Veterinary Science

Preparatory Training for the Veterinary Assistant
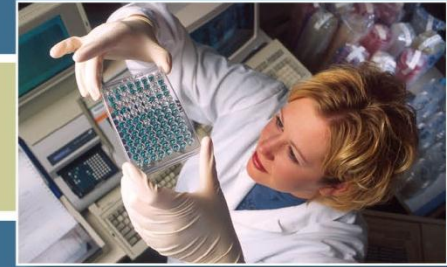
Floron C. Faries, Jr., DVM, MS

Genetics

Floron C. Faries, Jr., DVM, MS

Objectives

- Describe the structure of genetic material
- Describe the replication and expression of genetic material
- Discuss the role of biotechnology in the animal industries
- Describe the process of selection for convenience traits

A Science

- Genetics
  - Study of inheritance (heredity)
    - Inherited genetics
    - How characteristics are passed from generation to generation
  - Study of genetic codes of body cells
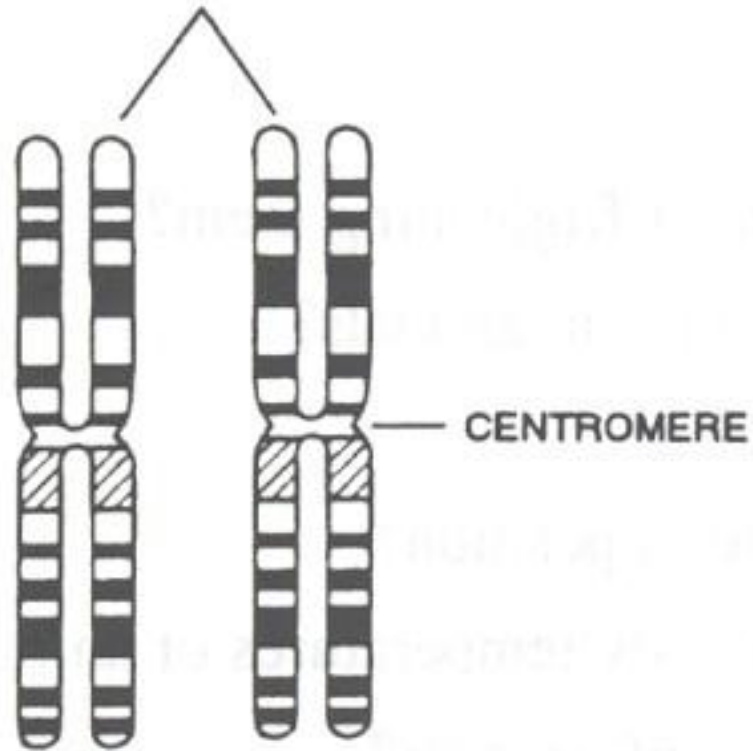   - Molecular genetics
- Heredity
  - Transmission of characteristics from parent to offspring
  - By means of genes on chromosomes in nucleus of body cells
  - Controlled by genes (DNA)

IN A CELL, A CHROMOSOME PAIR CARRYING A GENE PAIR WITH DIFFERENT ALLELES (A,a) FOR A SPECIFIC TRAIT.

GENOTYPES AND PHENOTYPES
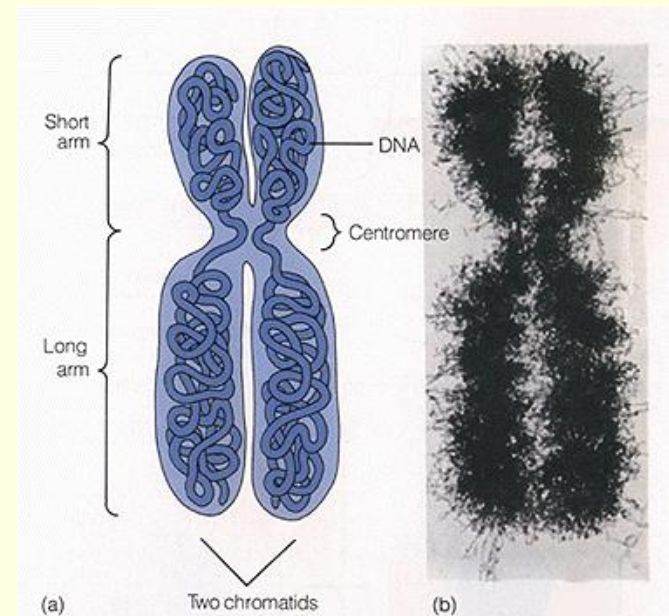
HOMOLOGOUS
CHROMOSOMES

CENTROMERE

HOMOLOGOUS CHROMOSOMES CARRY
THE SAME GENES, BUT MAY HAVE THE
DOMINANT OR RECESSIVE FORM.
MAMMALIAN CHROMOSOMES CARRY
APPROXIMATELY 3000 GENES.

Chromosomes

- Occur in pairs
  - One from paternal parent
  - One from maternal parent
- Made of DNA with a strand of 4 nucleotide bases

Short arm — DNA

Centromere

Long arm

(a) Two chromatids   (b)

Genes (Traits)

- Occur in pairs on chromosome pairs
  - One from each parent
- Stores information on chromosomes
  - Tells cell how to build protein (good or bad)
- Proteins made are coded by specific genes
  - Genetic code of nucleotide bases

Alleles

- Alternative copy of same gene
    - Dominant or recessive
    - Protein construction slightly different
    - Function slightly different

- Different forms
    - Co-dominant
    - Co-recessive
    - One dominant and one recessive

- Recessive genes expressed if no dominant genes
    - May be good or bad

Genetic Code

- Combination and order of nucleotide bases
  - In DNA of chromosomes in nucleus of body cells
- Ordered by genes to build proteins

Nucleotide Bases

- Found in DNA of chromosomes
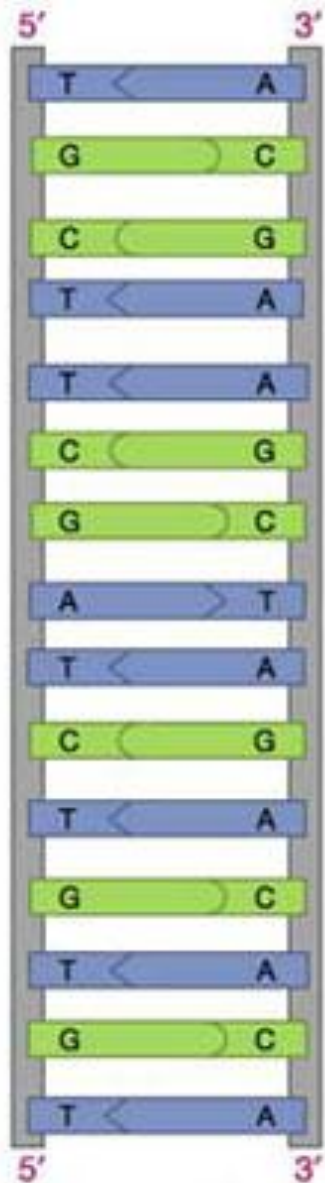- Bind on pairs of chromosome strands
- Building blocks of genetic code

DNA   DNA

Adenine --- Thymine

Thymine --- Adenine

Cytosine --- Guanine

Guanine --- Cytosine

5′		3′	5′		3′
T		A	T		A
G		C	G	C	
C		G	C	G	
T		A	A		T
T		A	A		T
C		G	C		G
G		C	G		
A		T	A	T	
T		A	T		A
C		G	C		G
T		A	T		A
G		C	G		
T		A	A	T	
G		C	C		G
T		A	A		T
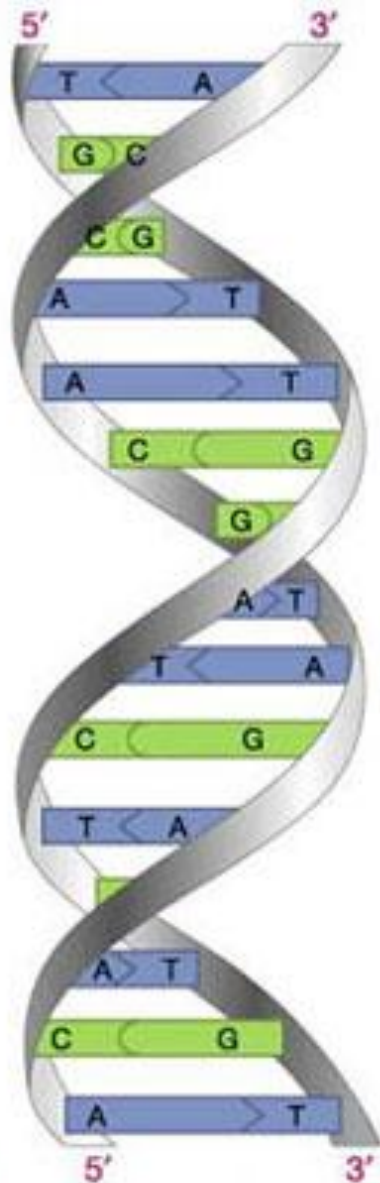
Cartoon of base pairing	Cartoon of double helix	Space-filling model of double helix

Transcription

- To make protein from nucleotide code of RNA copy of chromosome DNA
  - RNA strand copy binds with DNA strand
  - Messenger RNA (mRNA)
    - Leaves nucleus
    - Shuttles between nucleus and cytoplasma of cell

DNA   RNA

Adenine --- Uracil

Thymine --- Adenine

Cytosine --- Guanine

Guanine --- Cytosine

Complementary DNA strands   RNA strand
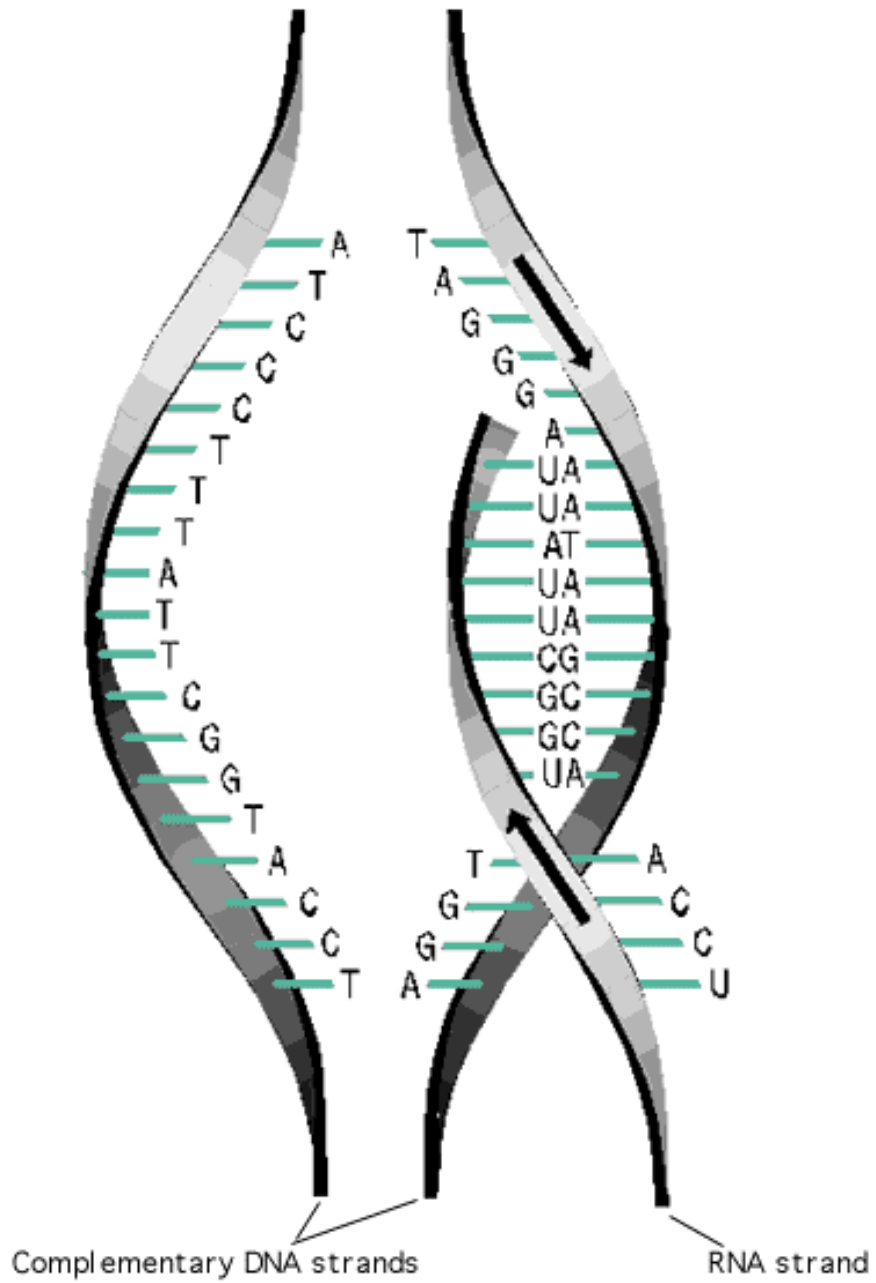
Translation

- Process of protein synthesis from the code on mRNA

- Ribosome in cytoplasma bind to mRNA to read code

- Produces strand of amino acids = protein

- Code of 3 nucleotide bases = codon

Second Letter

1st letter	U	C	A	G	3rd letter
U	UUU UUC Phe / UUA UUG Leu	UCU UCC UCA UCG Ser	UAU UAC Tyr / UAA UAG Stop Stop	UGU UGC Cys / UGA Stop / UGG Trp	U C A G
C	CUU CUC CUA CUG Leu	CCU CCC CCA CCG Pro	CAU CAC His / CAA CAG Gln	CGU CGC CGA CGG Arg	U C A G
A	AUU AUC AUA Ile / AUG Met	ACU ACC ACA ACG Thr	AAU AAC Asn / AAA AAG Lys	AGU AGC Ser / AGA AGG Arg	U C A G
G	GUU GUC GUA GUG Val	GCU GCC GCA GCG Ala	GAU GAC Asp / GAA GAG Glu	GGU GGC GGA GGG Gly	U C A G

•**The start codon is AUG. Methionine is the only amino acid specified by just one codon, AUG.**
•**The stop codons are UAA, UAG, and UGA. They encode no amino acid. The ribosome pauses and falls off the mRNA.**

GAG	TTT	TAT	ATC	ACT	TAC	GAC	TAA	CAG	TTA	ACA	CTT	TCG	GAC	CTT	CAA	AAT	GCT	ACT
|||	|||	|||	|||	|||	|||	|||	|||	|||	|||	|||	|||	|||	|||	|||	|||	|||	|||	|||
CUC	AAA	AUA	UAG	UGA	AUG	CUG	AUU	GUC	AAU	UGU	GAA	AGC	CUG	GAA	GUU	UUA	CGA	UGA

Body Cells Divide

- Mitosis – 2 cells with copies of chromosome pairs (diploid)

- Meiosis- 4 cells with copies of chromosome singles (haploid)
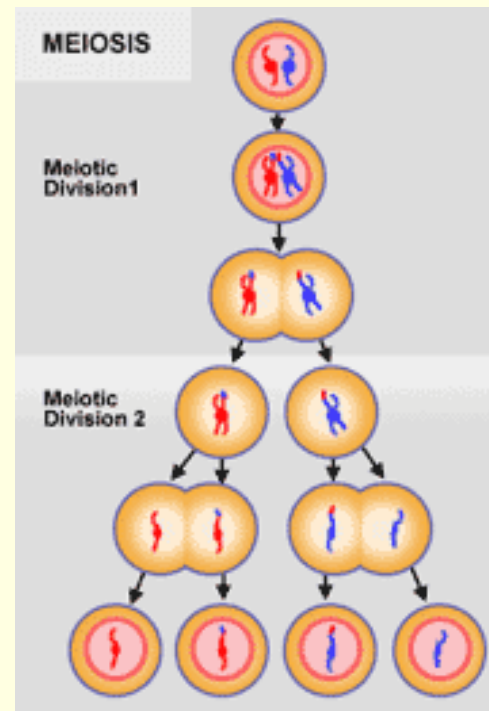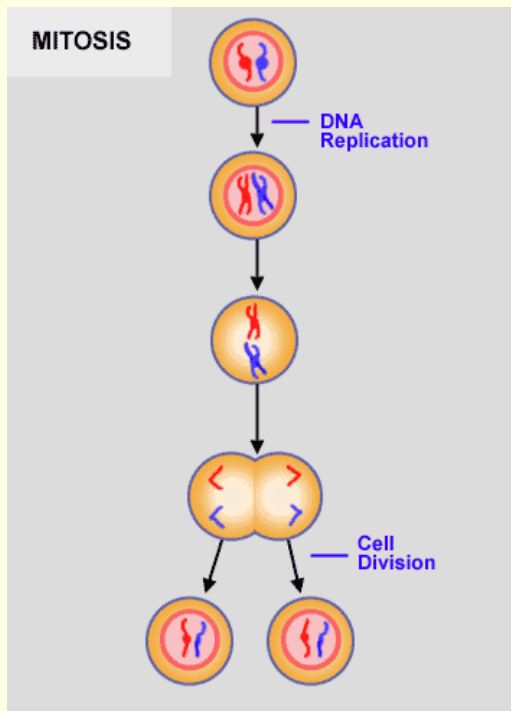
Reproduction

- Transfer of haploids from both parents' (gametes) to form embryo (diploid)

- Phenotype
  - A particular trait that is observed
- Genotype
  - Genetic makeup of a single trait
  - Not visible

Expression of Genes (Phenotype)

- Homozygous
  - Genes are alike
    - Dominant alleles
      - **PP**
    - Recessive alleles
      - **pp**
- Heterozygous
  - Genes are different
    - One dominant and one recessive alleles
      - **Pp**
  - Carriers

F₁ CROSS

PHENOTYPE: POLLED   X   POLLED

GENOTYPE: Pp   X   Pp

	P	p
P	1/4 POLLED PP	1/4 POLLED Pp
p	1/4 POLLED Pp	1/4 HORNED pp

3/4 POLLED   (1/4 HOMOZYGOUS 1/2 HETEROZYGOUS)

1/4 HORNED   (HOMOZYGOUS)

AA x AA
Black x Black

Sire

	A	A
Dam		
A	A A Black	A A Black
A	A A Black	A A Black

All black

AA x AA

AA

AA

AA   AA   AA   AA

AA x aa
Black x Red

Sire

	A	A
a	A a Black	A a Black
a	A a Black	A a Black

Dam

All black

AA x aa

AA

aa

Aa   Aa   Aa   Aa

Aa x Aa
Black x Black

Sire

	A	a
A	A A Black	A a Black
a	A a Black	a a Red

Dam

¾ Black

¼ Red

Aa x Aa

Aa

Aa

AA   Aa   Aa   aa

Aa x aa
Black x Red

Sire

	A	a
a	A a Black	a a Red
a	A a Black	a a Red

Dam

½ Black

½ Red

Aa x aa

Aa

aa

Aa   Aa   aa   aa

Biotechnology

- A science- study of techniques
- Genetic Engineering (Biotechnology)
  - Gene mapping
  - Recombinant DNA processes – produces vaccines, hormones, tests
  - Gene deletion – produces vaccines
  - Gene transfer – produces improved production and resistance
  - Nuclear transfer – produces cloning (twinning)