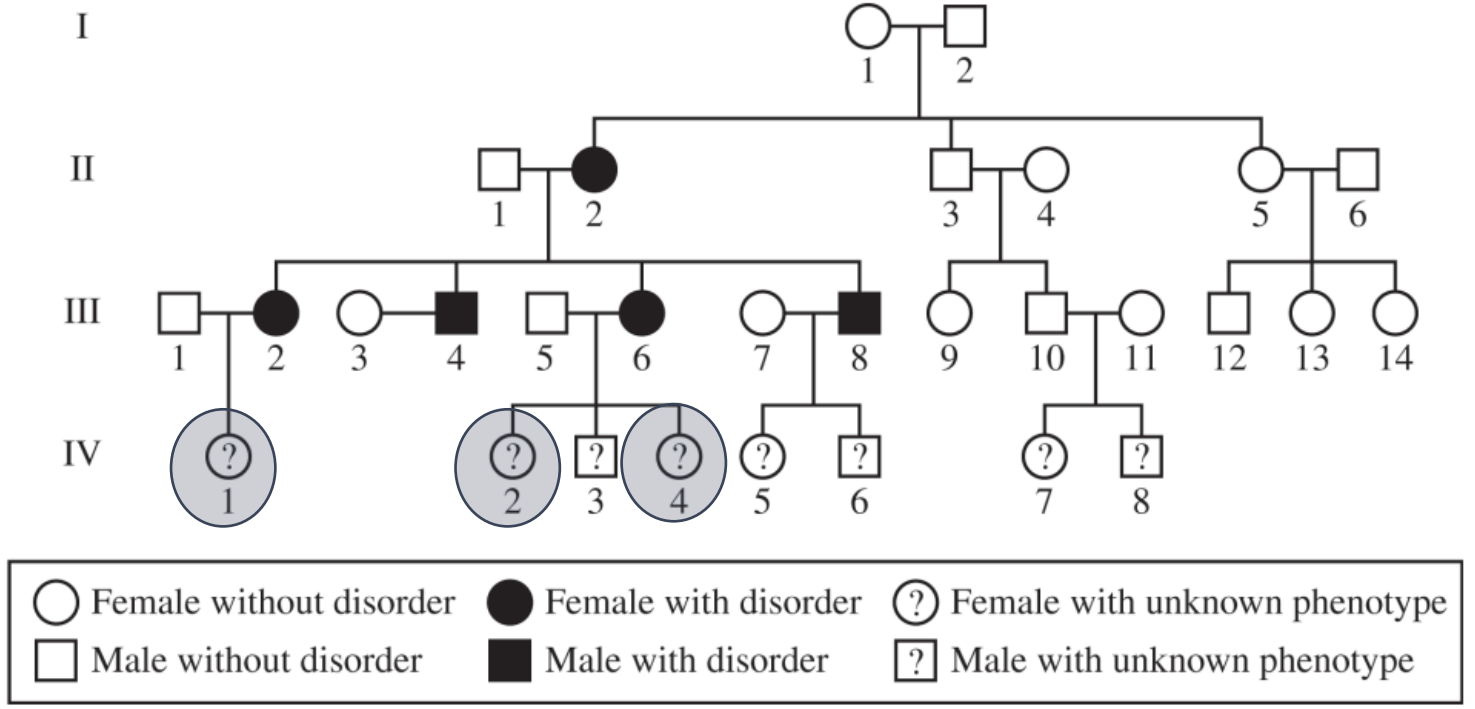

Figure 1. Pedigree of a family showing individuals with the glucose metabolism disorder. A question mark indicates that the phenotype is unknown.

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

c) the individuals that can pass on the mutation are individuals IV-1, IV-2, IV-4. this trait is found in mitochondrial ~~sex-linked~~ DNA so it is only passed down by females with the trait. since in generation III only individuals 1, 2, and 4 ~~have~~ are female and have parents with the trait and show at risk blood glucose levels they can pass the mutation to their children.

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

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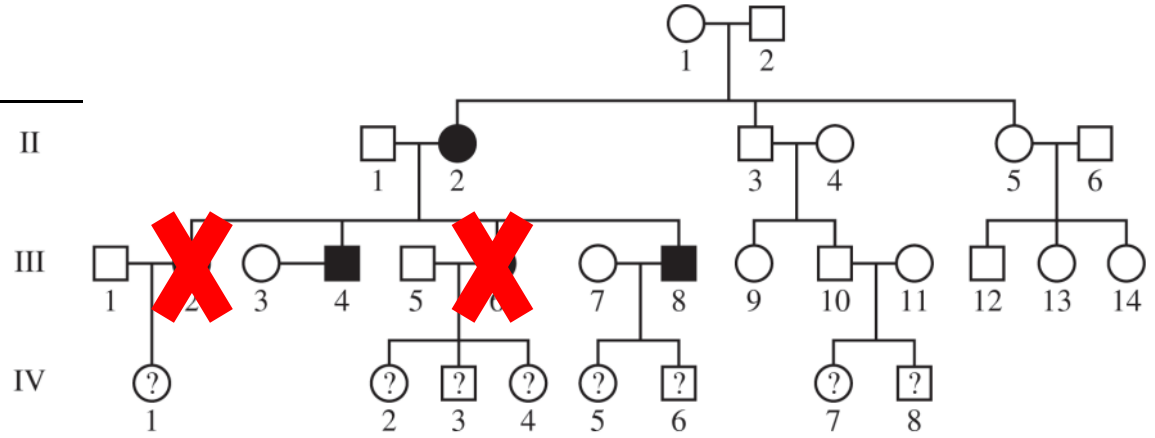
(d) Based on the fact that individual II−2 is affected, a student claims that the disorder is inherited in an X-linked recessive pattern. Based on the student's claim, **predict** which individuals of generation III will be affected by the disorder. Based on the pedigree, **justify** why the data do NOT support the student's claim.

- III-4 and III-8



- 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.

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- III-4 and III-8

- 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.

d) Based on the students claim all of the ~~male~~ offspring of II-2 will have the trait although ~~some~~ no females will have it ~~because~~ because it is a recessive disorder and their father has the dominant trait which will be expressed. The individuals predicted to have it based on the students claim are 4, 8 in generation III. The data does not support the students claim because the trait is found in mitochondrial DNA which is passed down by the mother and not autosomal DNA which is from both parents. For this reason, all of II-2 offspring will have the mutation.

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