WRAP Exams · wrapexams.com
Prelims PYQ, Mains model answers, and copy evaluation. Write to the desk for this paper, a doubt, or the AI waitlist.
ask@wrapexams.com · +91 85951 84903 · wrapexams.com

Q7(b)

What assumptions must be met for a population to be in genetic equilibrium. Explain the importance of genetic equilibrium.

UPSC Civil Services Mains 2023 · Anthropology GS 1 · 15 marks · Concept of genetic polymorphism and selection, Mendelian population, Hardy-Weinberg law

9.3 Concept of genetic polymorphism and selection, Mendelian population, Hardy-Weinberg law; causes and changes which bring down frequency-mutation, isolation, migration, selection, inbreeding and genetic drift. Consanguineous and non-consanguineous mating, genetic load, genetic effect of consanguineous and cousin marriages.

Core demand of the question

- What assumptions must be met for a population to be in genetic equilibrium?
- Explain the importance of genetic equilibrium
- Write at 15-mark length

Revision summary

Hardy and Weinberg showed that p^2, $2pq$, and q^2 persist under stated assumptions.

Assumptions are large size, random mating, and no mutation, migration, or selection.

Equilibrium is the null against which evolution is inferred.

Forensics and counselling use it to get genotype frequencies.

Sickle-cell selection and isolate inbreeding are standard anthropological departures.

Real populations only approximate the model.

Introduction

Genetic equilibrium is the Hardy-Weinberg state in which allele and genotype frequencies stay stable across generations. It is a null model, and it holds only when a short list of assumptions is met.

Body

The Hardy-Weinberg statement

- For two alleles, p and q, random mating produces genotypes p^2, $2pq$, and q^2, a relation named for **G. H. Hardy** and **Wilhelm Weinberg** in 1908.
- If the assumptions hold, those frequencies recur, and allele frequencies do not drift by the mating system itself.

Assumptions

- The population is indefinitely large, so chance **genetic drift** is negligible.
- Mating is random with respect to the locus, with no inbreeding or assortative mating that would raise homozygotes.
- There is no **mutation** at rates that would shift p and q in the study window.

WRAP Exams

- There is no **migration** that imports a different allele frequency.
- There is no **selection** for or against genotypes at that locus.
- Generations are discrete in the simple teaching model, and the locus is autosomal in the basic two-allele form; sex-linked and multiple-allele extensions need extra algebra.

Importance

- **Equilibrium is the** null hypothesis **of population genetics:** departure diagnoses drift, inbreeding, migration, or selection, which is why **R. C. Lewontin** and anthropological genetics use it on blood groups and now on SNPs.
- Forensic match probabilities and genetic counselling use Hardy-Weinberg expectations to translate allele frequencies into genotype frequencies.
- **Sickle-cell** heterozygote advantage in malaria belts is taught as a selection break of equilibrium, not as a failure of Mendelism.
- Inbreeding in small tribal isolates raises homozygosity above 2pq expectations, which is an anthropological use of the same test.
- Conservation genetics of small populations uses the opposite of the infinite-population assumption to explain loss of diversity.

What it is not

- No real human population meets every assumption forever.
- The model is still necessary as a measuring stick.

Flow diagram

Large random mating -> Hardy-Weinberg

No mutation migration selection -> Hardy-Weinberg

Hardy-Weinberg -> Null model

Departure -> Drift inbreeding selection

Conclusion

Hardy-Weinberg equilibrium needs a large, randomly mating population without mutation, migration, or selection at the locus. Its importance is as a null model for detecting evolutionary forces and for translating allele frequencies into expected genotypes.

Facts & figures

Hardy and Weinberg, 1908

Independently stated the equilibrium relation between allele and genotype frequencies under random mating.

$p^2 + 2pq + q^2$

Expected genotype frequencies for two alleles in the basic autosomal model.

Genetic drift

Random frequency change in small populations, forbidden by the infinite-size assumption.

Heterozygote advantage

Selection that maintains both alleles, as in sickle-cell and malaria, a systematic departure from equilibrium frequencies.

Inbreeding

Non-random mating that increases homozygotes relative to Hardy-Weinberg expectation.

WRAP Exams · Write. Read. Analyse. Practice. · https://wrapexams.com/upsc/mains-answers/anthropology-gs-1/2023/what-assumptions-must-be-met-for-a-population-to-be-in-genetic-equilibrium-explain-the-importance-of-genetic-equilibrium/ · ask@wrapexams.com · wrapexams.com

WRAP Exams