Province of the
EASTERN CAPE
EDUCATION

GENETICS AND INHERITANCE

INHERITANCE OF BLOOD GROUPS (MULTIPLE ALLELES)

EXAMINATION GUIDELINES

Blood grouping	❑ Different blood groups are a result of multiple alleles ❑ The alleles I^A, I^B and **i** in different combinations result in four blood groups ❑ Genetics problems involving the inheritance of blood type
Paternity testing	❑ The role of each of the following in paternity testing: • Blood grouping • DNA profiles

MULTIPLE ALLELES

- Sometimes genes may have more than two alleles
- They are regarded as alleles for the same gene because they are all found at the **same locus** on a **particular chromosome**
- When we have more than two alleles of a gene we refer to them as being **Multiple Alleles**
- However, an individual can only inherit two alleles at a time, one allele from each parent.

MULTIPLE ALLELES IN HUMAN BLOOD GROUPS

- In humans:
  - ❖ blood grouping is controlled by a **single gene** represented by the letter **I**
  - ❖ The are **3 alleles** for the blood group gene instead of 2.
  - ❖ Therefore in HUMAN BLOOD GROUPS we have **MULTIPLE ALLELES**
- The 3 alleles for blood groups are:
  - $\mathbf{I^A}$ for blood type A
  - $\mathbf{I^B}$ for blood type B
  - **i** for blood type O
- These alleles combine in various ways to form **four phenotypes** i.e. blood type A, blood type B, blood type AB and blood type O

TYPES OF DOMINANCE IN BLOOD GROUPS

- **I^A** and **I^B** alleles are **dominant** over **i,** that means **, i is recessive** to both I^A and I^B
- Therefore the type of dominance existing between I^A/ I^B and i is **complete dominance**
- **I^A** and **I^B** are **co-dominant (i.e. are both equally dominant)**
- Therefore the type of dominance existing between I^A and I^B **is co-dominance.**
- Since I^A and I^B are co-dominant when they come together in a person's blood type **they form I^AI^B** which is the **genotype for blood group AB**

PHENOTYPES AND GENOTYPES OF HUMAN BLOOD GROUPS

3 alleles for a single gene produce **6** different **genotypes** and **4** different **phenotypes**

PHENOTYPE	GENOTYPE
Type A	I^AI^A (homozygous) OR I^Ai (heterozygous)
Type B	I^BI^B(homozygous) OR I^Bi (heterozygous)
Type O	ii (homozygous recessive)
Type AB	I^AI^B (co-dominant)

NOTE 1: Type A and Type B each have 2 possible genotypes whereas Type O and Type AB only have 1 genotype

NOTE 2: When writing the genotype you must NOT indicate whether one is homozygous or heterozygous for the trait. You write only the letters representing the genotype, no description. It is only indicated for learning purposes in the table above

Blood Type	Donate	Receive
A+	A+, AB+	A+, A-, O+, O-
A-	A+, A-, AB+, AB-	A-, O-
AB+	AB+	All (UNIVERSAL RECIPIENT)
AB-	AB+, AB-	A-, AB-, B-, O-
B+	AB+, B+	B+, B-, O+, O-
B-	AB+, AB-, B+, B-	B-, O-
O+	A+, AB+, B+, O+	O+, O- (UNIVERSAL DONOR)
O-	All	O-

FOR YOUR INFORMATION – NOT FOR EXAMS

ACTIVITY1:

- Do a genetic cross where you cross mother and a father, both with AB blood group. What are the possible phenotypes of the offspring?

ACTIVITY 1

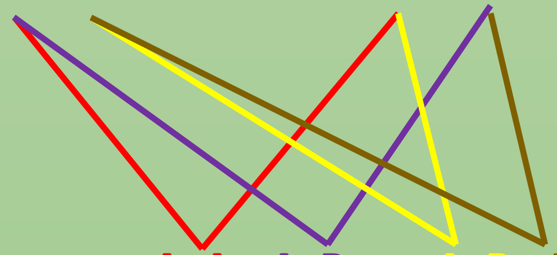
P1 phenotype **Group AB X Group AB**

genotype I^AI^B **X** I^AI^B

meiosis

gametes I^A, I^B **X** I^A, I^B

fertilization



F1 genotype I^AI^A I^AI^B I^AI^B I^BI^B

phenotype 1 Group A:2 Group AB: 1 Group B

ACTIVITY 2

In the TV series Days of Our Lives, two good friends, namely, Hope and Lexie each gave *birth to a son. These babies were deliberately switched in the hospital.*

From the following blood types, determine which baby belongs to which parents:

Baby 1 : Type O = ii

Baby 2 : Type A = I^AI^A/ I^Ai

Hope : Type B = I^BI^B/ I^Bi

Hope's Husband : Type AB = I^AI^B → CANNOT produce Type O but can produce Type A, so baby 2 belongs to Hope and her husband

Lexie : Type B = I^BI^B / I^Bi

Lexie's Husband : Type B = I^BI^B/ I^Bi → Can produce Type O so baby 1 belongs to Lexie and her husband

ACTIVITY 3:MARCH 2017 BLOOD GROUPS

3.2 Human blood groups are controlled by multiple alleles.

3.2.1 How many alleles control blood groups? 3/ Three (1)

3.2.2 Which TWO alleles are codominant in the inheritance of blood groups? I^A and I^B (2)

3.2.3 A man is heterozygous for blood group A and marries a woman who has blood group O. Use a genetic cross to show the phenotypic ratio of their offspring. (7)

(10)

ACTIVITY 3

P1	phenotype	**Group A**	**x**	**Group O**
	genotype	**I^Ai**	**x**	**ii**
	meiosis			
	gametes	**I^A, i**	**x**	**i, i**
	fertilization			
F1	genotype	**I^Ai I^Ai**		**ii ii**
	phenotype	**2 Group A,**		**2Group O**
	phenotypic ratio	**1 Group A: 1Group O**		

NB Phenotypic ratio must be in its simplest form (i.e. simplify it)

Role of Blood Grouping in Paternity Testing

Blood grouping can be used to determine **paternity** (who father of the child is) if **both parents'** and the **child's blood groups** are **known**

It is **inconclusive:**

- Determine whether someone is definitely ***not*** the **father**
- Determine whether someone ***might*** be the **father**

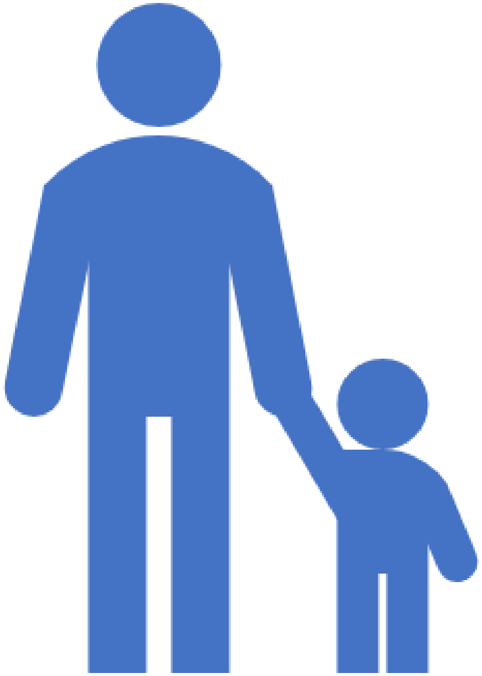
Extract Q4 P2 Nov 2019

Sometimes the paternity of a son or a daughter is disputed.

Explain how blood grouping and DNA profiling are used in paternity testing

Blood Grouping

- The blood group of a child is determined by the alleles received from both parents
- The blood group of the mother, the child and the possible father is determined
- If the blood group of the mother and possible father cannot lead to the blood group of the child, the man is not the father
- If the blood group of the mother and the possible father can lead to the blood group of the child, the man might be the father
- This is not conclusive because many men have the same blood group



Role of DNA profiling in Paternity

- A child receives DNA from both parents
- The DNA profiles of the mother, child and the possible father are determined
- A comparison of the DNA bands of the mother and the child is made
- The remaining DNA bands are compared to the possible father's DNA bands
- If all the remaining DNA bands in the child's profile match the possible father's DNA bands then the possible father is the biological father
- If all the remaining DNA bands in the child's profile does not match the possible father's DNA bands then the possible father is not the biological father
- In determining paternity DNA profiling gives conclusive results unlike blood grouping

WORKSHEET 3: INHERITANCE OF BLOOD GROUPS

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