ABO blood group inheritance

Biology · Class 12 Biology: Ch 4 Principles of Inheritance and Variation (multiple alleles: ABO blood groups)

The trap

✗ Most students think

~~A group B father and a group A mother can only have children of group B, A or AB, never O.~~

✓ Actually

Group B can be **I^Bi** and group A can be **I^Ai**: each hides an O. **$I^Bi \times I^Ai$** gives AB, A, B and O, **1 : 1 : 1 : 1**.

The concept in 5 lines

1. One gene, **I**, with three alleles: **I^A** (A sugar on red cells), **I^B** (B sugar), **i** (no sugar): **multiple alleles**.
2. Everyone carries **two copies**, one from each parent, and passes on one of them at random.
3. **I^A and I^B are dominant over i**; together, I^A and I^B are **co-dominant** (group AB). 6 genotypes, 4 blood groups.
4. Group O is **ii**: one i from each parent. **Only someone who carries an i can give an i**, so an AB parent never has an O child.
5. A blood group can **rule a parent out**, never prove one. Start every genotype question from the child.

Remember

$I^Bi \times I^Ai \rightarrow I^AI^B$ (AB) : I^Ai (A) : I^Bi (B) : ii (O) = 1 : 1 : 1 : 1

Why it matters

Principles of Inheritance and Variation gives NEET about **2 to 6 questions a year** (2021 to 2025), and **NEET 2024** asked the ABO genotypes directly.

Previous-year question, solved

NEET 2024

As per ABO blood grouping system, the blood group of father is B^+, mother is A^+ and child is O^+. Their respective genotype can be: A. I^Bi / I^Ai / ii · B. I^BI^B / I^AI^A / ii · C. I^AI^B / iI^A / I^Bi · D. I^Ai / I^Bi / I^Ai · E. iI^B / iI^A / I^AI^B

(A) A only
(B) B only
(C) C and B only
(D) D and E only

Answer: A only (I^Bi / I^Ai / ii)

1. The child is O, so the child is **ii**: one i came from each parent.
2. So the father is group B **with** an i: **I^Bi**; the mother is group A with an i: **I^Ai**.
3. B fails ($I^BI^B \times I^AI^A$ gives only AB); C, D and E each give a wrong group to someone. The $^+$ is the separate Rh gene.

In Code R this is Q194 and "A only" is option (4); in other codes it is option (1). Match the answer by its wording.

Practice: try each one before you check the answers

Q1 Class 12 A man of blood group AB marries a woman of blood group O. Which blood groups are possible in their children, and in what ratio?

Q2 NEET pattern The ABO blood group system in humans is an example of: (1) incomplete dominance only (2) multiple alleles and co-dominance (3) polygenic inheritance (4) pleiotropy

Q3 NEET pattern How many different genotypes and how many different phenotypes (blood groups) are possible for the ABO gene?

Q4 NEET pattern Both parents are group A, and their first child is group O. What is the probability that their second child is group O?

Q5 YES / NO Father AB, mother O. Can their baby be group O? YES / NO

Answers

1. **A and B only, 1 : 1.** The man (I^AI^B) gives I^A or I^B; the woman (ii) can only give i. Children are I^Ai (group A) or I^Bi (group B), each with a chance of 1 in 2. No child can be AB or O.
2. **(2) multiple alleles and co-dominance.** Three alleles (I^A, I^B, i) of one gene exist in the population (multiple alleles), and I^A and I^B are both fully expressed together in group AB (co-dominance). Blood group is not polygenic: it is controlled by one gene.
3. **6 genotypes, 4 phenotypes.** Genotypes: I^AI^A, I^Ai, I^BI^B, I^Bi, I^AI^B, ii. Phenotypes: A, B, AB, O. With n alleles there are n(n + 1) ÷ 2 genotypes: 3 × 4 ÷ 2 = 6.
4. **1/4.** The O child (ii) shows that both parents are I^Ai. I^Ai × I^Ai gives I^AI^A : I^Ai : ii = 1 : 2 : 1, so 3/4 group A and 1/4 group O. Each child is a fresh draw, so the first child does not change the second child's chance.
5. **NO.** The father's two copies are I^A and I^B, so he has no hidden i to give. Every child gets I^A or I^B from him and i from the mother: I^Ai (group A) or I^Bi (group B), never ii. Only someone who has an O can give an O.

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