Overview

Hereditary material is DNA, a double helix of complementary polynucleotides. Genes are segments of DNA encoding the amino acid sequence of a polypeptide. Hereditary variation is caused by variant forms of genes known as alleles. Alleles can be studied at many levels. Each species has its own distinctive pool of genes. Evolution is a consequence of genetic changes in a population over time.

Discontinuous variation


Genetic methodology

Isolation of mutations (natural or induced). Analysis of progeny of controlled matings (crosses). Biochemical analysis of underlying cellular processes. Microscopic analysis of chromosomes (cytogenetics) and phenotypes. Direct analysis of DNA. Genomics: sequencing genome. Bioinformatics: extraction of information from DNA.

Continuous variation

Unbroken range of phenotypes; no discrete classes. Intermediate phenotypes more common than extreme ones. A result of a combination of genetic and environmental variation. Underlying genetic basis often difficult to study. Important in plant and animal breeding.

Genes, environment, organism


Genes and evolution

Darwin recognized role of hereditary variation in evolution (but was unaware of true mechanism of heredity). Genetic variation (product of mutation) is raw material for evolutionary change. Natural selection: differential reproduction of individuals with different alleles. Random genetic drift: change in frequencies of genetic variants resulting from random, non-selective processes.
Genetics and human affairs

>1000 inherited genetic diseases in humans
Cancer is caused by mutation in somatic cells
Genetics pertains to social policy
$ debate over role of genetics and IQ
$ genetics of sexual orientation
Biotechnology and genetic engineering
$ new pharmaceuticals
$ new varieties of plants and animals
$ concerns over ethics and safety

Genetics

Experimental science of heredity
Grew out of need of plant and animal breeders for greater understanding of inheritance of economically important characters
Gregor Mendel: discovered principles of heredity
Today, genes are explained in molecular terms

Physical and chemical basis

Genome: basic complement of DNA of an organism
$ haploid: one copy of genome (fungi, algae, bacteria)
$ diploid: two copies of genome (plants, animals)
Genes: regions of chromosomal DNA encoding polypeptides
$ different genes on each chromosome
$ homologs: chromosomes with same genes
$ in diploids, one homolog inherited from each parent
DNA: complementary polynucleotide chains
$ A-T and G-C base pairs
$ double helix

From gene to protein

Protein
$ linear chain of amino acids (polypeptide) encoded by gene
subject to variation
$ folds into 3 dimensional structure
$ may associate with other proteins
DNA $ mRNA $ polypeptide
$ DNA $ mRNA $ transcription
$ mRNA $ polypeptide $ translation
$ genetic code
ribosomes
tRNA

Genetic variation

Alleles
$ alternative forms of a gene encoding proteins with altered amino acid sequence
$ located at same position (locus) on chromosome
Phenotype: appearance or physiological expression of gene
Genotype: alleles present in individual
Discontinuous variation (qualitative)
Continuous variation (quantitative)