Haldane's Dilemma

Current Cost of Substitution today is 30 (30 times more die than survive)

Average Reproductive Excess is 10% (the number that the species can afford to lose)

The rate of gene replacement = $\frac{\text{Cost of Substitution}}{\text{Reproductive Excess}}$

$= 30 \div 10\%$

$= 300$ generations for each new gene

Maximum number of genes replaced in 10 mil yrs = $\frac{\text{number of years}}{\text{rate of gene replacement per year}}$

$= 10{,}000{,}000 \div (20 \times 300)$

$= 1667$ nucleotides

How much genetic material is 1667 nucleotides?

Percentage of total nucleotides = $\frac{\text{total amount of genetic material}}{\text{No. nucleotides changed}} \times 100$

$= 7{,}000{,}000{,}000 \div 1667 \times 100$

$= 0.000{,}000{,}2 \times 100$

$= 0.00002\%$

How long then for the ape to evolve into a human?

0.00002% changes in 10,000,000 years

$\therefore$ 1% changes in $10{,}000{,}000 \div 0.00002$ years

= 500 billion years

But, if a 10% change in genetic material is need for the ape to evolve into a human, then .....

a 10% change requires 500 billion x 10 years

= 5,000 billion years

If 5,000 billion years is required to change 10% of the genetic material, but 90% of the time is in stasis, then.....

the 10% non-stasis period is 5,000 billion years

$\therefore$ 100% of the time needed for our 10% change in genetic material

= 5,000 billion years x 10

= 50,000 billion years

BUT.... (1) Apes are said to have evolved into humans in 5 million years
(2) The earth is said to be only 5 billion years old
(3) The Big Bang occurred 20 billion years ago

Starting Occurrence of Gene	Cost of Dominant Gene	Cost of Recessive Gene
500,000	14	1,000,013
50,000	12	100,011
5,000	9	10,008
500	7	1,006

Data:

(1) POPULATION SIZE = 100,000

(2) LENGTH OF A GENERATION = 20 years

(3) STATUS FOR THE NEW TRAIT = higher survival rate than the old trait

(4) NEW TRAIT GENERATION METHOD = mutation

(5) MODE OF ACTION OF MUTATION = alter <u>one</u> DNA nucleotide in the chromosomes

(6) AMOUNT OF GENETIC MATERIAL = $7x10^9$ nucleotide sites in the DNA (typical of a mammal)

(7) LENGTH OF EVOLUTION = 10,000,000 years (10 million years)

(8) TYPE OF EVOLUTION = perfect, uninterrupted & continuous for the whole time

(9) CONTRA-EVOLUTION FACTORS = not considered