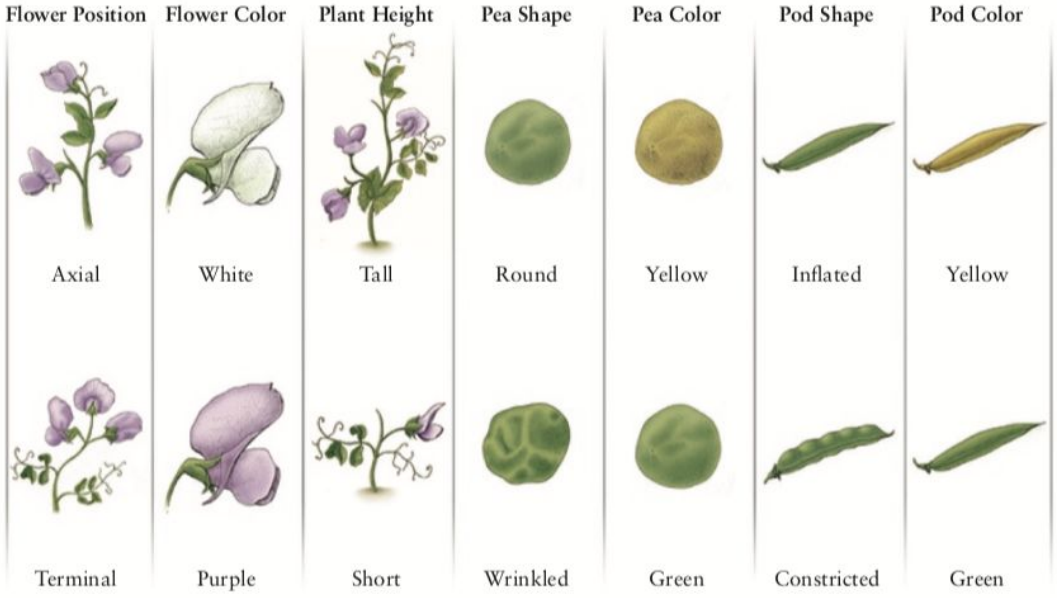
Ch 4: Mendel and Modern evolutionary theory

Mendelian principles of inheritance

Mendel's principles explain how traits are transmitted from generation to generation

Background: eight years breeding **pea plant hybrids**.



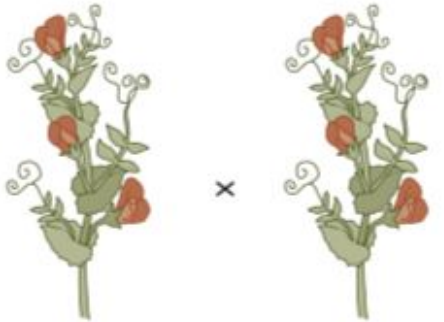
Mendel's experiments

-crossbred pure-bred pea plants

Parent generation:

-**tall** pea plants x **short** pea plants

F1 generation:



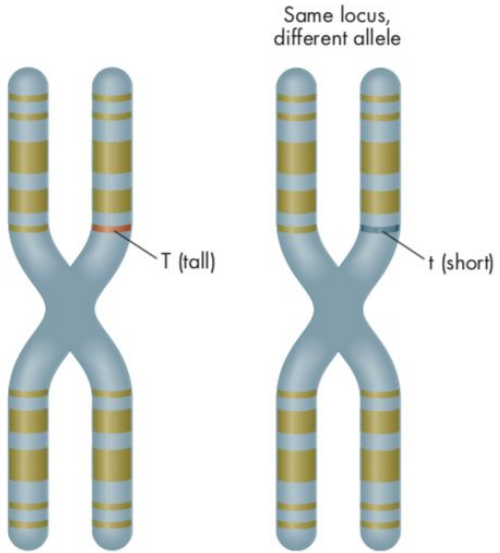
F2 generation:

First principle of inheritance

Alleles: variations of a gene

E.g., pea plant height is controlled by **allele pair**

Principle of segregation: traits are controlled by allele pairs and each parent contributes one allele to each pair.

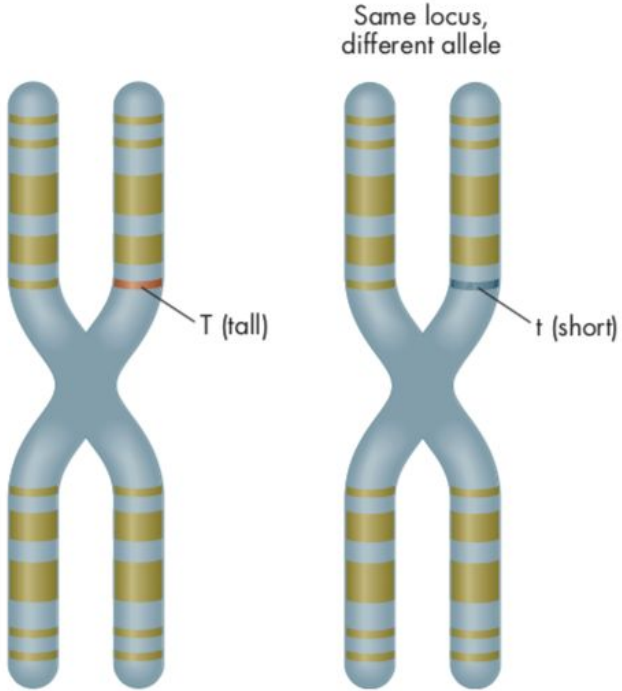


Mendel's first principle of inheritance

Recessive alleles are masked by the expression of **dominant alleles**

Homozygous: two allele copies

Heterozygous: different alleles

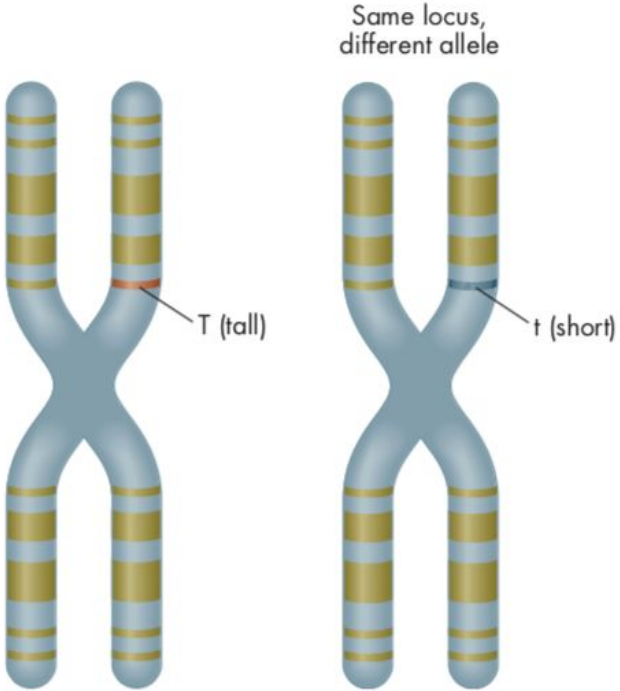


Dominance and recessiveness

Dominant alleles mask the expression of **recessive** alleles

Homozygous: two allele copies

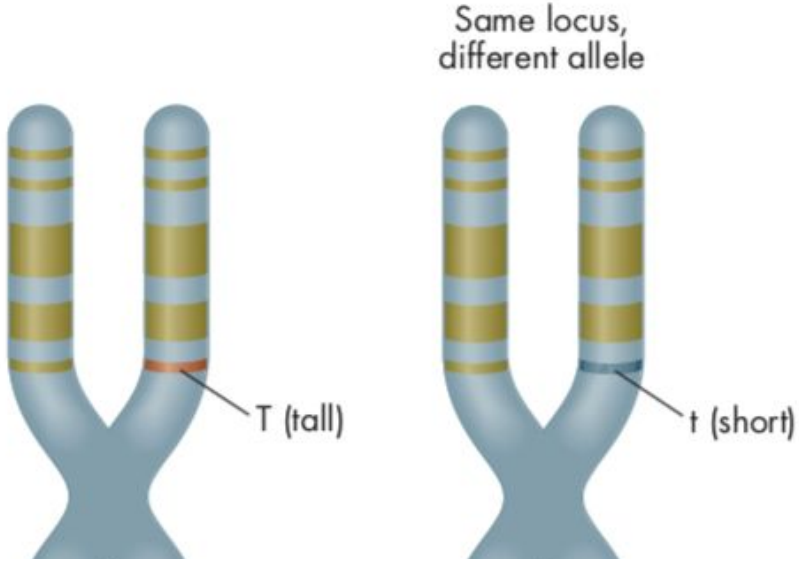
Heterozygous: different alleles



Mendel's principles of inheritance

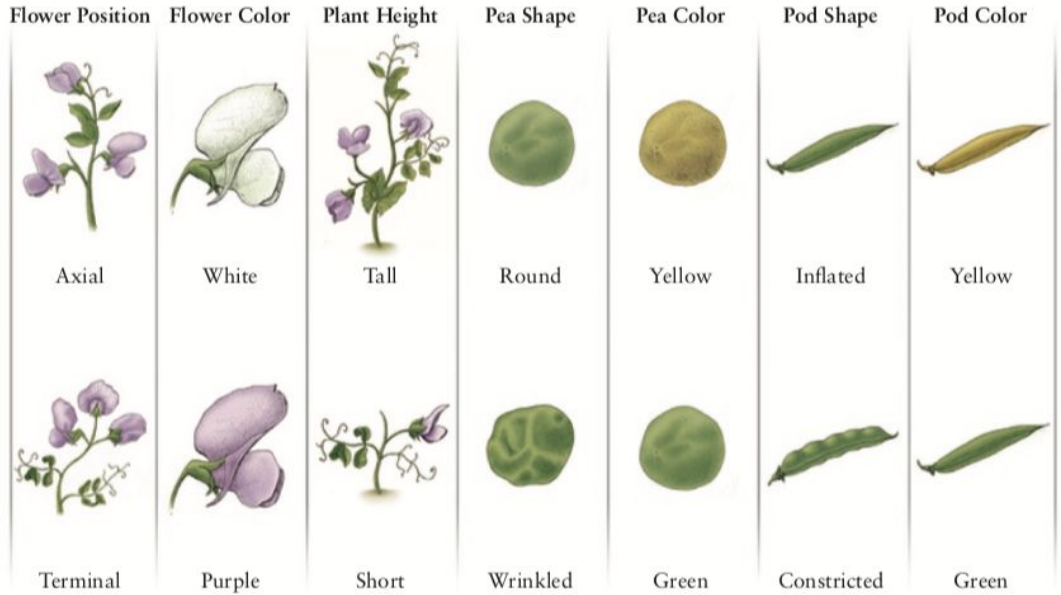
Genotype: organism's actual genetic makeup

Phenotype: observed physical expression of genotype/genes



Punnett square problems

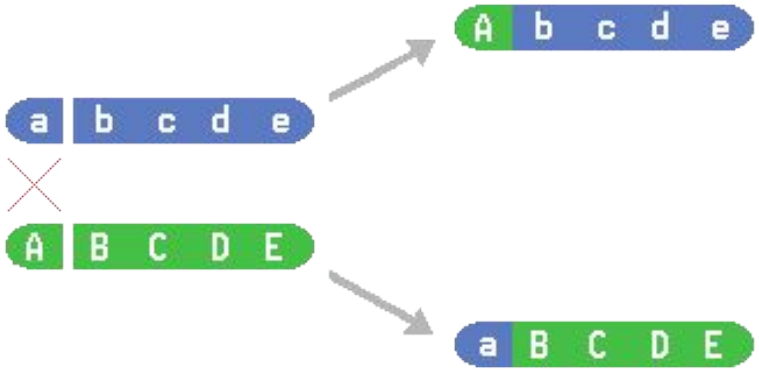
Identify the different phenotypic and genotypic ratios in F2 generations for a cross of two heterozygous tall plants (tall = dominant trait).

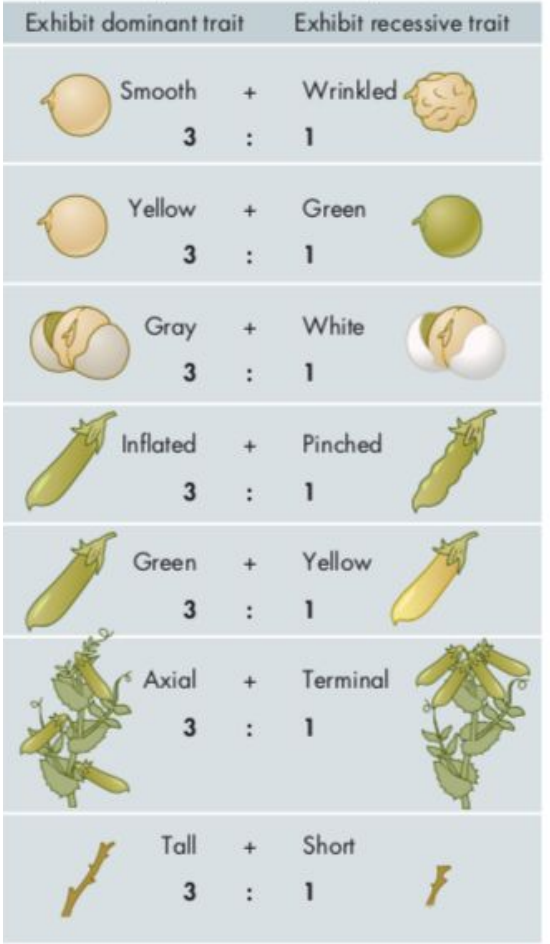


Second principle of inheritance

Principle of independent assortment: traits are inherited separately

-inheritance of one trait is independent from inheritance of other traits

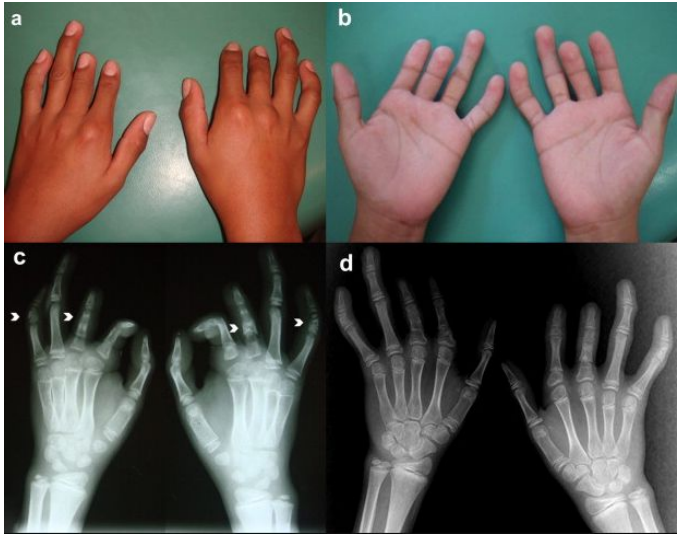




Punnett square problems

Hypothetically, B is the allele that causes brachydactyly. If a man with two normal alleles (bb) has average length fingers/toes has kids with a woman with brachydactyly (Bb).

What proportion of their kids will have average length fingers/toes?



Mendelian genetics recap

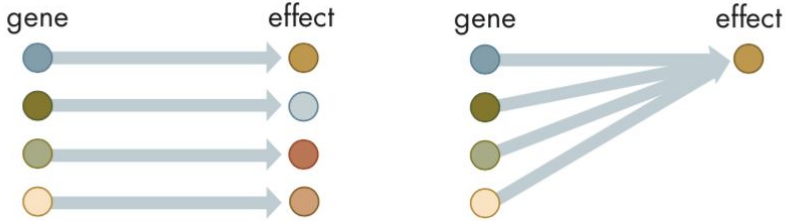
Mendelian traits

-discrete traits

-one gene determines one trait

-rarely influenced by environment

Mendelian genetics

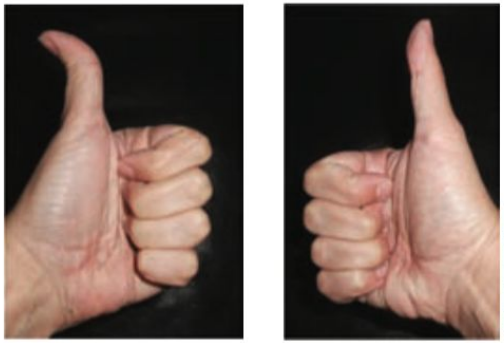


Mendelian traits

-discrete traits

-one gene determines one trait

-rarely influenced by environment



Polygenic traits

-continuous

-multiple genes determine one trait

-heavily influenced by environment

Mendelian genetics recap

Alleles: variations of a gene

Allele pairs	determines	trait
Genotype	determines	phenotype
Tt	determines	tall pea plants

Mendelian genetics recap

Dominant alleles mask the expression of **recessive** alleles.

Homozygous: allele pairs (TT or tt or XX)

Heterozygous: alleles pairs (Tt or XY)

Organism	Number of chromosomes
pea plant	14
sun flower	34
cat	38
puffer fish	42
human	46
dog	78

Mendelian genetics recap

Principle of segregation: traits are controlled by discrete units which come in pairs and separate into sex cells.

Principle of independent assortment: traits are inherited separately

Ch 4: Modern Synthetic Theory of Evolution

Synthetic theory of evolution

-modern synthesis of Darwin's theory and genetics now:

Evolution defined: change in **allele frequencies** of a population from one generation to the next.

Gene pool: the genetic material (alleles) making up a population of organisms

Synthetic theory of evolution

Two-stages of evolution involve variation and natural selection

Stage 1: Factors produce and redistribute variation

Stage 2: Natural selection acts on variation

Microevolution: changes from generation to generation

Macroevolution: speciation, changes over time seen in the fossil record

Processes of evolution

Mutations: any change in alleles

-produces new alleles (only source of new genetic material)

-only passed on if occurs in gametes

E.g., sickle-cell anemia due to **point mutation** (changes in a single nucleotide base).

Processes of evolution

Recombination:

-chromosome pairs exchange DNA during meiosis

-greater genetic diversity for natural selection to act on

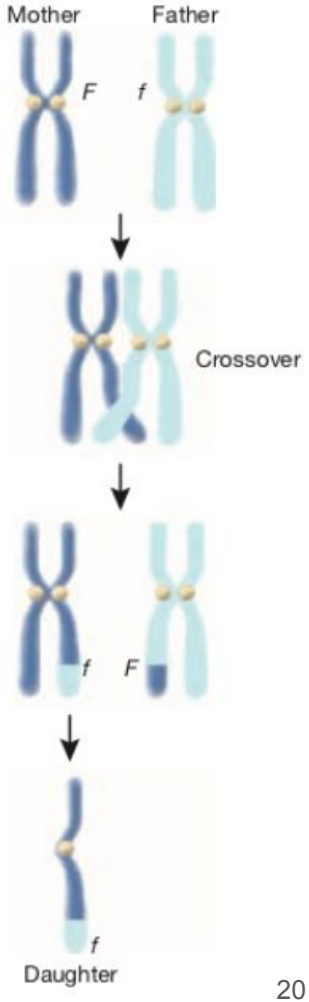


FIGURE 4.2 Genetic Recombination

Factors producing and redistributing variation

3. Genetic drift: changes in allele frequencies due to chance

Founder effect: small subpopulation starts new popn

E.g., polydactyly in Amish communities

-founders/immediate descendants = **carriers**

-homozygous recessive individuals emerged in gene pool

Amish mother and child. The child has Ellis-van Creveld syndrome, which is characterized by polydactyly (six fingers on each hand), short stature, and shortening of the forearms and lower legs. (Image reproduced with permission from Johns Hopkins University Press).

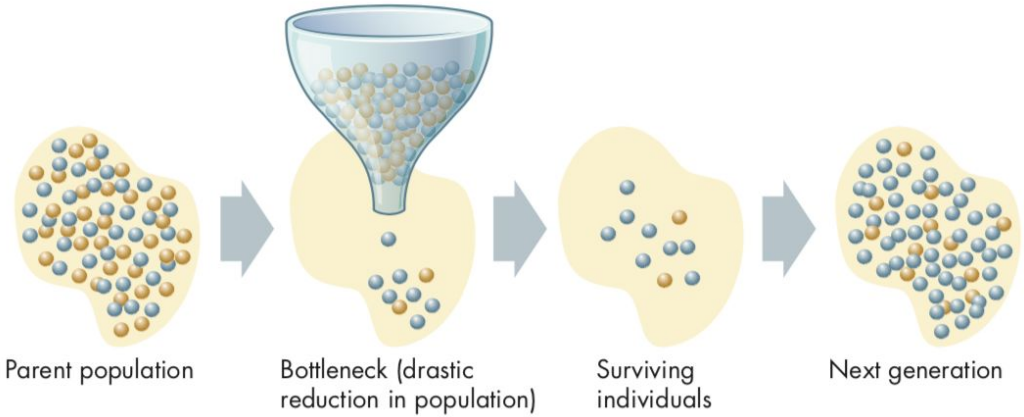
Factors producing and redistributing variation

3. Genetic drift: changes in allele frequencies due to chance

Founder effect: small subpopulation starts new popn

Bottleneck: population shrinks and recovers

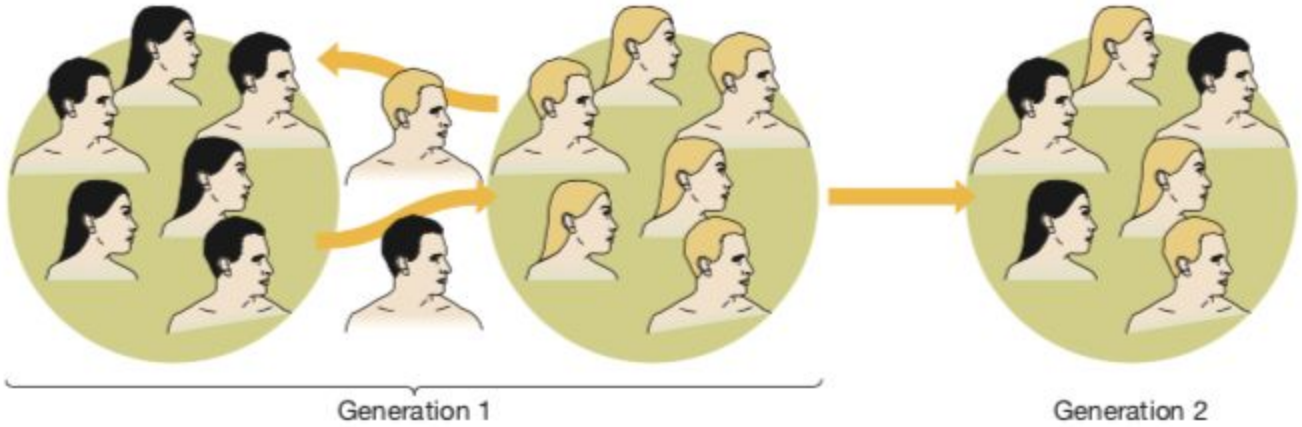
E.g., Pingelap islanders are mostly colorblind



Factors producing and redistributing variation

4. Gene flow: (migration) exchange of genes between populations

E.g., gene flow between human populations explains the low occurrence of hominin speciation in the past million years

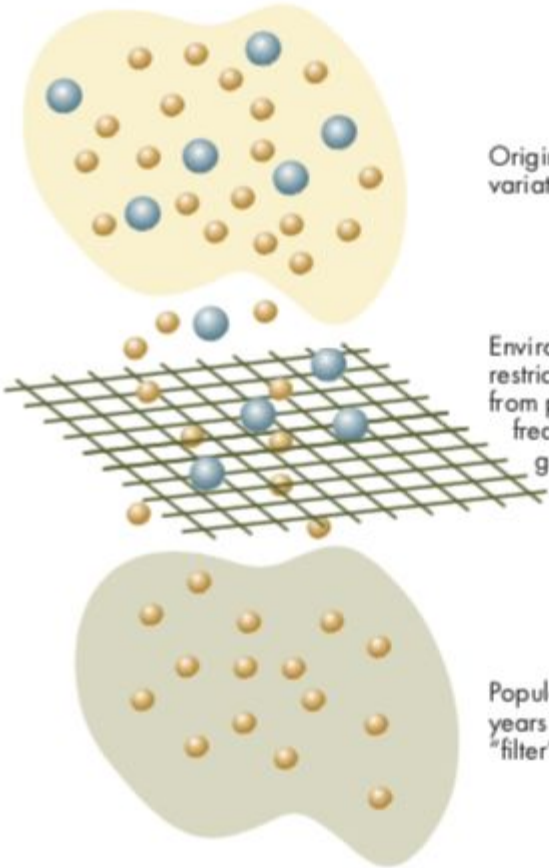


Variation and natural selection

Natural selection

-directional change relative to environment

-acts on variation



Processes of evolution

Natural selection:

-directional change relative to environmental context

-acts on variation produced and redistributed by mutations, recombination, drift, and migration

Anthropology example

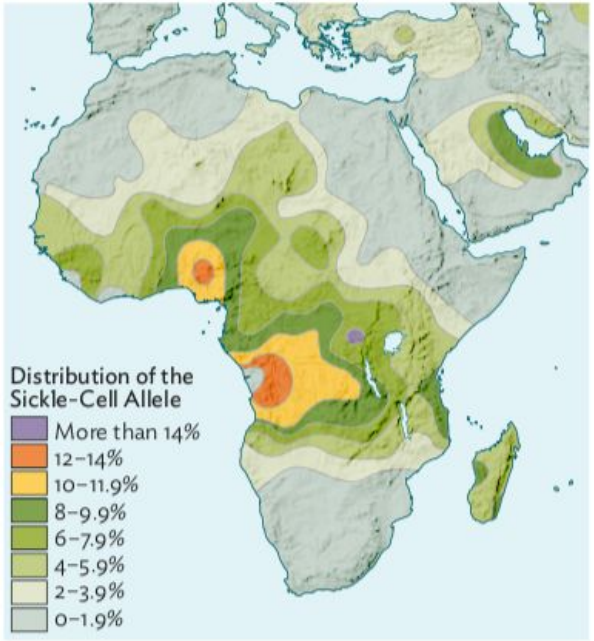
Sickle-cell anemia: genetically inherited blood disease

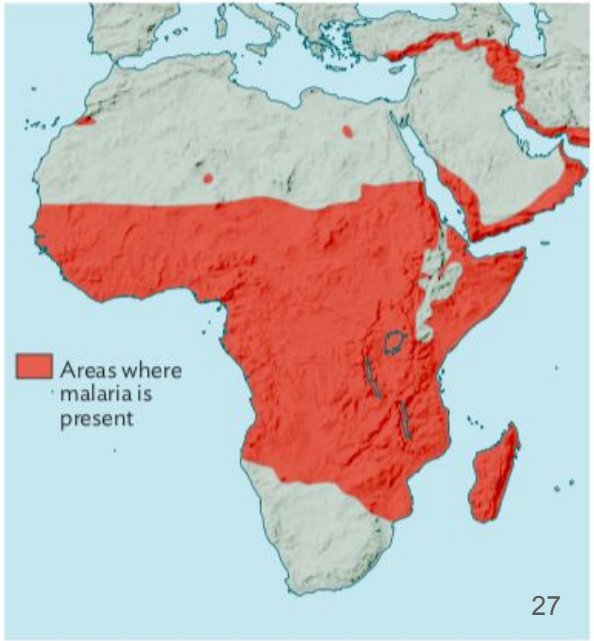
Mutated hemoglobin collapses red blood cells into sickles leading to anemia and death

Anthropology example

Expect: selection against sickle-cell trait

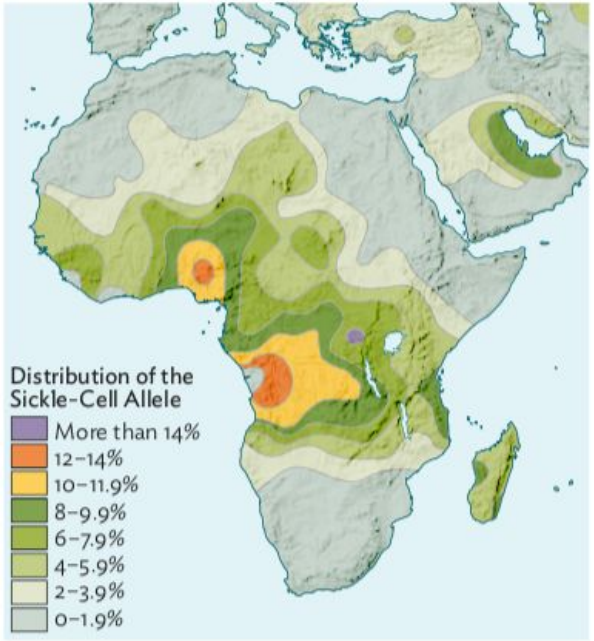
Instead: 30% some regional populations are carriers

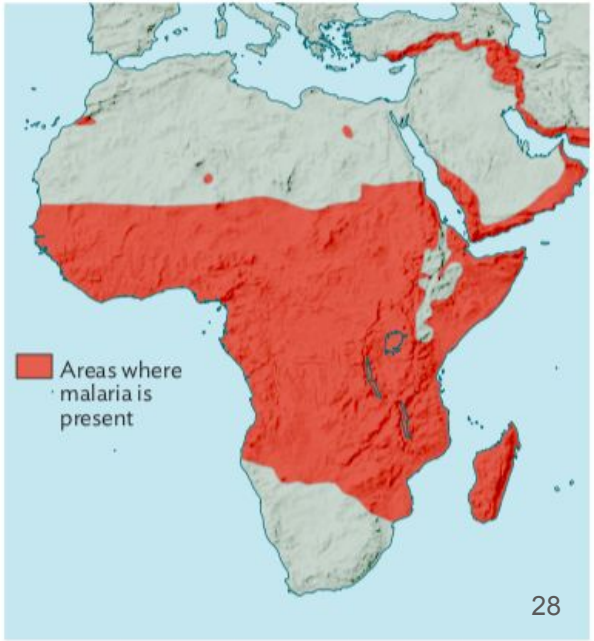




Anthropology example

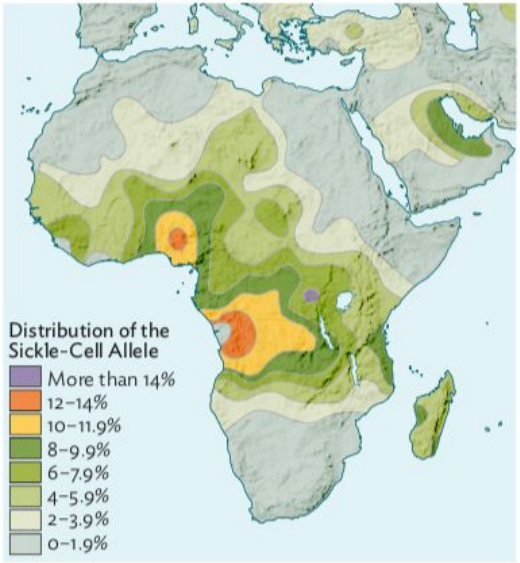
Correlation between geographic locations with a malarial pressure and high frequencies of SCT

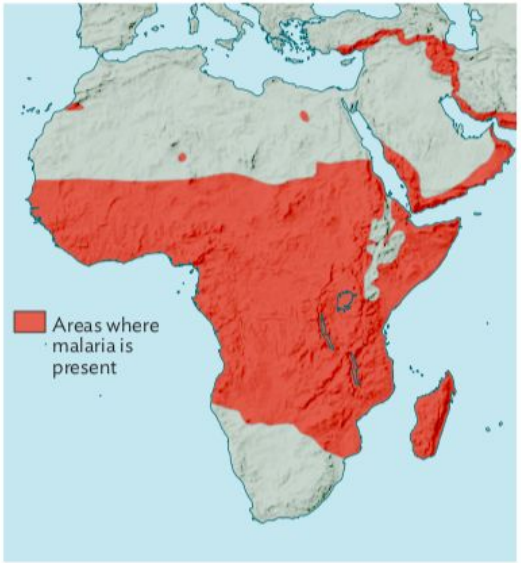




Anthropology example

Geographic distribution: Mediterranean, Arabian peninsula, Southeast Asia, West Africa.





Sickle-cell trait: Natural selection in humans

FIGURE 10.16
Regions where malaria is endemic. What does this suggest about the relationship between the sickle cell allele and malaria?

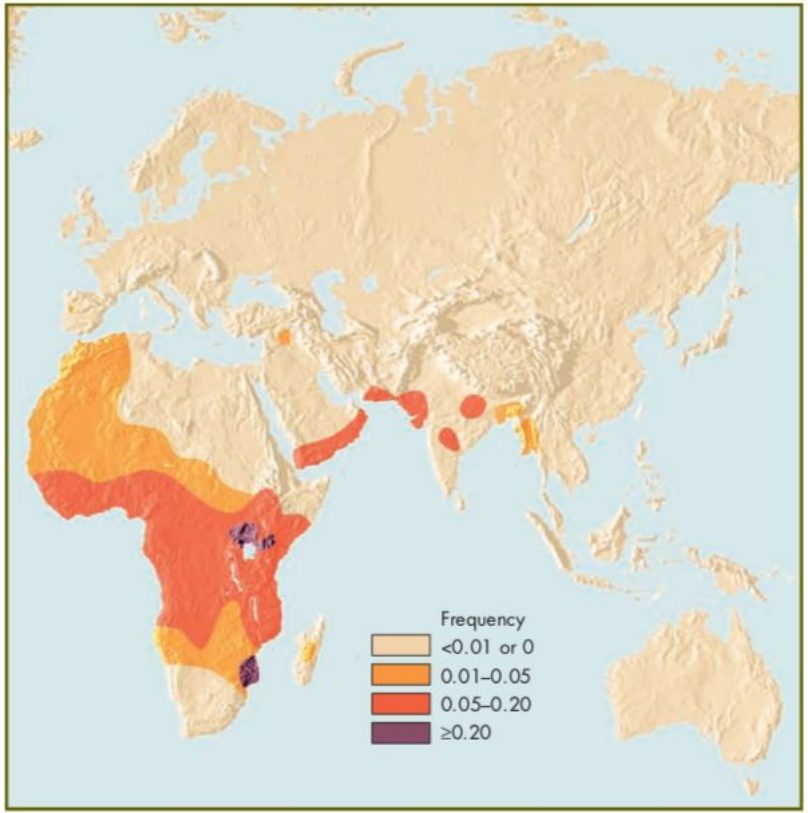


FIGURE 10.15
Distribution of the sickle cell allele. Compare with Figure 10.16.