University of New England

Genes and Inheritance

Lecture 2

Applied Animal and Plant Breeding

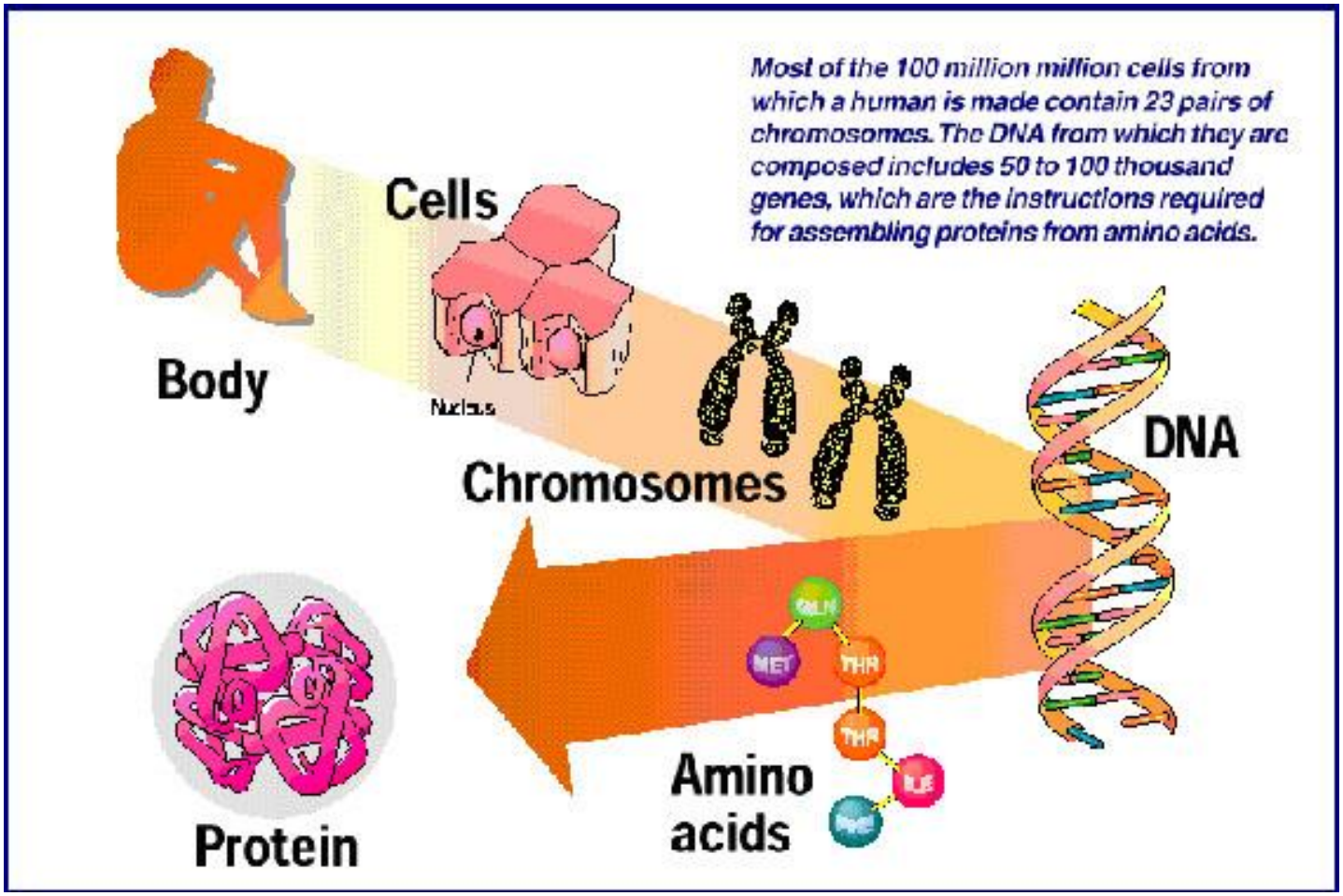
GENE 251/351

School of Environment and Rural Science (Genetics)

Summary

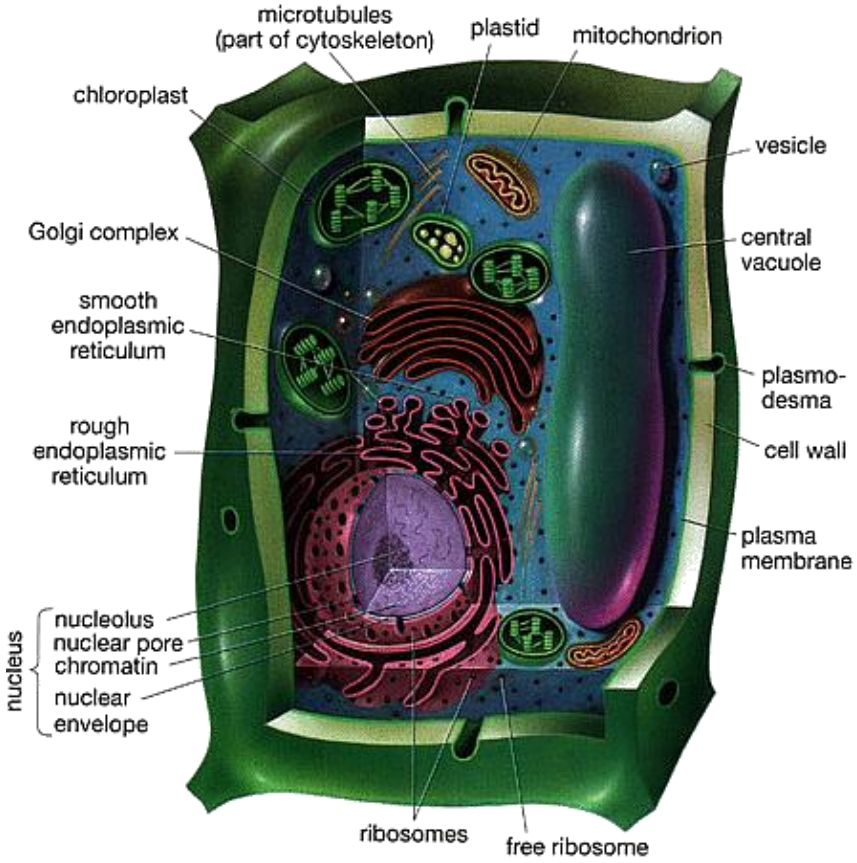
- DNA, Genes, Chromosomes, Cells, Organisms
- Cell division-Mitosis and Meiosis
- DNA to proteins
- Variation in DNA = Genetic Variation
- Genotype and Phenotype

From DNA to Organism

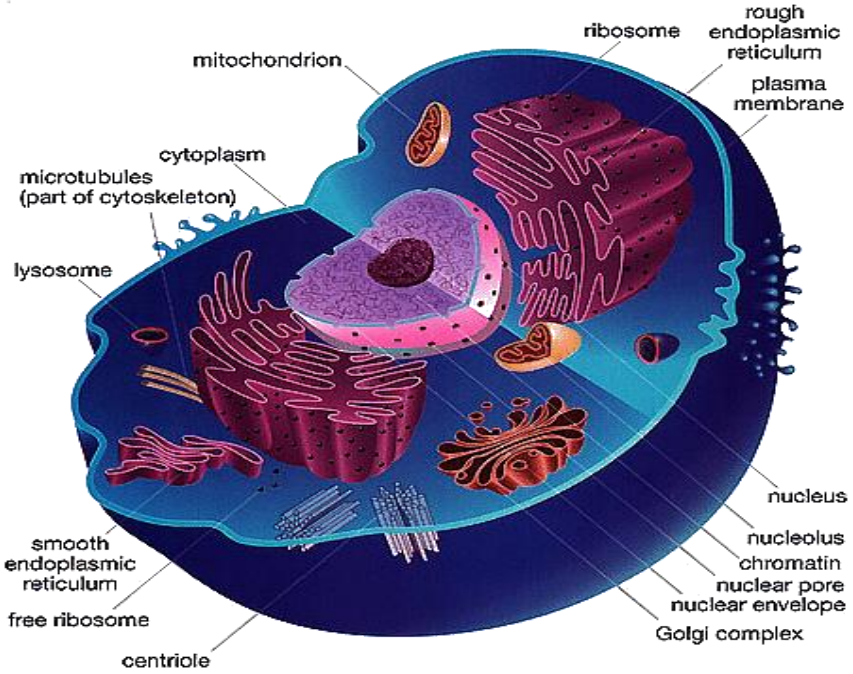


Cell structure and organelles

- A typical Plant Cell

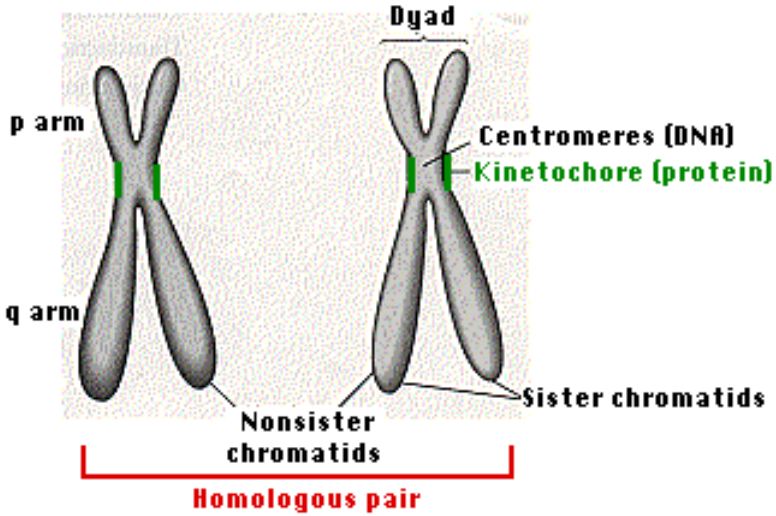


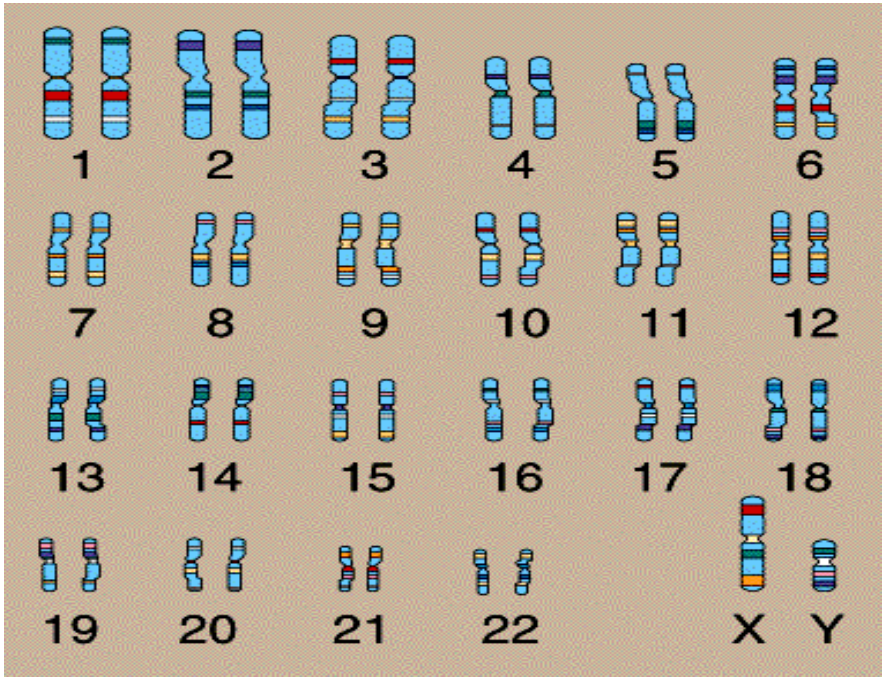
A typical Animal Cell



Chromosomes

- The study of chromosome structure is called cytogenetics
- Long strands of DNA with many genes (20-30 thousand)
- Diploid organisms have two copies of each chromosomes





Diploid chromosome number

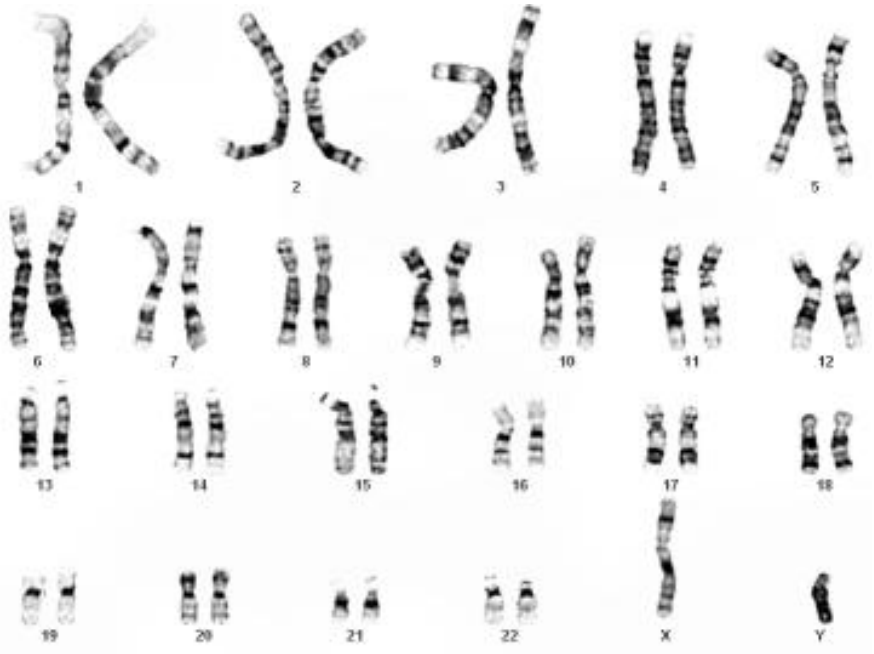
The human genome exists of 46 chromosomes

23 pairs

For each pair:

one comes from mum,
one comes from dad

Human Karyotype



Chromosome number

Species	Haploid (n)	Diploid (2n)
Humans	23	46
Dogs	39	78
Cattle	30	60
Sheep	27	54
Rye	7	14
Wheat	7	42 (6n)

Two types of Cell Division

- Mitosis - growth and renewal of body tissues

  make same copy of a cell 2n cell → another 2n cell

- Meiosis - production of gametes

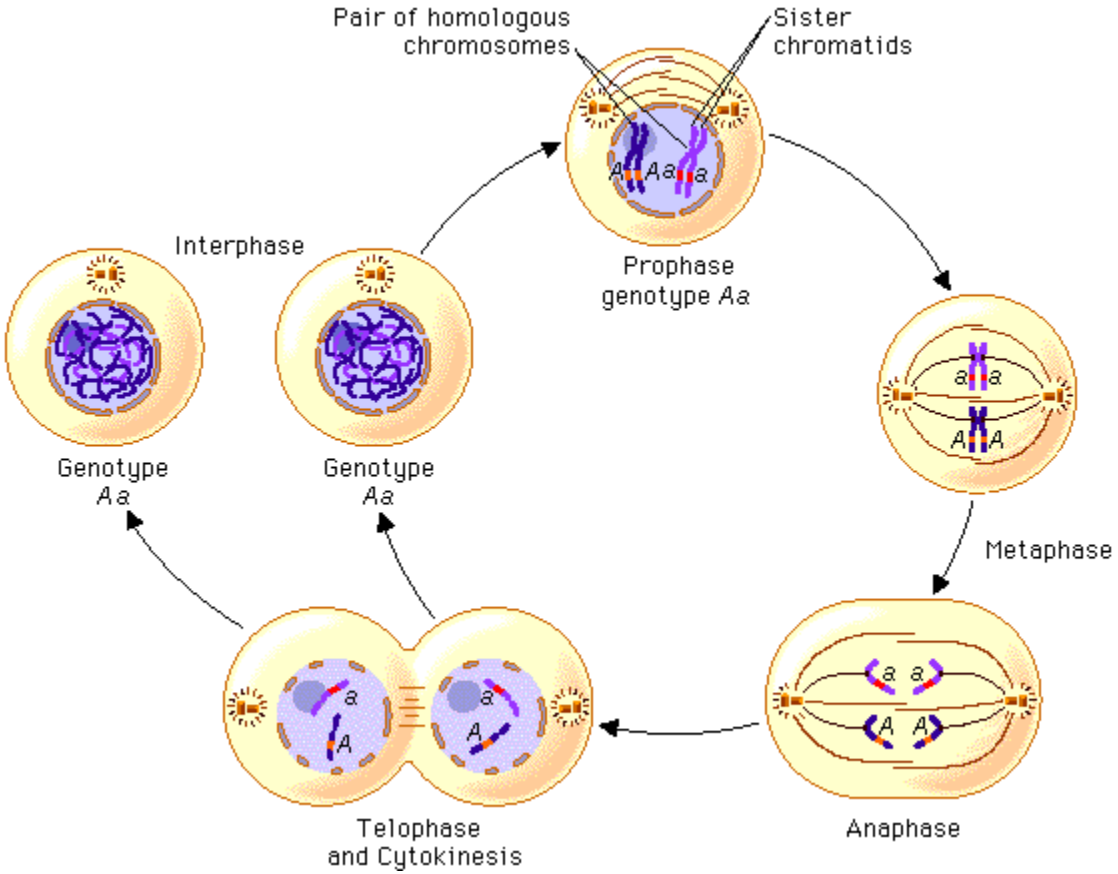
  Reduction division: one 2n cell → two n-cells

  a gamete gets one of the two chromosomes of each pair, either the maternal, or the paternal copy

  - Formation of spermatozoa in males and ova in females
  - Halving of chromosome number

Mitosis

Results in identical daughter cells



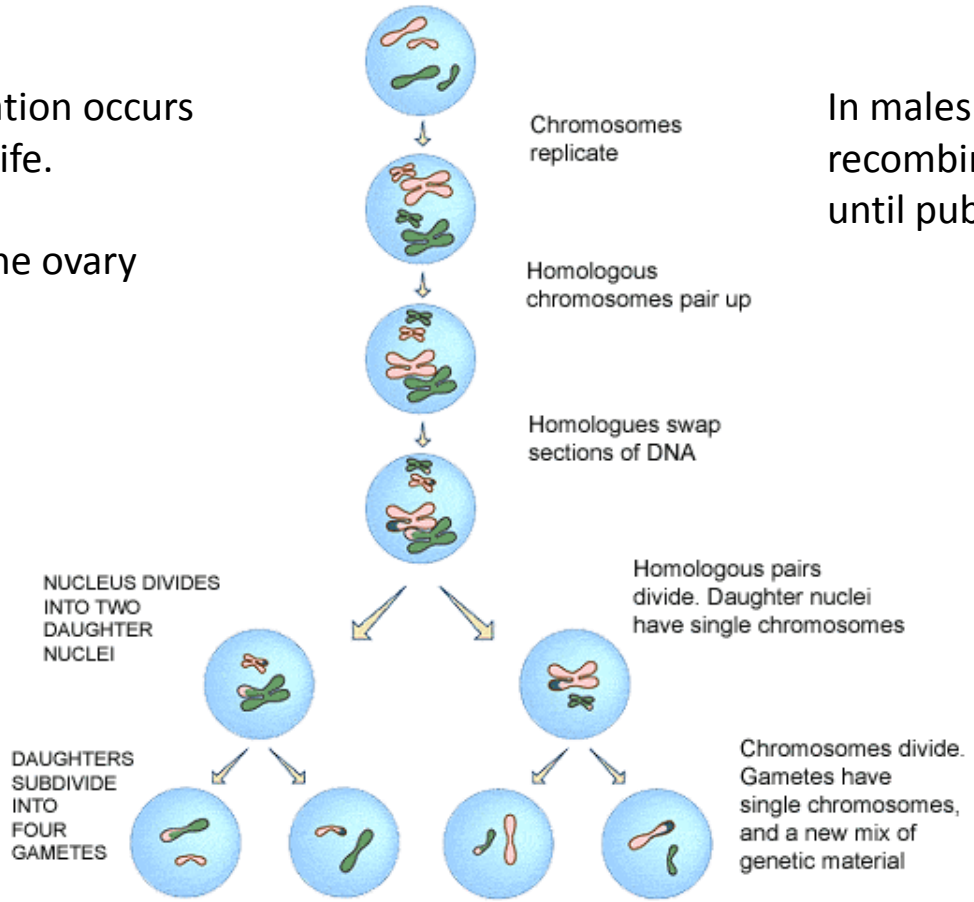
Meiosis

•Chromosome number is halved form the diploid number to the haploid number

•Recombination occurs - a major source of genetic variation

In females recombination occurs in mammals early in life.

Cells sit dormant in the ovary until puberty.



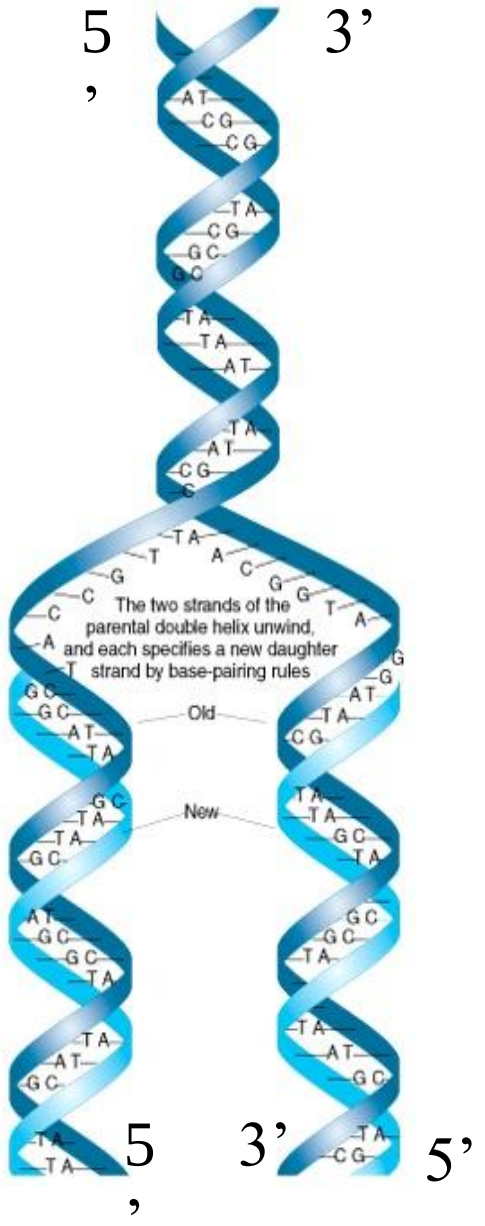
In males meiosis and recombination do not occur until puberty.

DNA- deoxyribonucleic acid

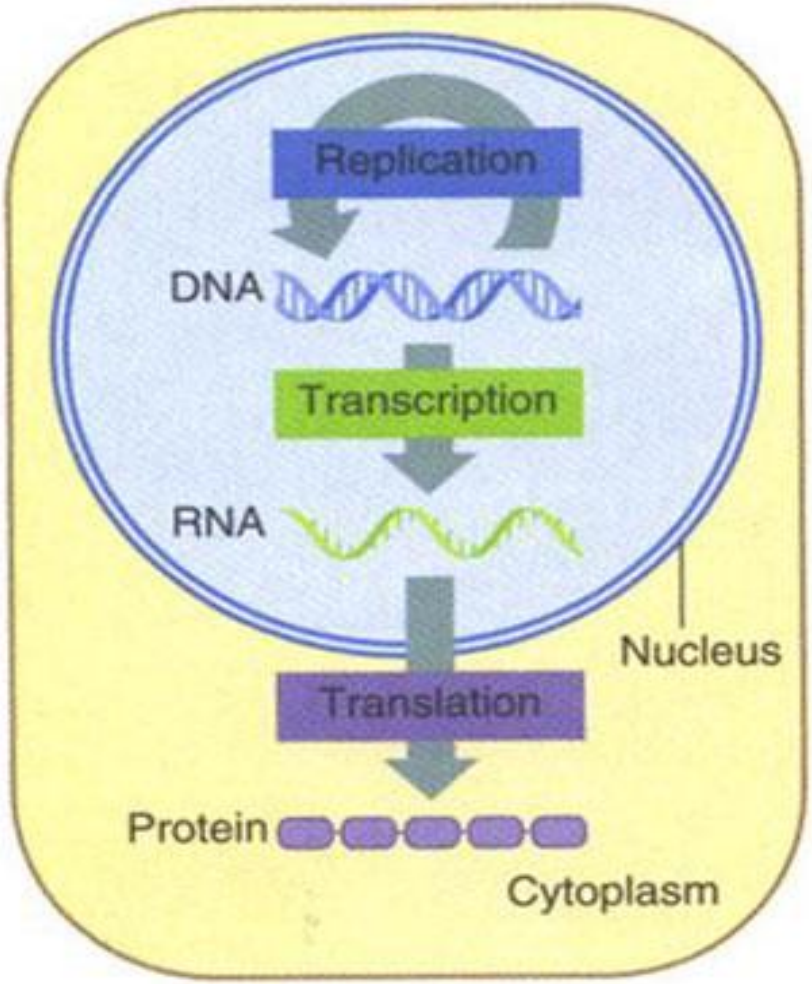
- Double helix that is directional
- Complimentary base pairing

  Adenine with Thymine A - T
  Cytosine with Guanine C - G

- Genes can be on either strand, they can be overlapping.



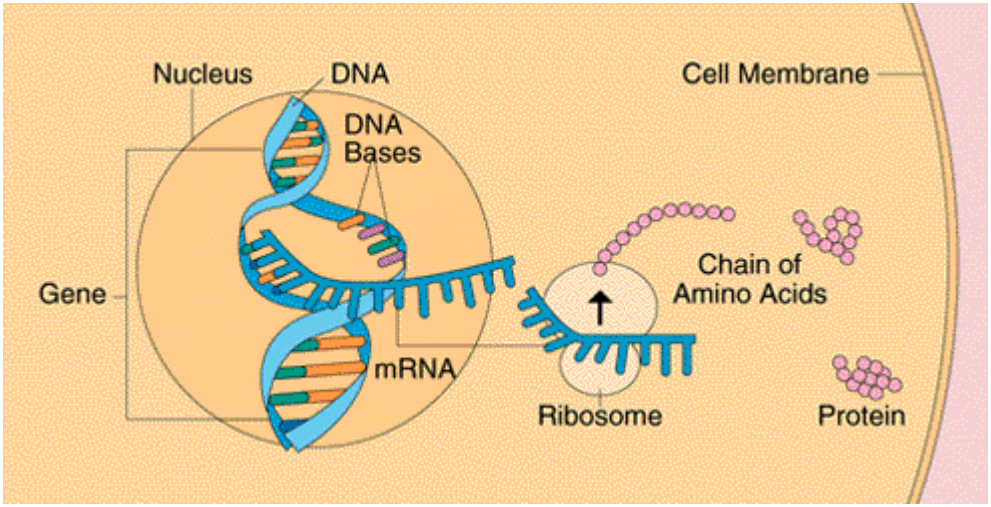
DNA to RNA to Protein – The Central Dogma of Genetics



Gene expression

- All Cells contain a nucleus with the full complement of DNA

  BUT
- Only a subset of genes are expressed in specialised cell types
- Many genes code for proteins that make up the various components of the cell
- Proteins are either structural proteins or enzymes in biochemical pathways



The Genetic Code

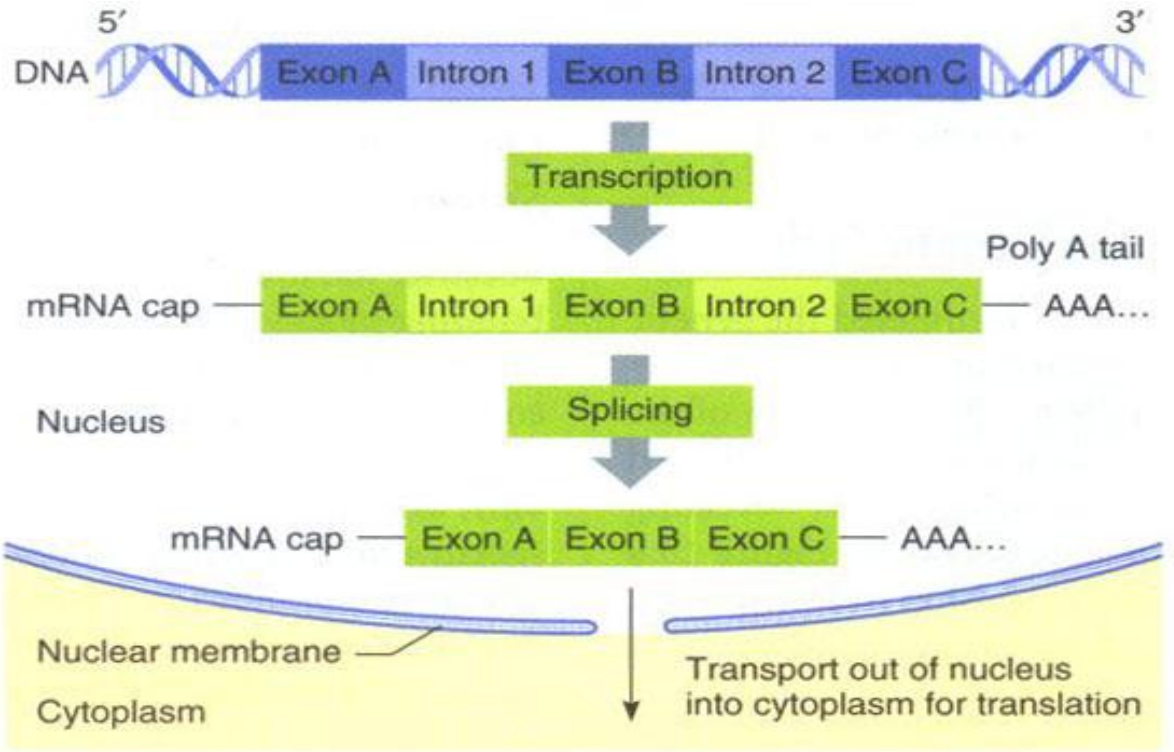
5' 1ST BASE	2ND BASE U	C	A	G
U	UUU phenyl alanine UUC UUA leucine UUG	UCU UCC UCA UCG serine	UAU tyrosine UAC UAA stop UAG	UGU cysteine UGC UGA stop UGG tryptophan
C	CUU CUC CUA CUG leucine	CCU CCC CCA CCG proline	CAU histidine CAC CAA glutamine CAG	CGU CGC CGA CGG arginine
A	AUU AUC AUA isoleucine AUG methionine	ACU ACC ACA ACG threonine	AAU asparagine AAC AAA lysine AAG	AGU serine AGC AGA arginine AGG
G	GUU GUC GUA GUG valine	GCU GCC GCA GCG alanine	GAU aspartic acid GAC GAA glutamic acid GAG	GGU GGC GGA GGG glycine

Gene structure

DNA

RNA

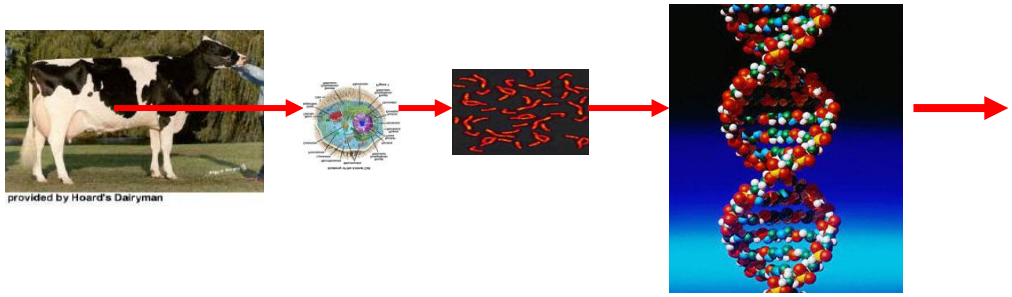
Protein

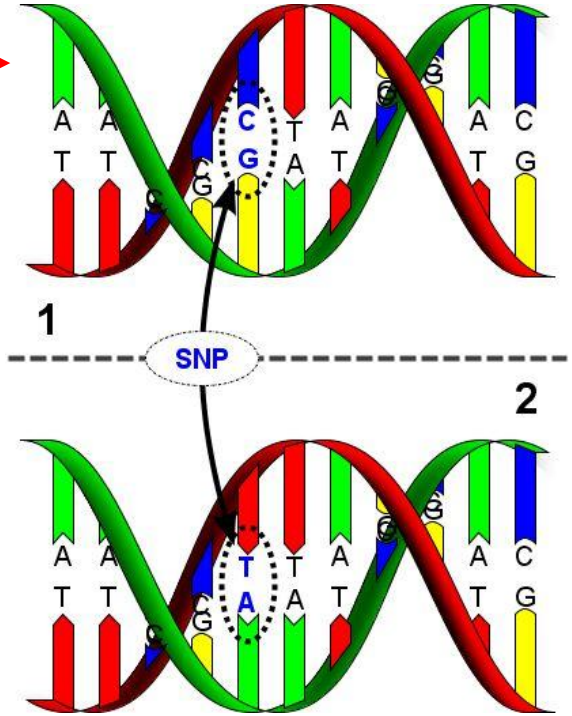


Alleles: different variants of a Gene - the basis of Genetic Variation

- Different versions of the same gene e.g. A and a
- Arise through mutation
- Individuals can be heterozygous or homozygous at each locus
- An individual is homozygous at a particular locus if it has the same allele on each chromosome e.g. AA or aa
- An individual is heterozygous at a particular locus if it has different alleles on each of the homologous chromosomes e.g. Aa or aA

Point mutations can affect proteins in different ways





Point mutations are “SNPs”:

single nucleotide polymorphisms

Silent mutation - synonymous mutation –
a base pair change without changing an amino acid
is still a “SNP”

Missense mutation - changes amino acid at a site

Nonsense mutation -changes an amino acid to a stop mutation

Sources of Genetic variation

- Chromosomal mutations
  - Usually deleterious

DNA sequence Mutations

- Give rise to new alleles of a gene
- point mutations
- deletions
- insertions
- inversions

Genotype vs Phenotype

Genotype is the complement of alleles for each of the genes inherited on chromosomes.

Phenotype

- Phenotype is the measured level for a trait in an individual or an observed category.
- Phenotype is a result of genotype and environmental interactions.