The Journey of a patient
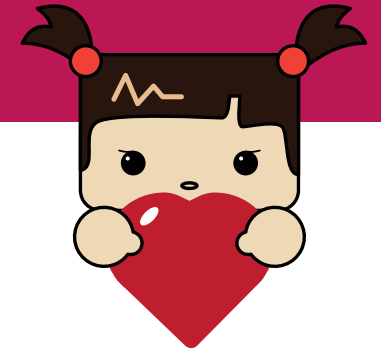
Scenario: Mr. Williams (aged 40) has had a serious heart attack, and all members of his family now want to know if they are at high risk of the same happening to them.

You have all been split into groups.

Group 1: Family Members: Each of you are members of Mr. Williams' family. You will be given the urine sample, information and clinic cards of the family member you will play. Choose the name of your character and look at the details and concerns on the information card. You will be playing the role of this family member as you visit the clinic and lab.

Group 2: The Clinic: Each of you will play the chemical pathologists at the cardiac risk factor clinic. You will find out or calculate the following about the family member:
Whether he/she smokes
His/her blood pressure
His/her Body Mass Index (BMI)

Group 3: The Lab: Each of you will play the biomedical and clinical scientists in the lab. You will find out each family member's blood cholesterol levels (and therefore whether he/she has familial hypercholesterolaemia – an inherited disorder leading to high cholesterol levels from a young age) and also test his/her urine to find out whether he/she may have diabetes or not.

When you have all the results, which family member(s) do you think is/are at high risk of having a heart attack, and why?

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Mr Williams

Name: _____

Age: 40

Occupation: Entrepreneur, owns a famous chain of hotels and restaurants

Notes: Had a heart attack 3 months ago and recovered well. He has been feeling thirsty and has been passing lots of urine. He has noticed some lumps on his knuckles.

Height: 1.7 metres

Weight: 85 kilogrammes

Body mass index (BMI): _____ (this indicates patient is Underweight/Healthy weight/Overweight/Obese*)

Blood pressure (BP): _____mm Hg (this is a High/Normal/Low BP*)

Smoker or Non-smoker: Doesn't smoke

Known health problems: None

Blood tests done: Cholesterol absorbance reading: _____ AU

Blood cholesterol:_____mmol/l (this is a High/Normal/Low Blood cholesterol level*)

Urine dipstick test: _____ (Positive for glucose - diabetic/Negative for glucose - not diabetic*)

Diagnoses: _____

Concerns: 'What about my family? Why has this happened to us?'

*(*Circle the correct option)*

Calculations can be worked out here:

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Mr Williams' Wife

Name: _____

Age: 38

Occupation: Interior designer

Notes: 12 weeks pregnant. On folic acid.

Height: 1.65 metres

Weight: 60 kilogrammes

Body mass index (BMI): _____ (this indicates patient is

Underweight/Healthy weight/Overweight/Obese*)

Blood pressure (BP): _____mm Hg (this is a High/Normal/

Low BP*)

Smoker or Non-smoker: Doesn't smoke

Known health problems: None

Blood tests done: Cholesterol absorbance reading: _____ AU

Blood cholesterol:_____mmol/l (this is a High/Normal/Low Blood

cholesterol level*)

Urine dipstick test: _____ (Positive for glucose -

diabetic/Negative for glucose - not diabetic*)

Diagnoses: _____

Concerns: 'What about our baby?'

*(*Circle the correct option)*

Calculations can be worked out here:

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Mr Williams' Father

Name: _____

Age: 70

Occupation: Retired

Notes: Poor control of diabetes.

Height: 1.8 metres

Weight: 100 kilogrammes

Body mass index (BMI): _____ (this indicates patient is

Underweight/Healthy weight/Overweight/Obese*)

Blood pressure (BP): _____mm Hg (this is a High/Normal/

Low BP*)

Smoker or Non-smoker: Doesn't smoke

Known health problems: Has diabetes and asthma

Blood tests done: Cholesterol absorbance reading: _____ AU

Blood cholesterol:_____mmol/l (this is a High/Normal/Low Blood

cholesterol level*)

Urine dipstick test: _____ (Positive for glucose -

diabetic/Negative for glucose - not diabetic*)

Diagnoses: _____

Concerns: Only concern is for his family, not himself. 'I'm OK as long as I

can still play snooker.'

*(*Circle the correct option)*

Calculations can be worked out here:

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Mr Williams Mother

Name: _____

Age: 64

Occupation: Retired

Notes: Had been on statins (cholesterol-lowering medication), but has now stopped due to the side effects.

Height: 1.6 metres

Weight: 67 kilogrammes

Body mass index (BMI): _____ (this indicates patient is Underweight/Healthy weight/Overweight/Obese*)

Blood pressure (BP): _____mm Hg (this is a High/Normal/Low BP*)

Smoker or Non-smoker: Doesn't smoke

Known health problems: Angina

Blood tests done: Cholesterol absorbance reading: _____ AU

Blood cholesterol:_____mmol/l (this is a High/Normal/Low Blood cholesterol level*)

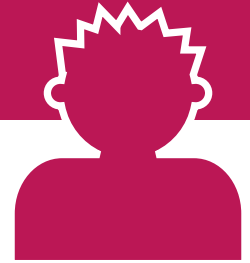**Urine dipstick test:** _____ (Positive for glucose - diabetic/Negative for glucose - not diabetic*)

Diagnoses: _____

Concerns: 'Can I still go walking in the Alps?'

*(*Circle the correct option)*

Calculations can be worked out here:

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Mr Williams' Son

Name: _____

Age: 10

Occupation: School pupil.

Notes: Loves anything to do with cars.

Height: 1.37 metres

Weight: 32 kilogrammes

(Body mass index (BMI) is calculated differently for children – this is a healthy weight.)

Blood pressure (BP): _____mm Hg (this is a High/Normal/Low BP*)

Smoker or Non-smoker: Doesn't smoke

Known health problems: Hay fever

Blood tests done: Cholesterol absorbance reading: _____ AU

Blood cholesterol:_____mmol/l (this is a High/Normal/Low Blood cholesterol level*)

Urine dipstick test: _____ (Positive for glucose - diabetic/Negative for glucose - not diabetic*)

Diagnoses: _____

Concerns: His friend's dad recently died of a heart attack. 'Will I die too?'

*(*Circle the correct option)*

Calculations can be worked out here:

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Mr Williams' Daughter

Name: _____

Age: 12

Occupation: School pupil.

Notes: Promising athlete.

Height: 1.55 metres

Weight: 41 kilogrammes

(Body mass index (BMI) is calculated differently for children – this is a healthy weight.)

Blood pressure (BP): _____mm Hg (this is a High/Normal/Low BP*)

Smoker or Non-smoker: Doesn't smoke

Known health problems: None

Blood tests done: Cholesterol absorbance reading: _____ AU

Blood cholesterol:_____mmol/l (this is a High/Normal/Low Blood cholesterol level*)

Urine dipstick test: _____ (Positive for glucose - diabetic/Negative for glucose - not diabetic*)

Diagnoses: _____

Concerns: 'Do I have to give up competitive swimming now?'

*(*Circle the correct option)*

Calculations can be worked out here:

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Mr Williams' Sister

Name: _____

Age: 35

Occupation: Party Planner

Notes: Drinks a lot at weekends especially

Height: 1.6 metres

Weight: 70 kilogrammes

Body mass index (BMI): _____ (this indicates patient is Underweight/Healthy weight/Overweight/Obese*)

Blood pressure (BP): _____mm Hg (this is a High/Normal/Low BP*)

Smoker or Non-smoker: Smoker

Known health problems: Alcoholic

Blood tests done: Cholesterol absorbance reading: _____ AU

Blood cholesterol:_____mmol/l (this is a High/Normal/Low Blood cholesterol level*)

Urine dipstick test: _____ (Positive for glucose - diabetic/Negative for glucose - not diabetic*)

Diagnoses: _____

Concerns: 'Oh no! Does this mean I can't go out partying anymore?'

*(*Circle the correct option)*

Calculations can be worked out here:

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Family member clinic cards
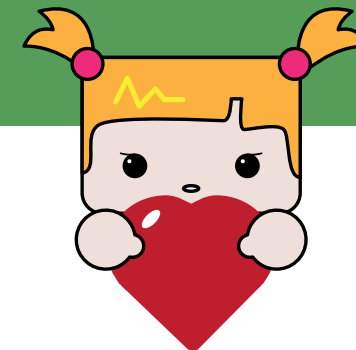
Mr. Williams

Blood pressure (BP): 160/95 mm Hg

Blood tests done: Cholesterol absorbance reading: 0.6 AU

Mr. Williams' Wife

Blood pressure (BP): 120/80 mm Hg

Blood tests done: Cholesterol absorbance reading: 0.69 AU

Mr. Williams' Son

Blood pressure (BP): 110/70 mm Hg

Blood tests done: Cholesterol absorbance reading: 0.45 AU

Mr. Williams' Father

Blood pressure (BP): 150/80 mm Hg

Blood tests done: Cholesterol absorbance reading: 0.39 AU

Mr. Williams' Daughter

Blood pressure (BP): 115/70 mm Hg

Blood tests done: Cholesterol absorbance reading: 0.29 AU

Mr. Williams' Mother

Blood pressure (BP): 130/70 mm Hg

Blood tests done: Cholesterol absorbance reading: 0.62 AU
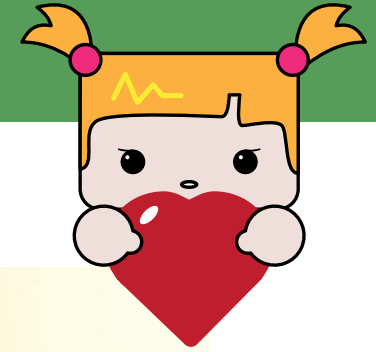
Mr. Williams' Sister

Blood pressure (BP): 150/92 mm Hg

Blood tests done: Cholesterol absorbance reading: 0.41 AU

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Blood Pressure: You have two figures for your patient's blood pressure:

systolic blood pressure/diastolic blood pressure

Healthy target: blood pressure reading of <140mm Hg/90mm Hg.

The systolic blood pressure is the maximum pressure in the arteries, as the ventricles contract. Diastolic blood pressure is the minimum blood pressure in the arteries when the ventricles are filled with blood.

Has Mr. Williams' family member got a high/normal/low blood pressure?

Calculating Body Mass Index (BMI):

BMI = weight (kg) / [height (m)]2

BMI – Less than 18.5: Underweight
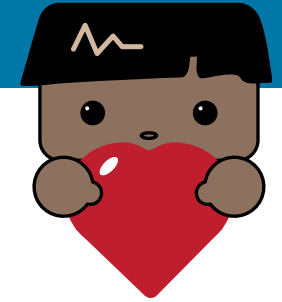BMI – 18.5-25: Healthy weight
BMI - 25-30: Overweight
BMI - 30-40: Obese
BMI – Over 40: Seriously obese

Based on the above and what you have calculated, is Mr. Williams' family member underweight, healthy or seriously obese?

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The Lab

Urine sample:

Members of Mr. Williams' family will give you their urine samples to test using a dipstick.

Using the colour chart provided, determine whether there is glucose present in each family member's urine or not. The presence of glucose is a guide in the diagnosis of diabetes mellitus.

Total serum cholesterol:

Mr. Williams' family members will provide an absorbance reading from their fasting blood sample, so you can find out their cholesterol level.

Using the Cholesterol Standard Curve provided here, read off the absorbance to find out each family member's total serum cholesterol level.

A total cholesterol level of 7.5mmol/l or more in an adult (or less in a young person, e.g. for a ten-year-old boy, 5.7mmol/l or more) is suggests familial hypercholesterolaemia (FH), although there are other causes of a high cholesterol level. FH is an inherited condition (hence familial) resulting in high (hyper) levels of cholesterol in the blood (cholesterolaemia).

Total cholesterol levels of around 15mmol/l may be seen in those who are homozygous for this condition, along with other clinical features.

Cholesterol Standard curve

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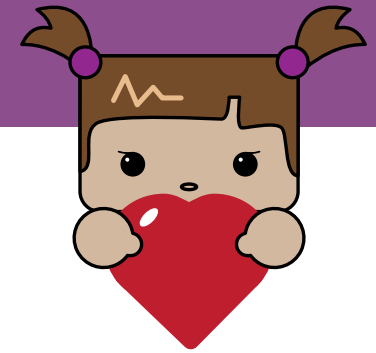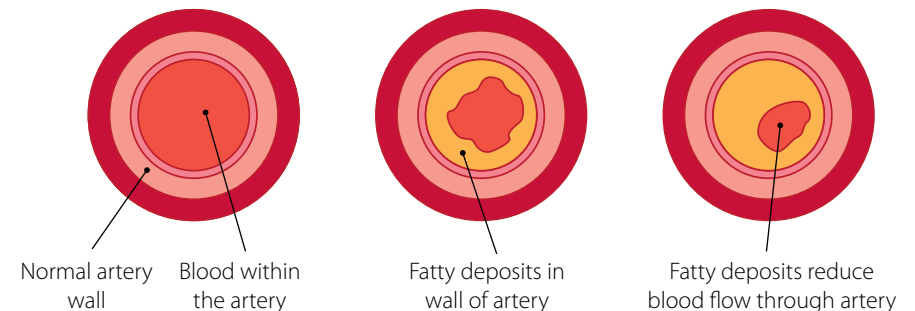Pathology: the science behind the cure
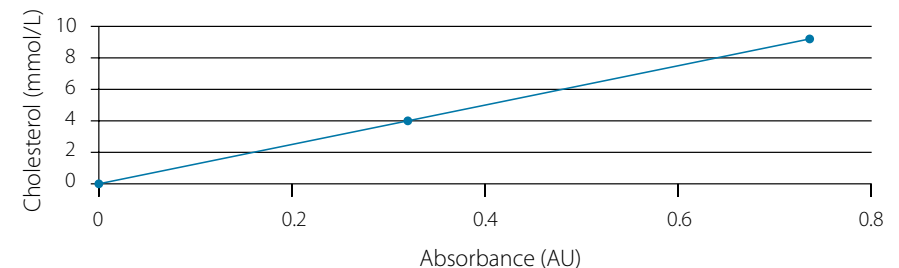
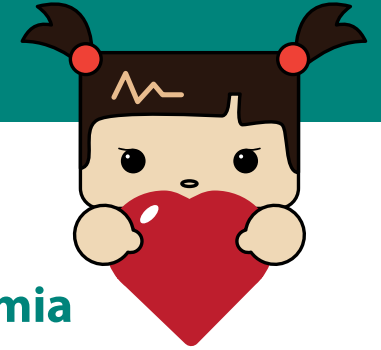# Discussion sheet

Interesting facts and information:

- Cholesterol is one of the body's fats and too much can lead to the narrowing of the arteries known as atherosclerosis, making blood flow difficult.

- High-density lipoprotein (HDL) is 'good cholesterol', and low-density lipoprotein (LDL) is 'bad cholesterol', as it leads to cardiovascular disease.

- People with familial hypercholesterolaemia have very high levels of low density lipoprotein (LDL) or 'bad' cholesterol.

- Cholesterol levels can rise with age.

- Women generally have higher HDL than men.

- Cholesterol levels rise during pregnancy.

- Cholesterol levels drop for at least three months after a heart attack.
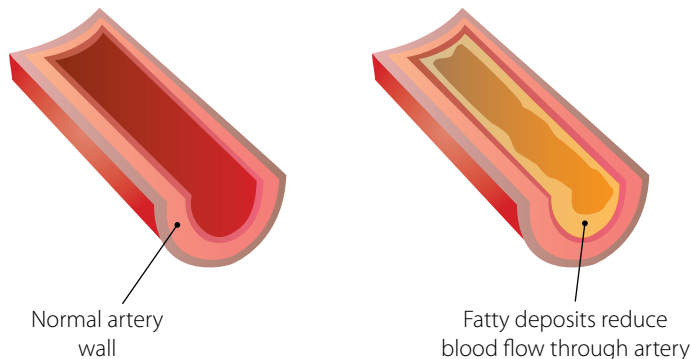
- Having a heart attack is not just about cholesterol – we need to look at other risks:

  - Those who smoke have a higher risk of suffering a heart attack.

  - Drinking too much alcohol can raise blood pressure, damage the liver and cause many health problems. Moderate drinking can increase HDL cholesterol.

  - Exercise and maintaining a healthy diet and weight can help reduce the risk of heart attacks.

Normal artery wall   Blood within the artery

Fatty deposits in wall of artery

Fatty deposits reduce blood flow through artery

Normal artery wall

Fatty deposits reduce blood flow through artery

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It's in the Genes

The Inheritance of Familial hypercholesterolaemia

Familial hypercholesterolaemia (FH) is an inherited condition (hence familial) resulting in high (hyper) levels of cholesterol in the blood (cholesterolaemia). It affects 1 in 500 of the population, many of whom do not know they have it. Those with FH have high levels of cholesterol and so have a high risk of heart disease. Many have a heart attack by the age of 40. It is important to diagnose FH to avoid future heart disease for the patient and to find out if other family members are at risk.

People with FH have very high levels of low density lipoprotein (LDL) or 'bad' cholesterol. A high level of these fats building up in the walls of the arteries contributes to atherosclerosis. A heart attack occurs when these areas of the artery walls burst, causing blood clots to form therefore blocking the arteries.

LDL levels are raised in the blood in FH because LDL is not removed by the liver, as there is something wrong with the liver's LDL receptors. The patient is likely to have a mutated LDL-receptor gene. Inheritance of FH is autosomal dominant, which means that you only need one faulty copy of this gene to have the disease. . If you have both, i.e. homozygous FH (ff), it is much more serious.

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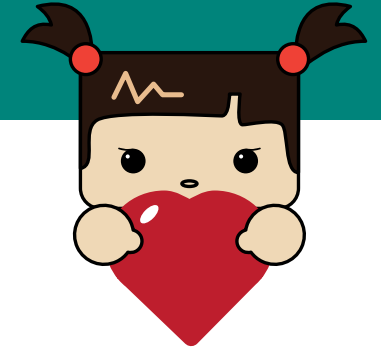
This is a very unfortunate family with both parents having FH! This is their phenotype (i.e. what we 'see' they have), but we need to know their possible genotype (i.e. the genetics).

First of all we need to find out who has FH?

So if we say that:

F=Faulty LDL-receptor gene
f=normal LDL-receptor gene

…how would you fill out the inheritance diagrams starting with Mr. Williams' mother and father being Ff and ff respectively, to find out what the genotypes for Mr. Williams and his sister could be?

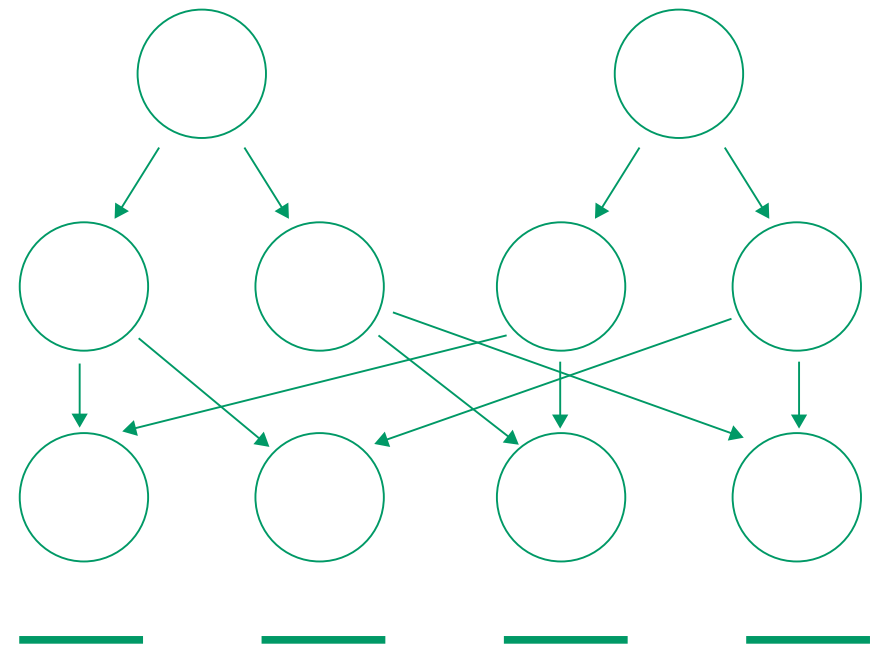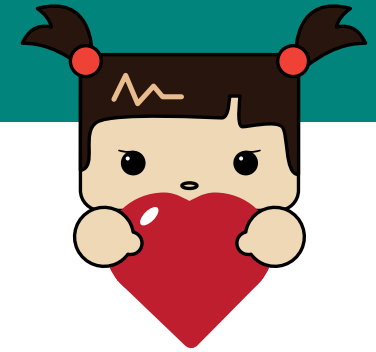|	**Mother - FH**	**Father - no FH**
Phenotypes of parents		
Genotypes of parents		
Genotypes of gametes		
Genotypes of offspring		
Phenotypes of offspring		

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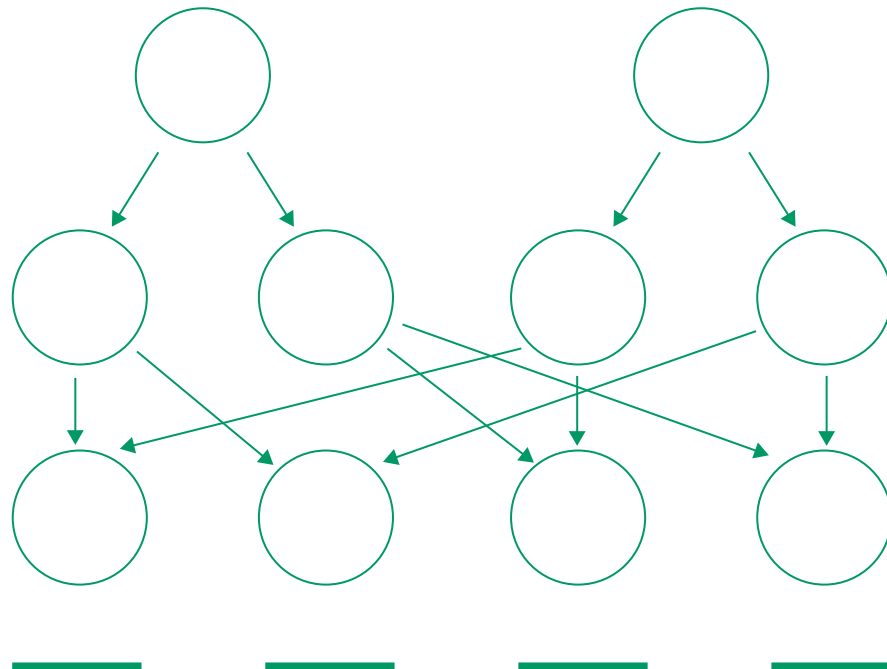# Part two: Pupil sheet

Phenotypes of parents

Mr Williams - FH   **Mrs Williams - FH**

Genotypes of parents

Genotypes of gametes

Genotypes of offspring

Phenotypes of offspring

Mr Williams' wife has FH. Using this information, and what you have found out earlier, fill out the diagram below with genotypes again to find out what the likelihood of the Williams' unborn child having familial hypercholesterolaemia is.

The likelihood of the Williams' unborn child having FH is:

_____ in _____ chance

The likelihood of the Williams' unborn child having FH (homozygous FH) is:

_____ in _____ chance

The likelihood of the Williams' unborn child having FH (heterozygous FH) is:
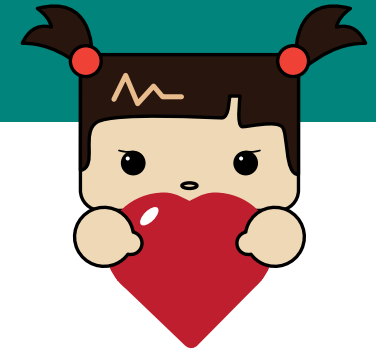
_____ in _____ chance

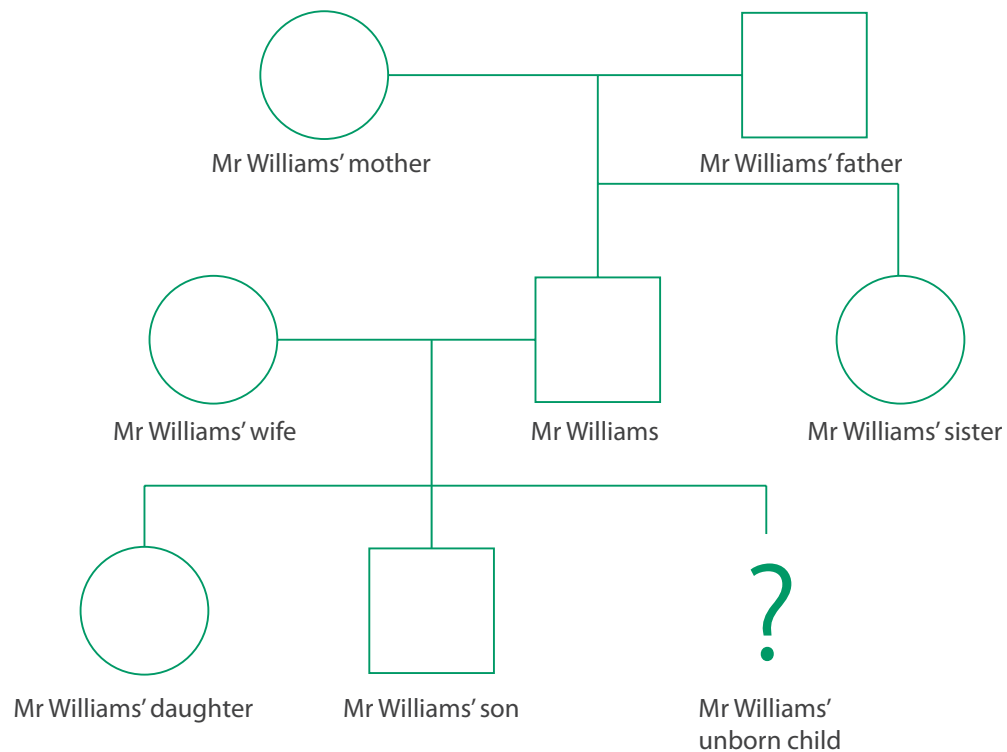The likelihood of the Williams' unborn child not having FH is:

_____ in _____ chance

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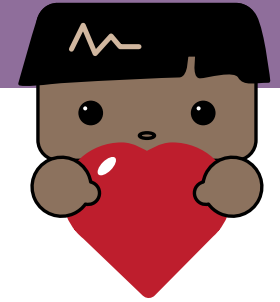Pathology: the science behind the cure

The Williams' Family Tree

Mr Williams' mother

Mr Williams' father

Mr Williams' wife

Mr Williams

Mr Williams' sister

Mr Williams' daughter

Mr Williams' son

?

Mr Williams' unborn child

Fill in the genotypes below, and colour in the shapes belonging to the affected family members.

Questions to think about and discuss:

- Should Mr. and Mrs. Williams have their unborn child genetically screened for familial hypercholesterolaemia? Give reasons for your answers.
- What are the ethical issues here?

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Answer sheets

Answers to the family tree and inheritance diagrams:

So Mr. Williams' genotype is likely to be Ff and his sister's is likely to be ff.
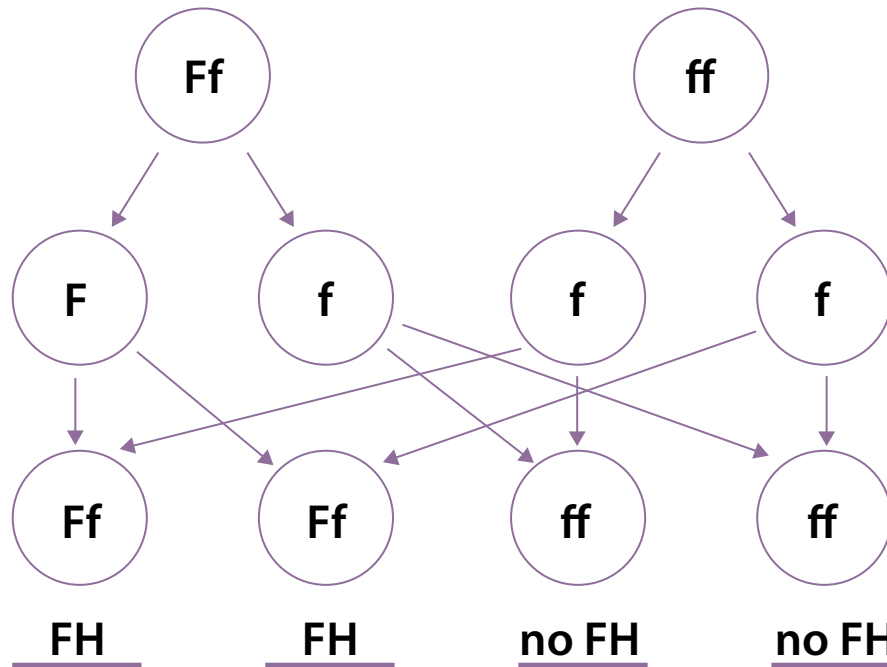
Phenotypes of parents	Mother - FH	Father - no FH

Genotypes of parents	**Ff**	**ff**

Genotypes of gametes: **F**, **f**, **f**, **f**

Genotypes of offspring: **Ff**, **Ff**, **ff**, **ff**

Phenotypes of offspring: **FH**, **FH**, **no FH**, **no FH**

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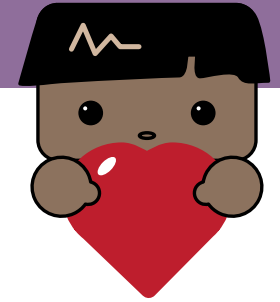
Answers to the family tree and inheritance diagrams:

Phenotypes of parents	Mr Williams- FH	Mr Williams - FH

Genotypes of parents

Ff   **Ff**

Genotypes of gametes

F   **f**   **F**   **f**

Genotypes of offspring

FF   **Ff**   **Ff**   **ff**

Phenotypes of offspring

FH   FH   FH   no FH

The likelihood of the Williams' unborn child having FH is:

3 in 4 chance

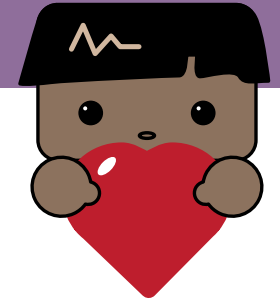The likelihood of the Williams' unborn child having FH (homozygous FH) is:

1 in 4 chance

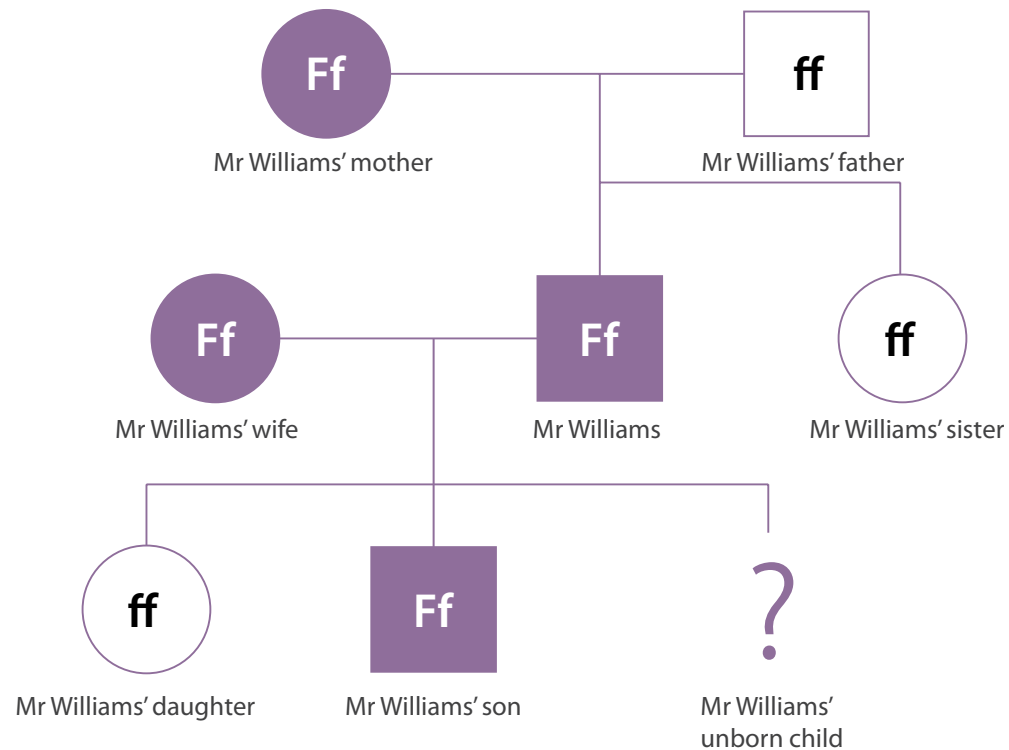The likelihood of the Williams' unborn child having FH (heterozygous FH) is:

1 in 2 chance

The likelihood of the Williams' unborn child not having FH is:

1 in 4 chance

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Answer sheets

Answers to the family tree and inheritance diagrams:

Affected family members are solid shapes in the above diagram.

Note: Mr Williams' son has heterozygous FH (as his cholesterol level is 6mmol/l), and no clinical signs.

Ff — Mr Williams' mother

ff — Mr Williams' father

Ff — Mr Williams' wife

Ff — Mr Williams

ff — Mr Williams' sister

ff — Mr Williams' daughter

Ff — Mr Williams' son

? — Mr Williams' unborn child
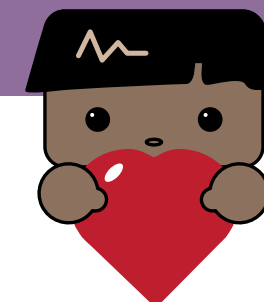
Answer sheets

About Each Family Member – Answer Sheet

	Diagnoses to be made	Age (years)	Cholesterol (mmol/l)	Cholesterol (AU)	Urine glucose dipstick	Blood Pressure (mm Hg)	Height (m)	Weight (kg)	Body Mass Index (BMI)	Smoker/ Non-Smoker	Known health problems	Notes	Family Member Concerns (for discussion)
Mr. Williams	FH, Diabetes	40	8 (V.High)	0.6	Positive (diabetic)	160/95 (High)	1.7	85	29 (Over-weight)	No	None	Has been feeling thirsty and passing lots of urine. Has knuckle lumps.	"What about my family? Why has this happened to us"
Wife	FH	38	9.2 (V.High)	0.69	Negative (not diabetic)	120/80 (Normal)	1.65	60	22 (Healthy weight)	No	None	12 weeks pregnant. On folic acid.	"What about our baby?"
Father	Diabetes	70	5.2 (Normal)	0.39	Positive (diabetic)	150/80 (Normal)	1.8	100	31 (Obese)	No	Diabetes, Asthma	Poor control of diabetes.	Only concern is for his family, not himself. "I'm OK as long as I can still play snooker."
Mother	FH	65	8.2 (V.High)	0.62	Negative (not diabetic)	130/70 (Normal)	1.6	67	26 (Over-weight)	No	Angina	Had been on statins (cholesterol-lowering medication), but has now stopped due to the side effects.	"Can I still go walk-ing in the Alps?"
Son	FH	10	6 (High)	0.45	Negative (not diabetic)	110/70 (Normal)	1.37	32	Healthy weight	No	Hay fever	School pupil. Loves anything to do with cars.	His friend's dad recently died of a heart attack. "Will I die too?"
Daughter	None	12	3.9 (Normal)	0.29	Negative (not diabetic)	115/70 (Normal	1.55	41	Healthy weight	No	None	School pupil. Promising athlete.	"Do I have to give up competitive swimming now?"
Sister	Diabetes	35	5.4 (Normal)	0.41	Positive (diabetic)	150/92 (High)	1.6	70	27 (Over-weight)	Yes	Alcoholic	Recently been feeling thirsty	"Oh no! Does this mean I can't go out partying anymore?"