Anthropology 215

CAUSES OF EVOLUTION

1

Summary of Hardy-Weinberg

In the absence of any disrupting factors the allele and genotype frequencies at any given locus in a randomly mating population will be repeated faithfully from one generation to the next; should the frequencies be perturbed for any reason, they will return to the expected equilibrium values after one generation of random mating (Giesel, 1974:14)

2

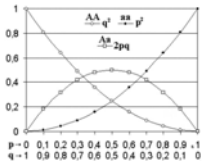
Predictions of H-W

- **Predict the offspring's genotypic proportions from the frequency of the alleles present in the parent's generation. For a trait determined by alleles, the proportion of the 3 genotypes is $p^2 : 2pq : q^2$**

3

Hardy-Weinberg

2. **Frequencies of genes (alleles) of a population are inherently stable from one generation to the next. i.e. the proportion p^2 2pq q^2 for a two-allele system will continue generation after generation.**
3. **In the event that two populations merge, an equilibrium of gene frequencies is reached immediately. The first hybrid population will be in a state of genetic equilibrium.**



4

The Utility of H-W

- **It allows estimates of departures from equilibrium to be measured.**
- **Can predict genotypic frequencies when gene frequencies are known and random mating is assumed.**
- **Can calculate the number of heterozygote carriers of autosomal dominant conditions.**

5

Which population is in Hardy-Weinberg Equilibrium?

	AA	Aa	aa	p	q
I	.20	.80	.00	.6	.4
II	.36	.48	.16	.6	.4
III	.50	.20	.30	.6	.4
IV	.60	.00	.40	.6	.4

Answer

II .36 .48 .16

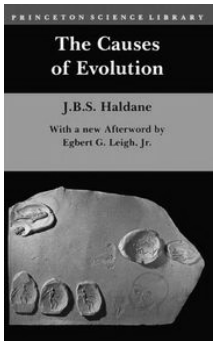
$p^2 + 2pq + q^2$

$q^2 = .16; q = .4; p = .6$

7

Causes of Evolution

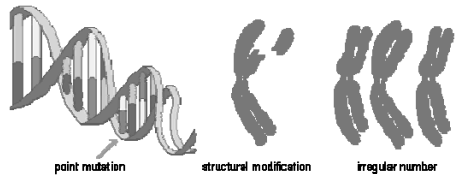
Non-random mating
Genetic drift
Mutation
Gene flow (migration)
Natural selection



8

Mutation

point mutations
chromosomal abnormalities



9

Causes of Mutations

- DNA replication errors
- exposure to radiation, alcohol, lead, lithium, organic mercury, viruses, microorganisms
- teratogens: inhibitors, streptomycin, tetracycline, and vitamin A
- spontaneous irradiation, chemicals, temperature extremes

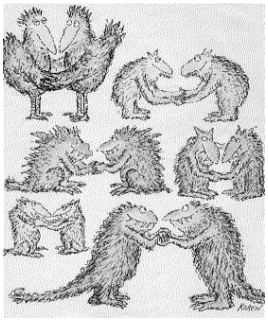
Mutation rate: 10^{-8} (1 in 100 million) per nucleotide per generation or 1 in 10,000-100,000 per sex cell

raw material for evolution

10

Non-Random mating

- non-random: assortative mating (positive, negative)
- consanguineous marriage (inbreeding) e.g., Amish or Mennonites of New Foundland and Harrington Harbor in Quebec
- Since 1000 A.D., 2 raised to 39th power or 549,755,813,888 (5 1/2 trillion) ancestors
- incest prohibition
- increase homozygosity



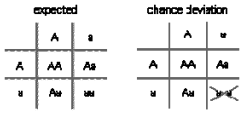
11

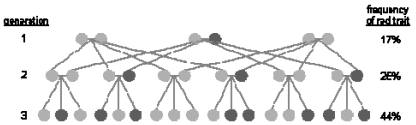
- genetic load: 3-5 lethal alleles
- E. g. rural Japanese: increased rates of congenital defects (higher rates of clef palate and cardiac defects); pre-reproductive mortality rates increase; mental and physical growth are depressed

12

Genetic Drift

Population Size and Sampling Error

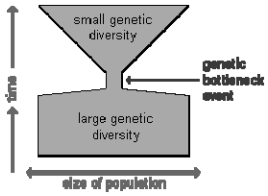




13

Genetic bottleneck

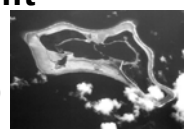
– when effective breeding population suddenly becomes reduced which might then drastically alter the genetic composition



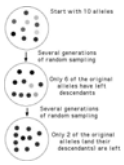
14

Genetic Drift

E.g., Pingelap; typhoon 1775
- achromatopsia (1/60 or .016)



E.g., Alpine Villages (albinism, deaf mutes, blindness, mental deficiency)

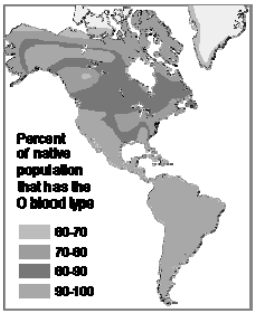


15

Founder Effect or Founder Principle

E.g., Amish (200), Hutterites (N=443), Pitcairn Is.

Type O blood in South & Central American Indians



16

Gene Flow

Hybridization and intermarriage – special kinds of gene flow

e.g., miscegenation; I^A and I^B alleles across Eurasia

admixture (e.g., American Black and American Whites)

Duffy blood group (Fy)

- Africans, Fy^o (a-b-) -- almost 100%
- Whites, Fy^o (a-b-) is rare -- 0%
- Fy^a = 43% in Whites and 0% in Africans

17

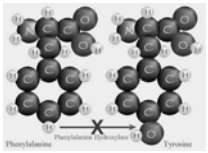
Natural Selection

- selection for or against one of the following:
- either homozygote (AA or aa but not both)
- both homozygotes (AA and aa)
- either homozygote and the heterozygote (AA and Aa or aa and Aa)
- the heterozygote (Aa)
- all alleles (AA, Aa, and aa)

18

Differential Mortality

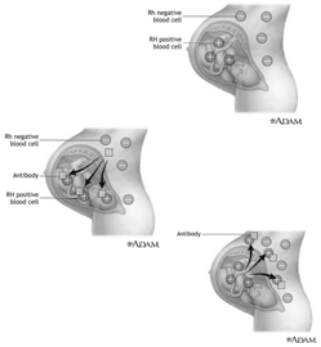
- **death: eliminates individuals**
  - **e.g. phenylketonuria (cannot metabolize phenylalanine)**
- **differential reproduction (or reproductive or survivance selection)**



19

Rh incompatibility

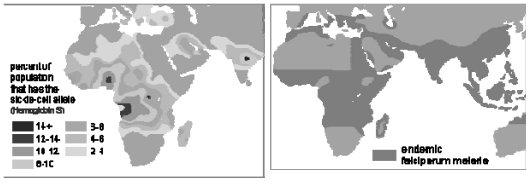
- **e.g. when mother is Rh- and offspring is Rh+: hemolytic disease of the newborn or *erythroblastoses fetalis***



20

Falciparium malaria & sickle cell hemoglobin

- **$Hb^S Hb^S$ - sickle cell anemia**
- **$Hb^A Hb^A$ - normal individuals (die of malaria)**
- **$Hb^A Hb^S$ - sickle cell trait (mild anemia)**



21