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Physical Anthropology

Population Genetics

Darwin
Mendel
F. Jenkins

Hardy & Weinberg, 1908

Hardy-Weinberg Law: gene and genotype frequencies remain inherently stable from generation to generation.
-genotype freq. of offspring generation are determined from the gene freq. of parent's.

Mendelian genetics: genes in families
Population genetics: distribution of genes in populations & how gene and genotype freq. are maintained or changed

Population (Mendelian pop.): unit of evolutionary change = group of interbreeding individuals
-breeding population
-common gene pool
-endogamy

Conditions for H-W equilbrium:

1. large population size (no genetic drift)
2. random mating
3. no migration (gene flow)
4. no natural selection
5. no mutation

Verification of H-W:

gene pool: 2 alleles, A, a

Maternal

		A	a
	A	AA	Aa
Paternal	a	Aa	aa

AA Aa aa
1 : 2 : 1

let p = freq. of A
q = freq. of a
$p+q = 1$ (100%)

p_A q_a $(p+q)^2$

p_A	p^2 AA	pq Aa
q_a	pq Aa	q^2 aa

p^2 = chance A combines with A = AA
$2pq$ = chance A combines with **a** = Aa
q^2 = chance **a** combines with **a** = aa

AA	Aa	aa
p^2	$2pq$	q^2

$p = 0.9$ $q = 0.1$

F_2	$p = .9$ A	$q = .1$ a
$p_A = .9$	AA .81	Aa .09
$q_a = .1$	Aa .09	aa .01

$(.9 + .1)^2 = .9^2 + 2(.9 \times .1) + .1^2$
81% AA 18% Aa 1% aa

F_2 generation mating frequencies:

	p_{AA} .81	q_{Aa} .18	r_{aa} .01
p_{AA}=.81	.6561	.1458	.0081
q_{Aa}=.18	.1458	.0324	.0018
r_{aa}=.01	.0081	.0018	.0001

$$=(p+q+r)^2 = p^2 + 2pq + 2pr + q^2 + 2qr + r^2$$
$$1 = .6561 + 2(.1458) + 2(.0081) + .0324 + 2(.0018) + .0001$$

Genotype composition and frequency of offspring generation:

			Offspring	
Mating	Frequency	AA	Aa	aa
AAxAA	.81x.81	.6561	---	---
AAxAa	.2(.1458)	.1458	.1458	---
AAxaa	2(.0081)	---	.0162	---
AaxAa	.18x.18	.0081	.0162	.0081
Aaxaa	2(.0018)	---	.0018	.0018
aaxaa	.01x.01	---	---	.0001
		.81	.18	.01

Illustrative example of Hardy-Weinber law

Given the following information concerning the genetics of the ability to taste PTC and these percentage frequencies of tasters and non-tasters, we can determine the gene frequencies and genotypic frequencies by using the Hardy-Weinberg law.

alleles	genotypes	phenotypes	%
T,t	TT & Tt	tasters	84%(.84)
	tt	non-tasters	16%(.16)

In this two-allelic system if p is let to equal the relative frequency (or proportion) of the dominant allele, T, and q the relative frequency of the recessive allele, t, and if $p+q=1$, then, in a randomly mating population, the frequencies (proportions) of the three possible genotypes will be $(p+q)^2$ according to Hardy-Weinberg or $p^{2\,(TT)}+2pq^{(Tt)} + q^{2(tt)}$ where p^2 is the percentage of homozygous dominant individuals, and $2pq$ is the percentage of heterozygous individuals, and q^2 the percentage of homozygous recessive individuals in the relative proportion: $1p^2{:}2pq{:}1q^2$.

a. Gene frequencies: Given that 16% of the population are non-tasters (tt):$q^2 = .16$

$q = .4$

and because $p+q = 1$

$p = 1 - q$

$= 1 - .4$

$p = .6$

Therefore the gene frequency for T = .6 & t = .4

b. Genotype frequencies (substituting these values in the formula):

p^2	+	$2pq$	+	q^2
(.6 x .6)		2(.6 x .4)		(.4 x .4)
.36		.48		.16
TT		Tt		tt

or 36% are homozygous dominant
48% are heterozygous dominant
16% are homozygous recessive

Gene frequency calculation in situation where ther is no dominance (alleles are co-dominant)

Alleles	Genotype	Phenotype(No.)		M	N	total
M,N	MM	M	197	394	---	394
	MN	MN	131	131	131	262
	NN	N	22	---	44	44
			350	525	175	700

M= 525/700 = .75
N= 175/700 = .25

Genotype freq. when no dominance: count the number of individuals of each phenotype and express this number as a proportion of the total no. of individuals and this will give you the genotype frequency.
MM = 197/350 = 0.563
MN = 131/350 = 0.374
NN = 22/350 = 0.063