Q1(a)

Mendelian and non-Mendelian traits.

UPSC Civil Services Mains 2025 · Anthropology GS 1 · 10 marks · Mendelian genetics in man-family study, single factor, multifactor, lethal, sub-lethal and polygenic inheritance in man.

9.2 Mendelian genetics in man-family study, single factor, multifactor, lethal, sub-lethal and polygenic inheritance in man.

Core demand of the question

- Define Mendelian traits in humans and the pedigree rules they follow
- Define non-Mendelian traits and show how they break those rules
- Give human and anthropological examples of each
- State why this distinction matters in biological anthropology

Revision summary

Mendelian traits follow one-locus segregation and can be read in a pedigree.

ABO, PTC tasting, albinism, haemophilia A and Huntington disease are standard examples.

Multiple alleles and sex-linkage extend Mendelism; they do not cancel it.

Non-Mendelian traits include polygenic stature and skin colour, linkage, maternal mtDNA and imprinting.

Environment plus many genes gives a curve, not a 3:1 ratio.

Use family study for Mendelian markers and quantitative genetics for everyday variation.

Single-factor, multifactor, lethal and polygenic inheritance is this same distinction.

Introduction

Mendelian traits are characters that pass from parents to children according to Mendel's two basic laws: segregation and independent assortment. Non-Mendelian traits do not follow those simple one-gene rules. Biological anthropology needs both ideas, because some human markers behave like garden peas, while height, skin colour and many diseases do not.

Body

Mendelian traits in humans

A Mendelian trait is usually controlled by alleles at one locus. Those alleles separate when gametes form, so a clear pattern appears in a pedigree. Dominance, recessivity and sex-linkage change how the trait looks, but they do not cancel particulate inheritance.

- **Gregor Mendel** showed this with peas. **William Bateson** and **Archibald Garrod** then applied the same logic to humans, including inborn errors of metabolism.
- **ABO blood groups**, described by **Karl Landsteiner**, are a standard anthropological example. There are three alleles at one locus (I^A, I^B and i). A and B are codominant, and O is recessive, but transmission is still one-locus Mendelism.

- **PTC tasting**, **oculocutaneous albinism**, **Huntington disease** (autosomal dominant) and **haemophilia A** (X-linked recessive, famous in European royal pedigrees) are further human examples.
- **Tay-Sachs disease** is still Mendelian even though the homozygous child often does not reproduce. The locus follows Mendel; the fitness of the genotype does not.

Family study and Hardy-Weinberg teaching both start from this single-locus picture.

Non-Mendelian traits

Most characters that anthropologists actually measure are not garden peas.

- **Polygenic and multifactorial traits:** Stature and skin colour are the classic anthropological examples. Many genes of small effect, plus sunlight, diet and disease, produce a continuous curve rather than two neat classes. **R. A. Fisher** and later quantitative genetics explained this as many Mendelian loci acting together, which is why skin colour must never be taught as a 3:1 "racial" mark.
- **Linkage:** Genes on the same chromosome travel together until recombination. They do not assort independently.
- **Mitochondrial inheritance:** mtDNA comes from the mother. A father with a mitochondrial disorder does not pass it to his children. Leber hereditary optic neuropathy is a clinical example.
- **Imprinting and epistasis:** A gene may be silenced according to which parent it came from, or one locus may hide another. Simple dominance arithmetic then fails.
- **Sickle-cell:** The locus is Mendelian, but the heterozygote has a different cellular picture from either homozygote. The inheritance is Mendelian; the phenotype is not a simple dominant-recessive class.

Why the distinction matters

Mendelian analysis is the right tool for blood groups, many clinical loci and genetic counselling. Non-Mendelian architecture explains everyday human variation, complex disease and the old misuse of "race". Single-factor, multifactor, lethal and polygenic inheritance are two readings of the same genome.

Flow diagram

Human traits -> Mendelian

Human traits -> Non-Mendelian

Mendelian -> One locus / pedigree

Mendelian -> ABO, PTC, haemophilia

Non-Mendelian -> Polygenic height and skin

Non-Mendelian -> Linkage / mtDNA / imprint

Conclusion

Multiple alleles and sex-linkage still obey segregation, so they remain Mendelian. The non-Mendelian label belongs to polygenic, linked, cytoplasmic and imprinted systems. Anthropology needs pedigrees for discrete markers and quantitative genetics for the living body.

Facts & figures

Mendel's laws

Segregation at a locus and independent assortment of unlinked loci. This is the baseline for pedigree analysis in humans.

ABO blood groups

One autosomal locus with alleles I^A, I^B and i. A and B are codominant; i is recessive. Transmission is still Mendelian.

PTC tasting

A classic taster versus non-taster contrast used in family studies as a Mendelian marker.

Haemophilia A

An X-linked recessive clotting disorder. Pedigrees show affected males and carrier mothers, including historic royal families.

Polygenic traits

Stature and skin colour involve many loci of small effect plus environment, producing a continuous distribution.

Mitochondrial inheritance

mtDNA is transmitted through the mother. Children of either sex may show the trait; affected males do not pass it on.