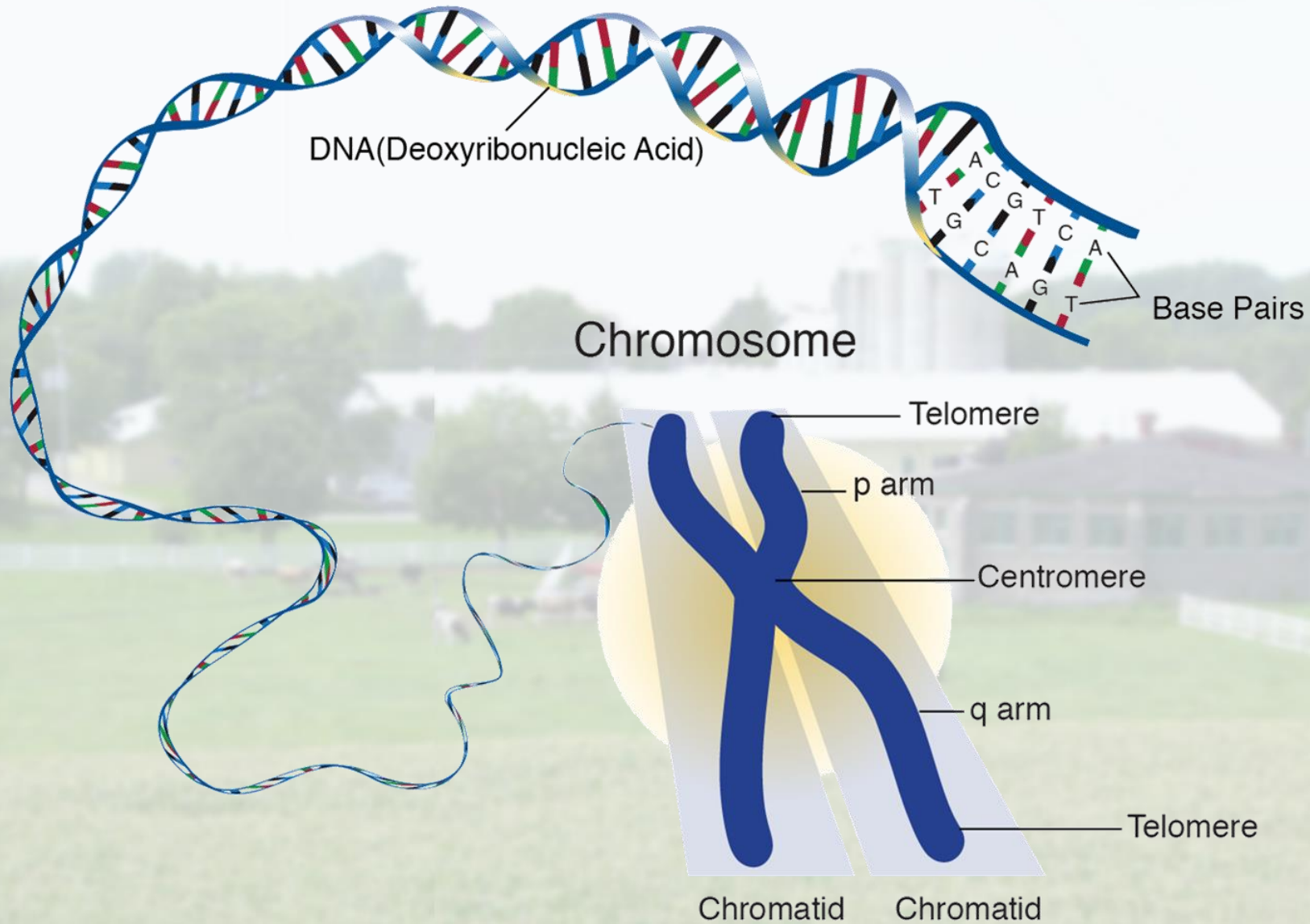


©Addison Wesley Longman, Inc.

Haploid
Dominant
Allele
Chromosome
Heterozygous
Diploid
Locus Recessive
Gene
Homozygous

Chromosomes



Chromosomes

- primary vehicle of inheritance
- passed from one generation to the next
- exist mostly in similar pairs = homologous chromosomes
- contain genes
- have a haploid / diploid number which is constant within a species...

Human = 46 (23 pairs)

Cattle = 60 (30 pairs)

Sheep = 54 (27 pairs)

Swine = 38 (19 pairs)

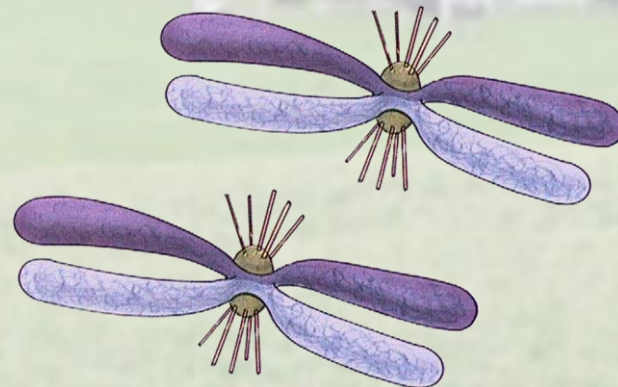
Poultry = 80* (40 pairs)

Horse = 64 (32 pairs)

Donkey = 62 (31 pairs)

Zebra = 32 (16 pairs)

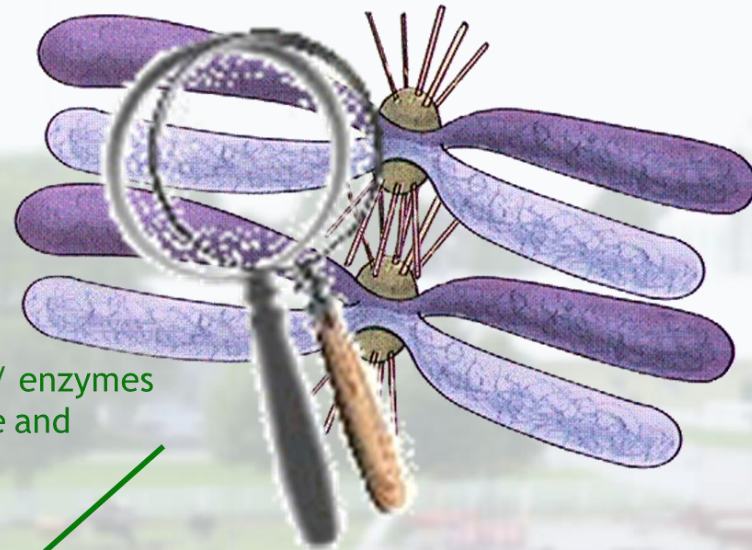
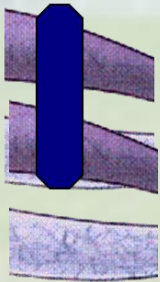
Harbour Seal = 32 (16 pairs)



Gene and Locus

Gene

- basic unit of inheritance
- can control a single trait
- normally controls synthesis of proteins / enzymes
- numbers vary with specific chromosome and species



Locus

- physical location/position of a gene on a chromosome
- equivalent location on homologous chromosomes

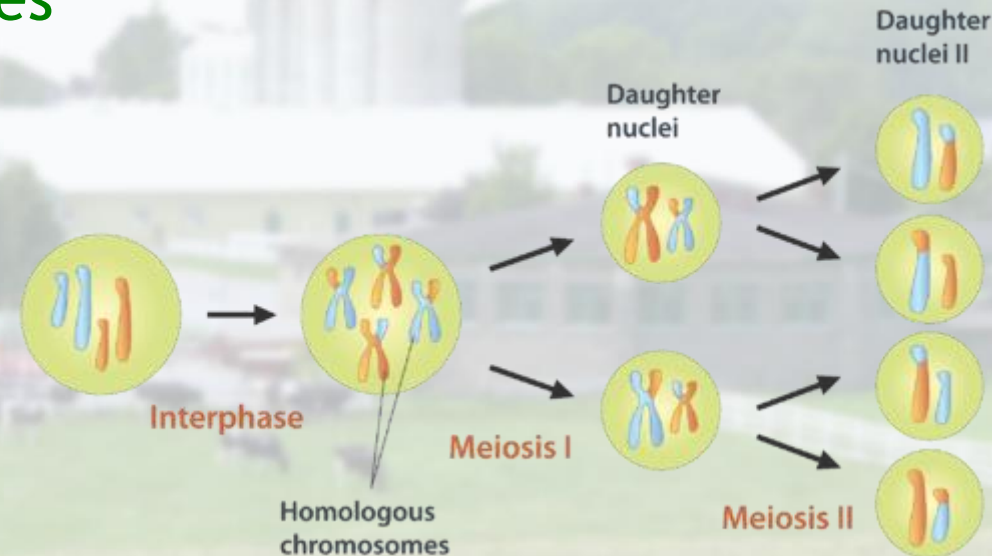


Mendel's First Law...

The Law of Segregation

- Individuals transmit $\frac{1}{2}$ their genes

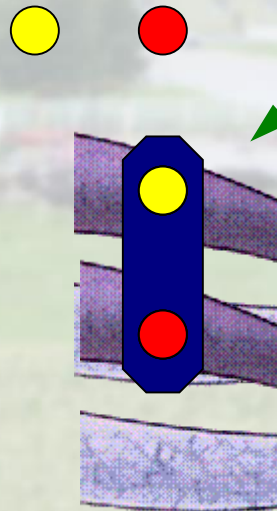
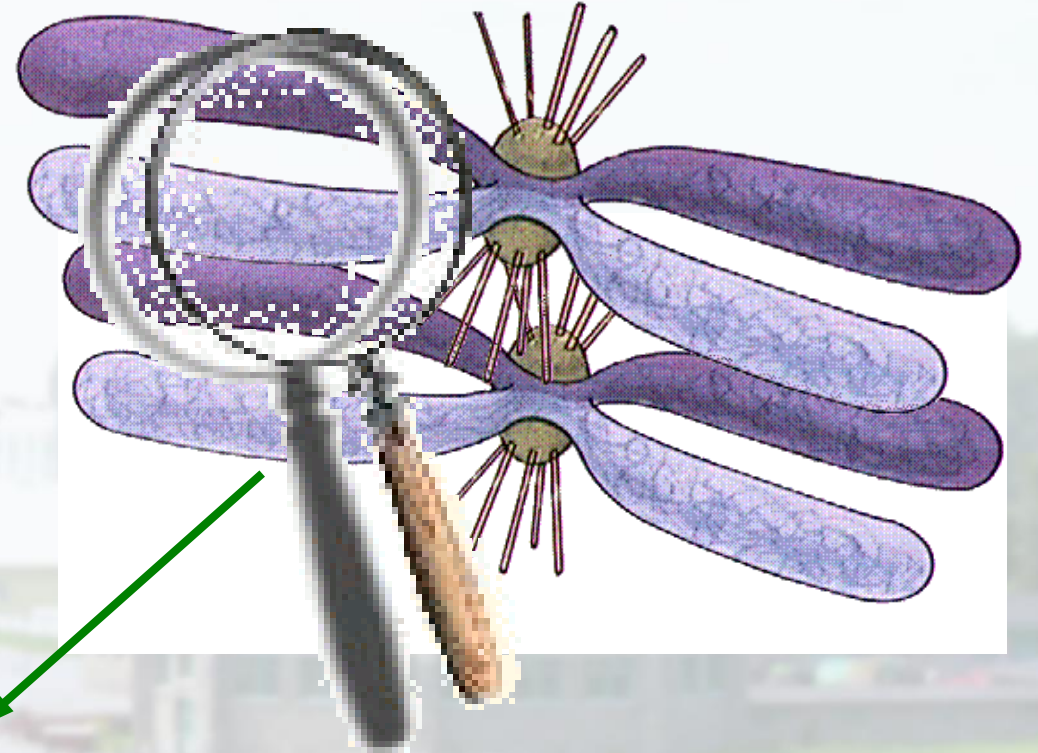
- Segregation occurs at meiosis



- Genes can segregate in all possible combinations

Alleles

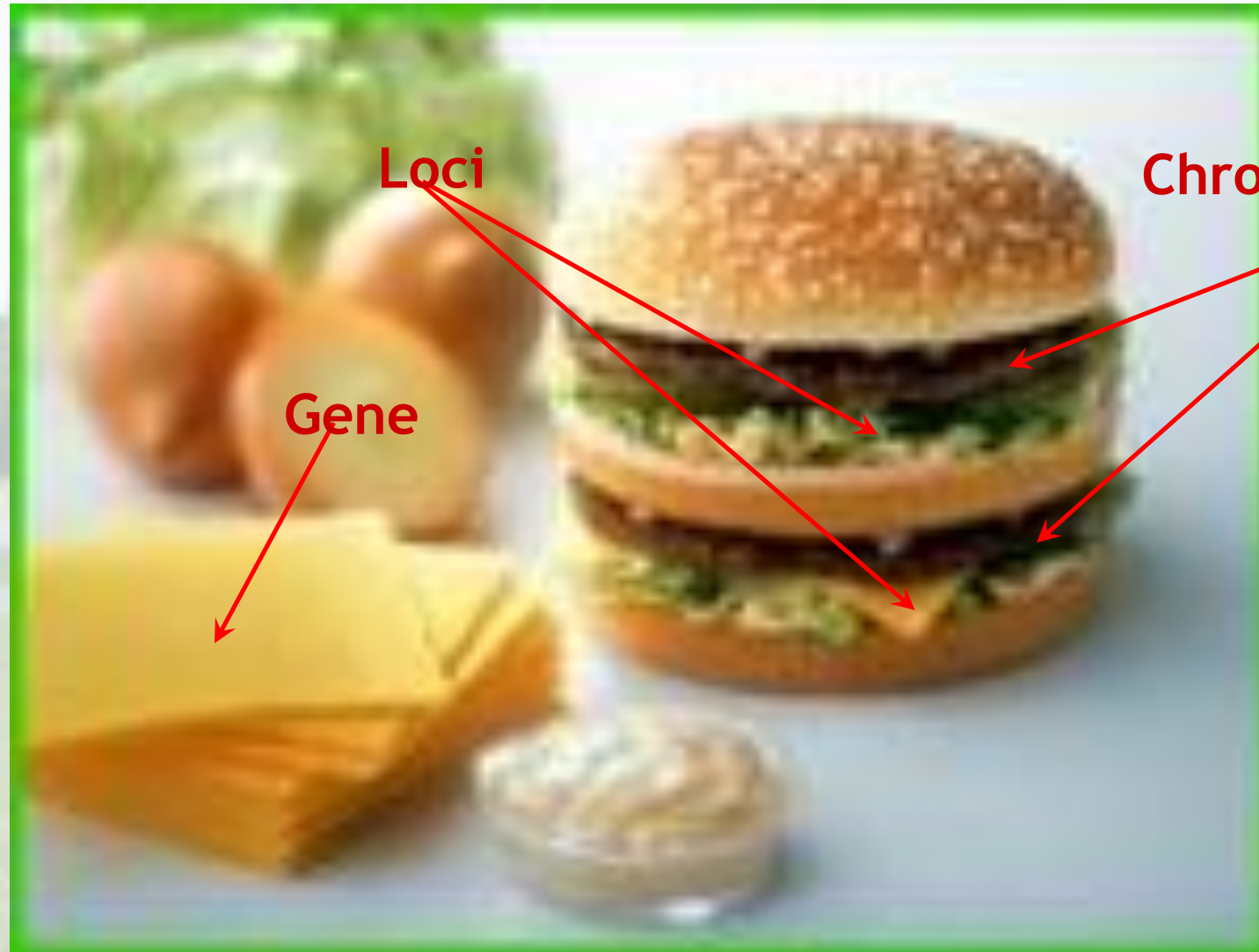
- alternate form of a gene
- “options” or “choices” for a gene at a given locus
- even though on the same locus they can have different structures and effects



Chromosomes, genes, loci and alleles...

Alleles ?

Cheddar
Swiss
Gouda
Emmental
etc.



Chromosome pair



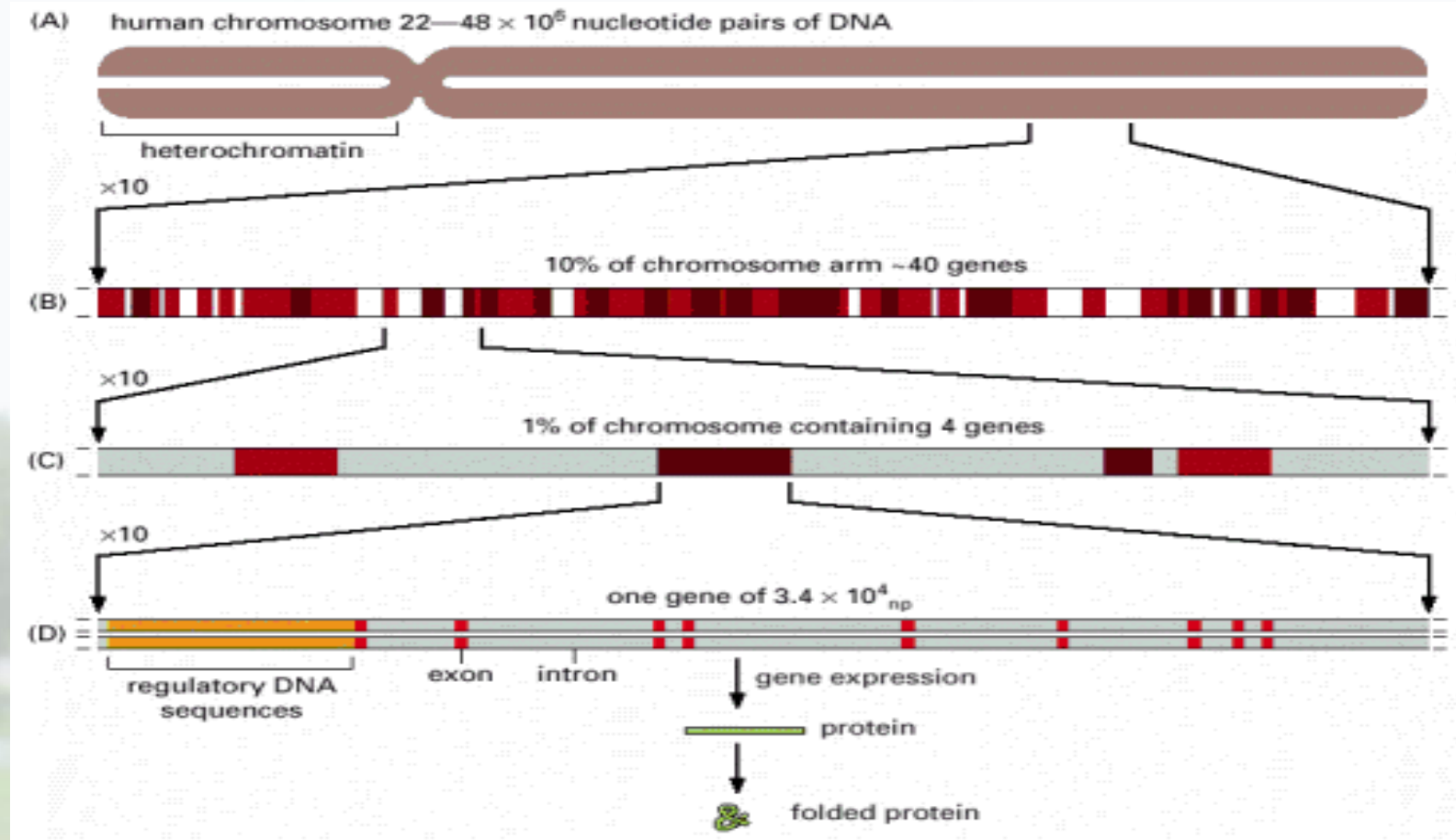
The Human Genome (human's genetic material)

The entire human genome contains about 3.2 Billion nucleotide pairs

These are distributed over 46 chromosomes (44 autosomal and 2 sex chromosomes).

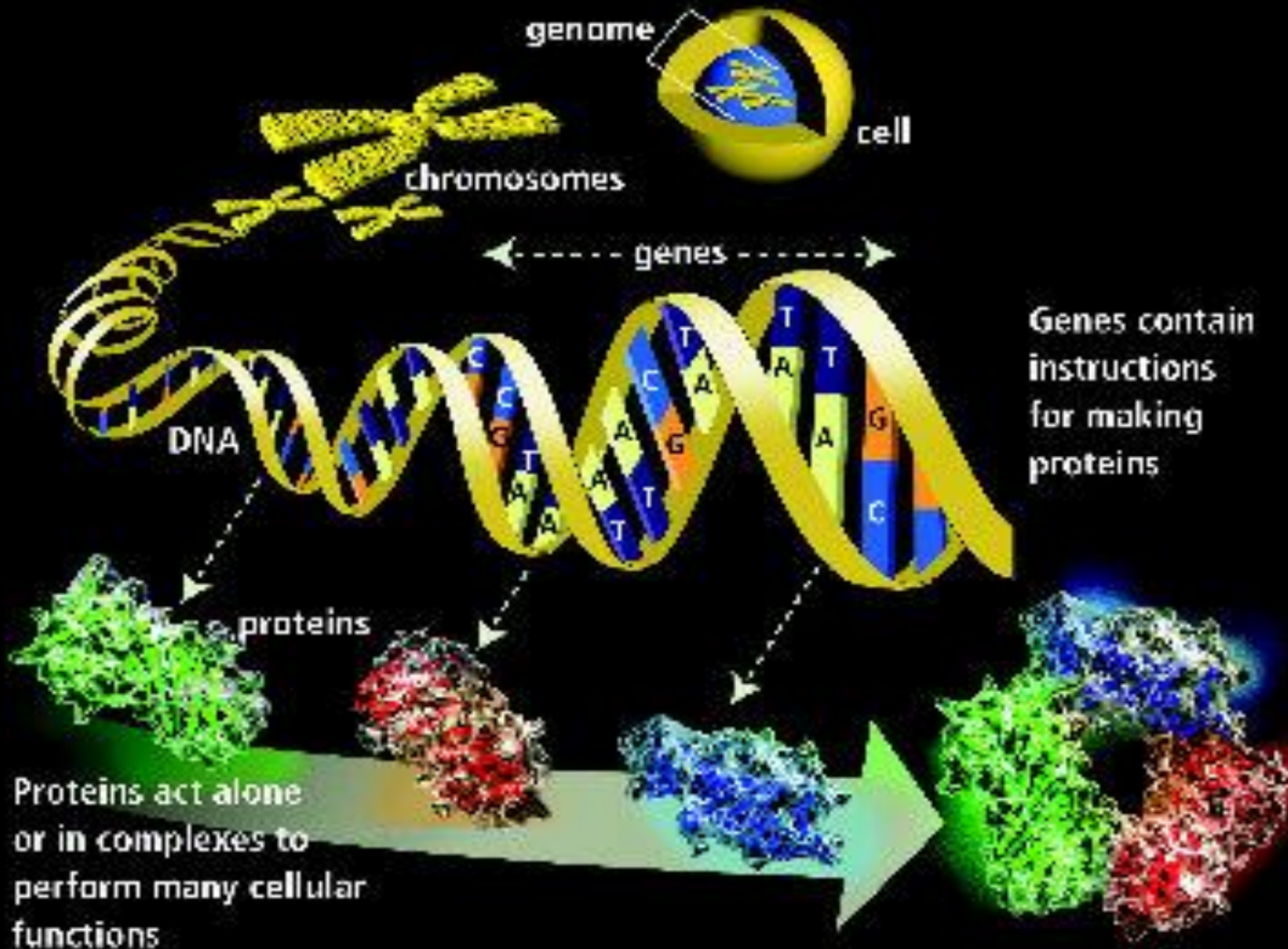
Humans differ from one another by an average of one nucleotide in every thousand.

Organization of genes inside a chromosome

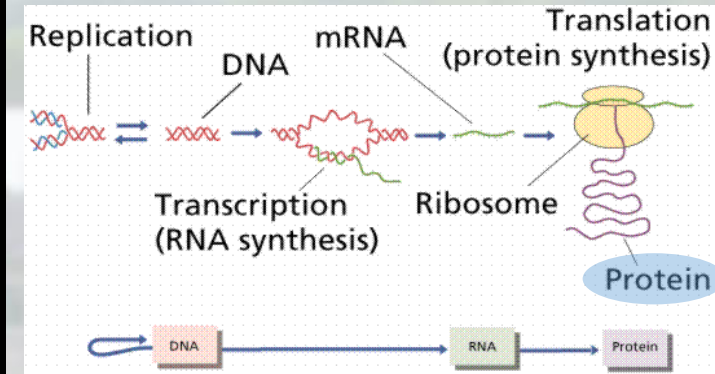


- (A) Chromosome 22, one of the smallest human chromosomes, contains 48 million nucleotide pairs and makes up approximately 1.5% of the entire human genome.
- (B) (B) A tenfold expansion of a portion of chromosome 22, with about 40 genes indicated. Those in *dark brown* are known genes and those in *light brown* are predicted genes.
- (C) (C) An expanded portion of (B) shows the entire length of several genes.
- (D) (D) A typical gene is shown after a further tenfold expansion. Each exon (*red*) codes for a portion of the protein, while the DNA sequence of the introns (*gray*) is relatively unimportant. *Nature* 409:860 921, 2001

Genes Make Proteins...



The information for making proteins is stored in DNA. There are processes (transcription and translation) by which DNA is converted into protein.

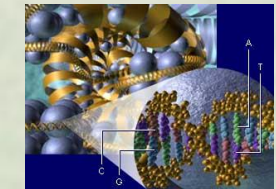
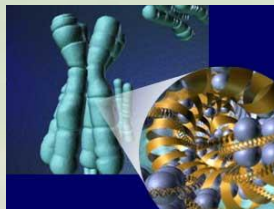
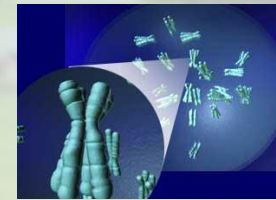
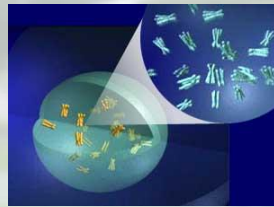
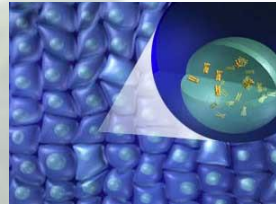
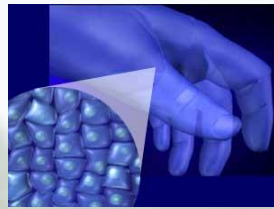


Genotype versus Phenotype

Genotype

Genetic makeup of an individual

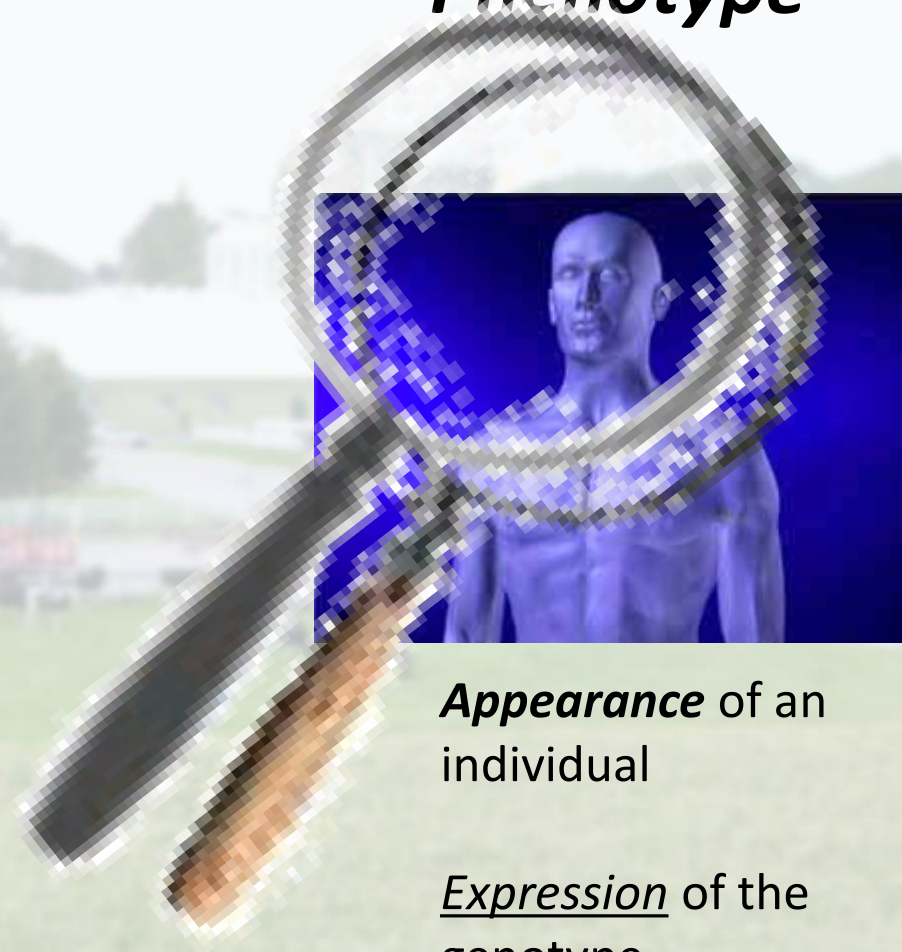
- overall
- for a specific trait



Phenotype

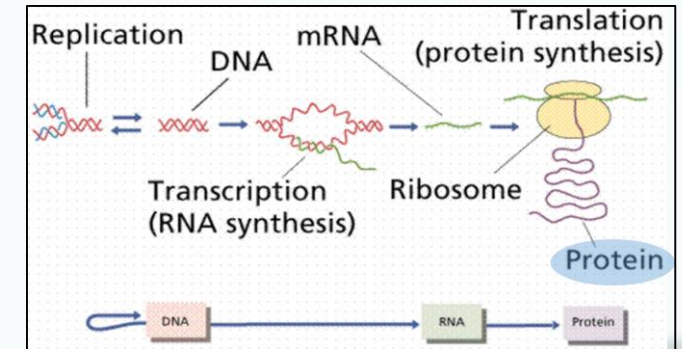
Appearance of an individual

Expression of the genotype



From protein to the phenotype: the expression of the trait

- Horns (keratin)



- Dwarfism (deficient bone formation)

- Color of hair (pigments)



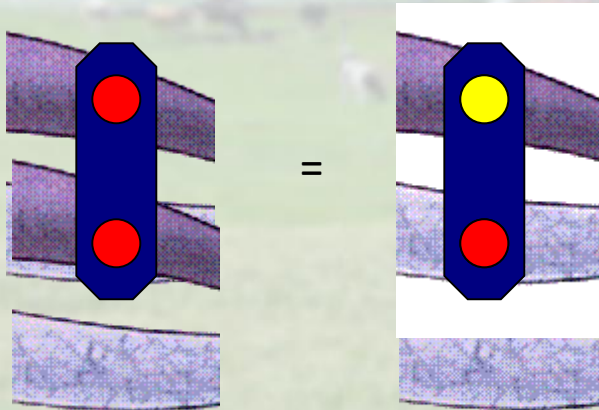
- Milk Protein (caseins)



Dominance...

The presence of one allele at a locus prevents (or inhibits) the expression of another allele at the same locus

If  > 



for phenotype

Fleece Appearance in Sheep



“Hairy”



“Wooly”

? Alleles:

H or h

Notation...

UPPER CASE is for dominant

lower case is for recessive

Notation...

UPPER CASE is for dominant

lower case is for recessive

Fleece Appearance in Sheep



“Hairy”

>



“Wooly”

Hairy (HH, Hh, or hH)

Wooly (hh)

Hairy is dominant to Wooly

Fleece Appearance in Sheep



“Hairy”

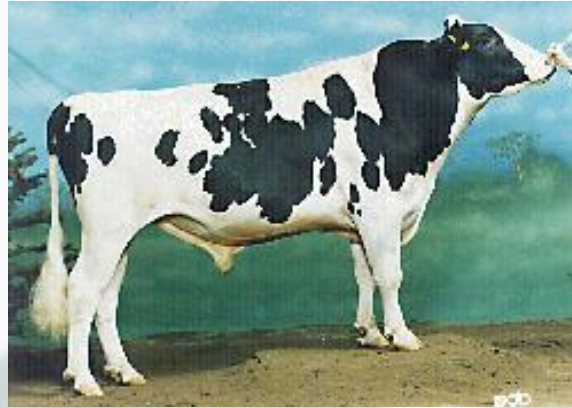


“Wooly”

Mendel's
1st Law

-
- 2 Alleles: H or h
 - 3 Genotypes: HH, Hh or hH and hh
 - 2 Phenotypes: “Hairy” = (HH, Hh or hH)
“Wooly” = (hh)

Coat Colour in Holstein Cattle



Black and White (BB, bB or Bb)

>



Red and White (bb)

“Polled” Condition in Hereford Cattle



Polled (PP, pP or Pp)

>



Horned (pp)

Comb shape in Poultry



>



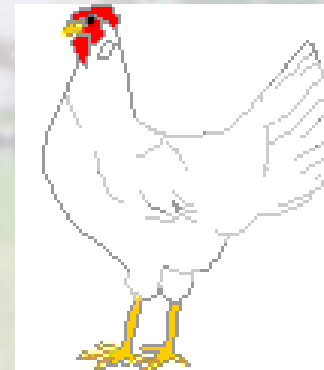
“Pea” shaped comb (PP, pP or Pp)

“Single” shaped comb (pp)

Feather colour in Chickens



>



“Colour” (CC, cC or Cc)

“No Colour” (cc)

Coat Colour in Swine



Black

>

“Pink”

Black (BB, Bb or bB)

“Pink” (bb)

Black is dominant to “Pink”

Examples of simple (qualitative) inherited traits in domestic animals

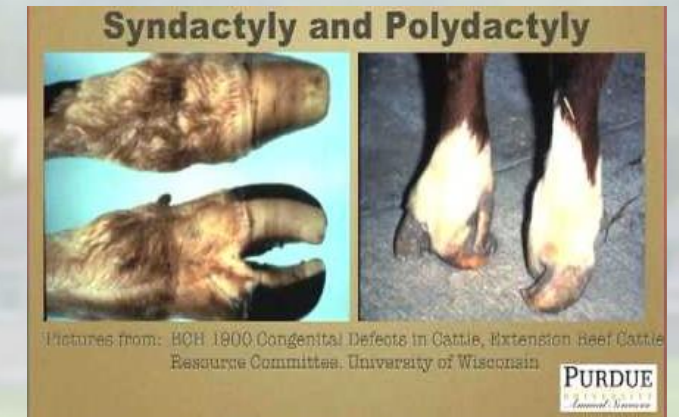
SWINE: Porcine Stress Syndrome (PSS), Skin colour, Coat pattern

CATTLE: Dwarfism, Mulefoot (syndactylism), Double muscling, Bovine Leukocyte Adhesion Deficiency (BLAD), Weaver Syndrome, Hair colour, Horns, Coat pattern, Milk proteins, Complex vertebral malformation (CVM)

SHEEP: Multiple Ovulations (Boroola gene), Callipyge gene, Horns

HORSES: Hemolytic disease, Combined Immune Deficiency

POULTRY: Skin colour, Egg colour, Slow and rapid feathering



Callipyge = “Beautiful Butt”

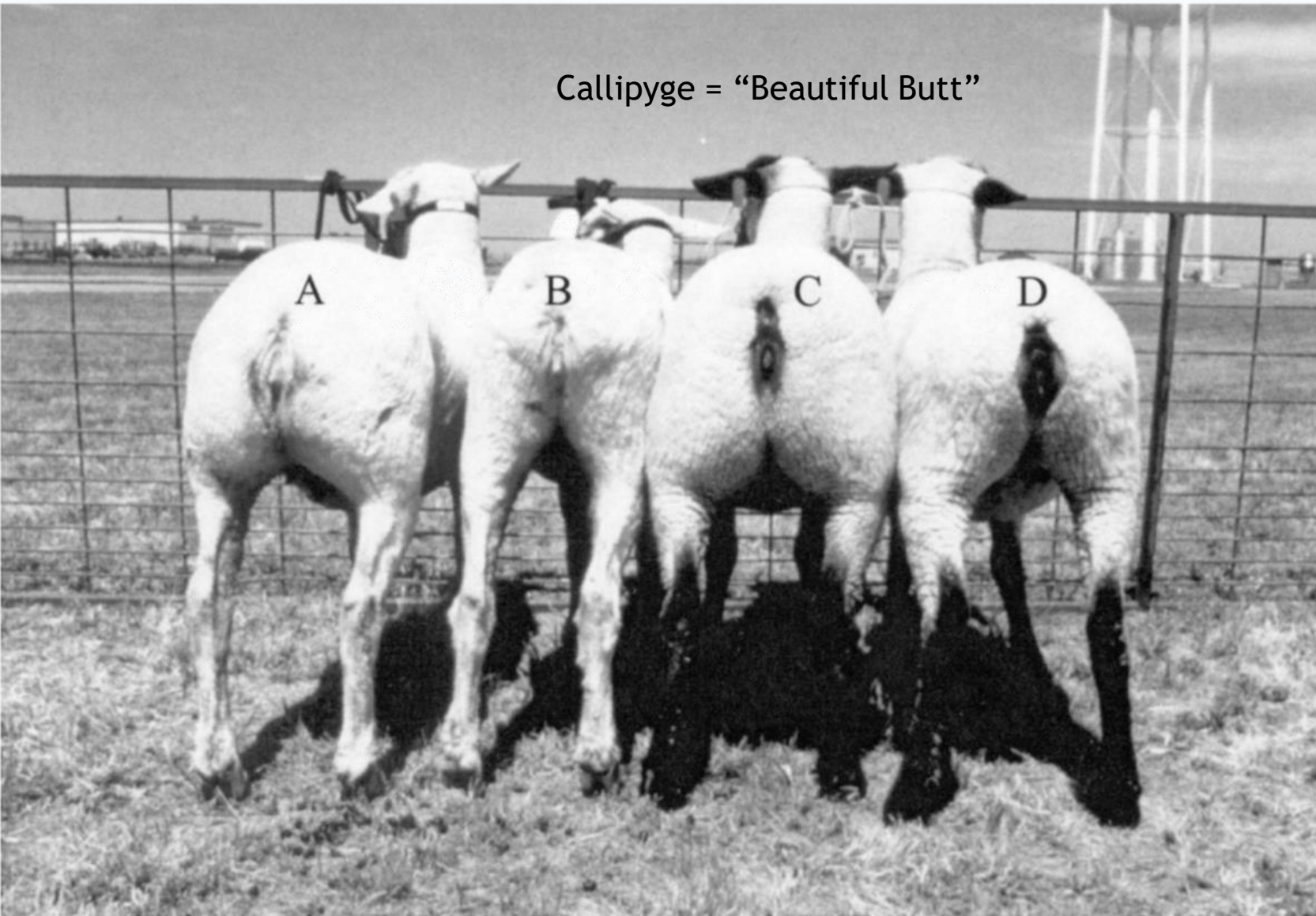


Figure 1. Rambouillet (A,B) and Hampshire (C,D) ewes expressing callipyge (A,C) and normal (B,D) phenotypes.

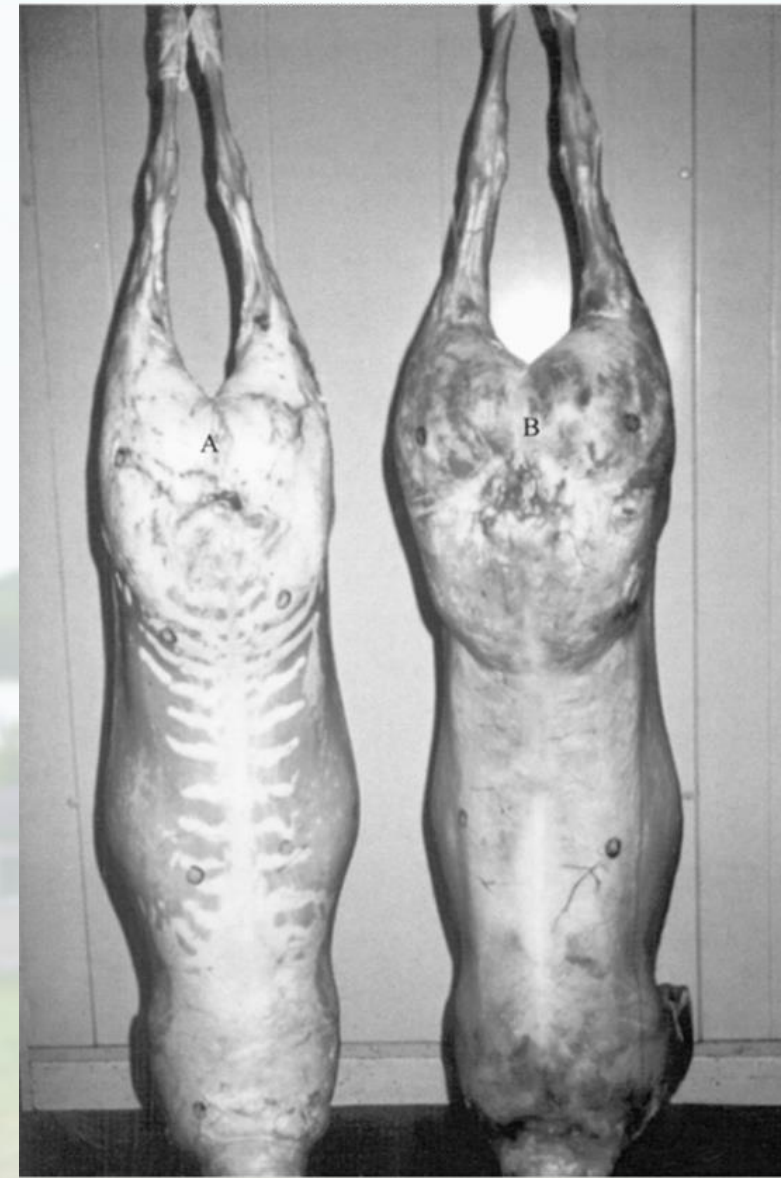
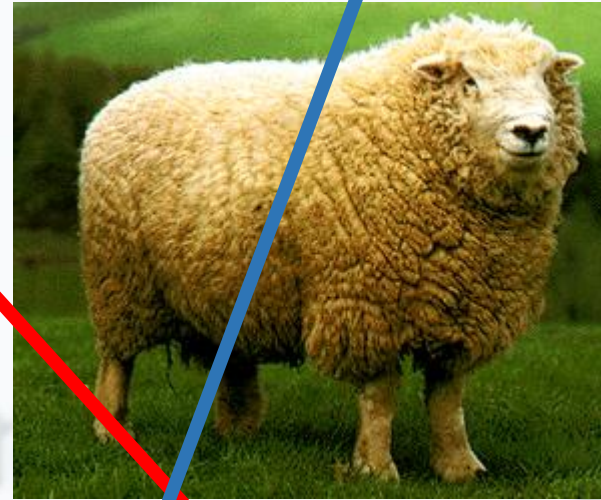


Figure 2. Normal (a) and callipyge (B) Rambouillet carcasses.

Dominant, Recessive, and Heterozygous



"Hairy"



"Wooly"

Alleles:

H or h

Genotypes:

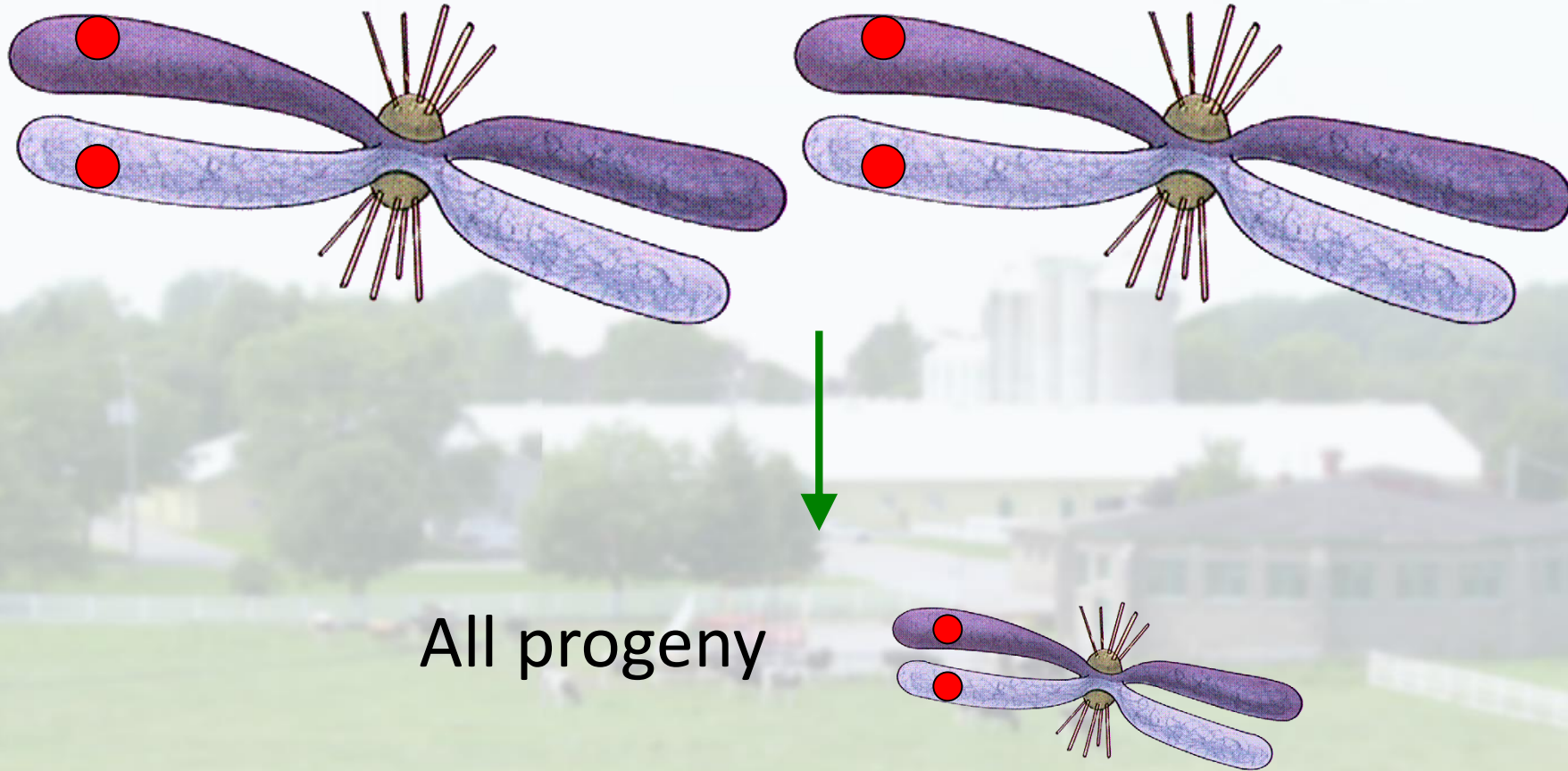
HH, Hh or hH and hh

Phenotypes:

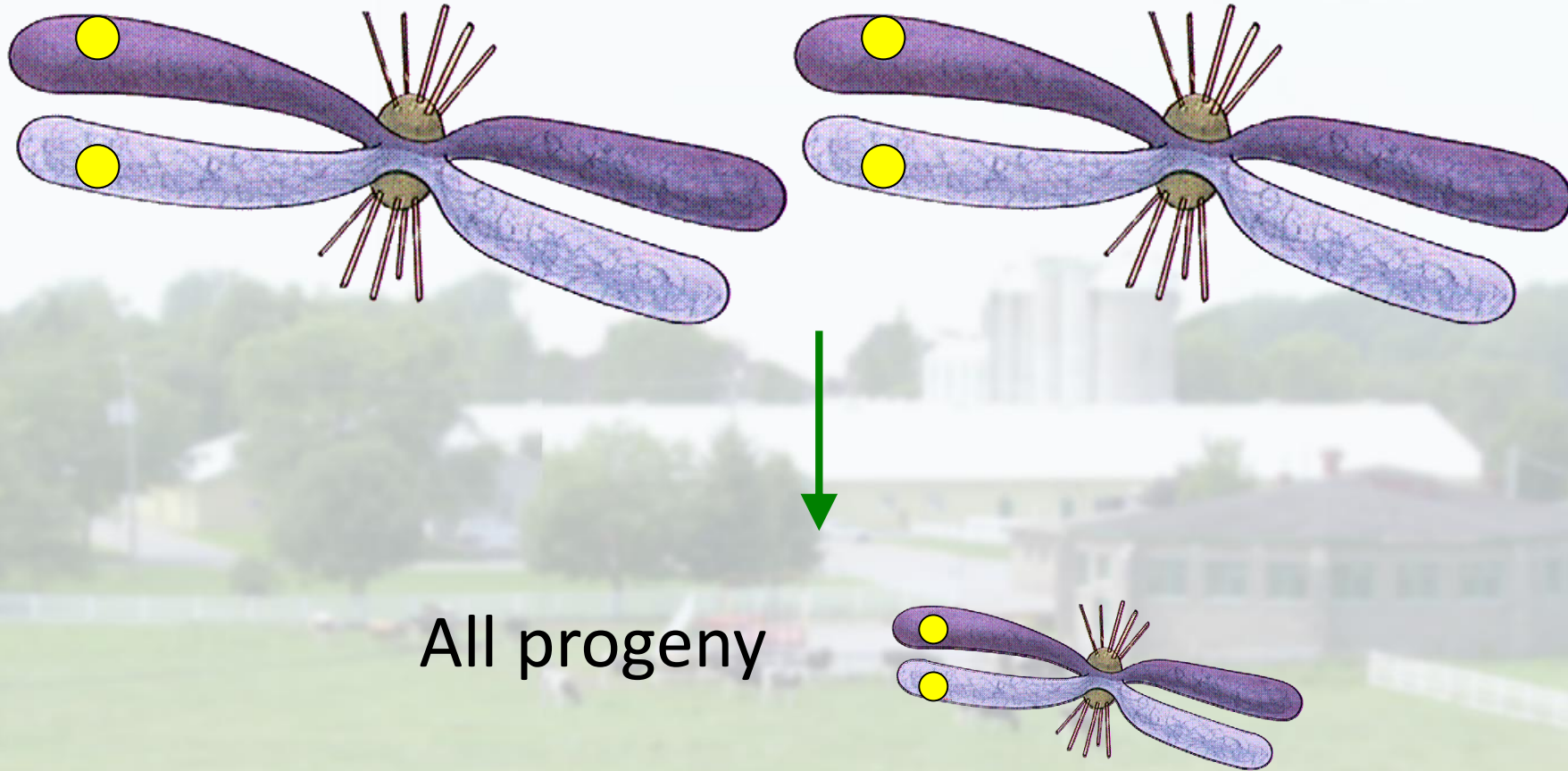
"Hairy" = (HH, Hh or hH)

"Wooly" = (hh)

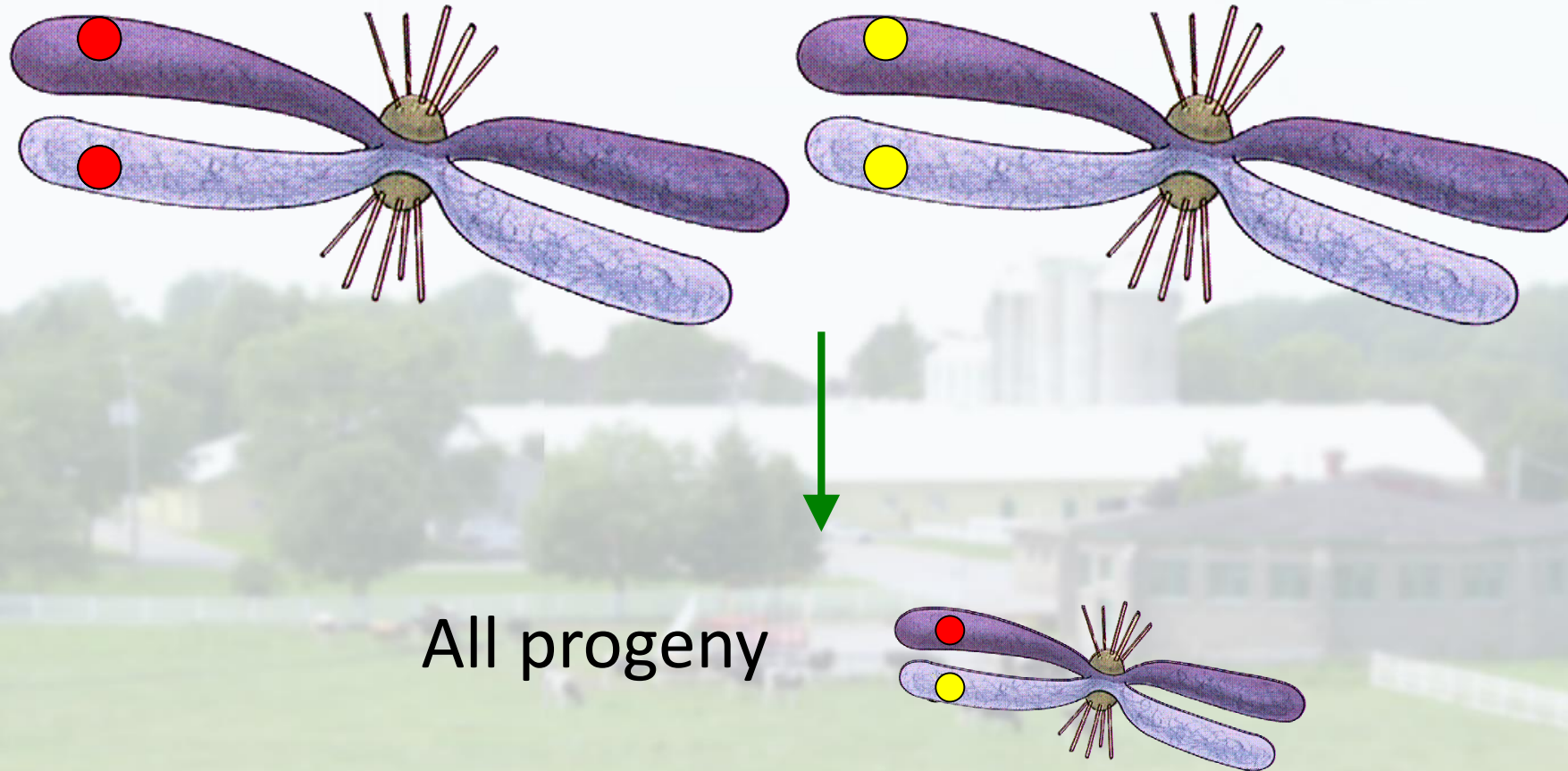
“The Six (6) Basic Crosses” 1



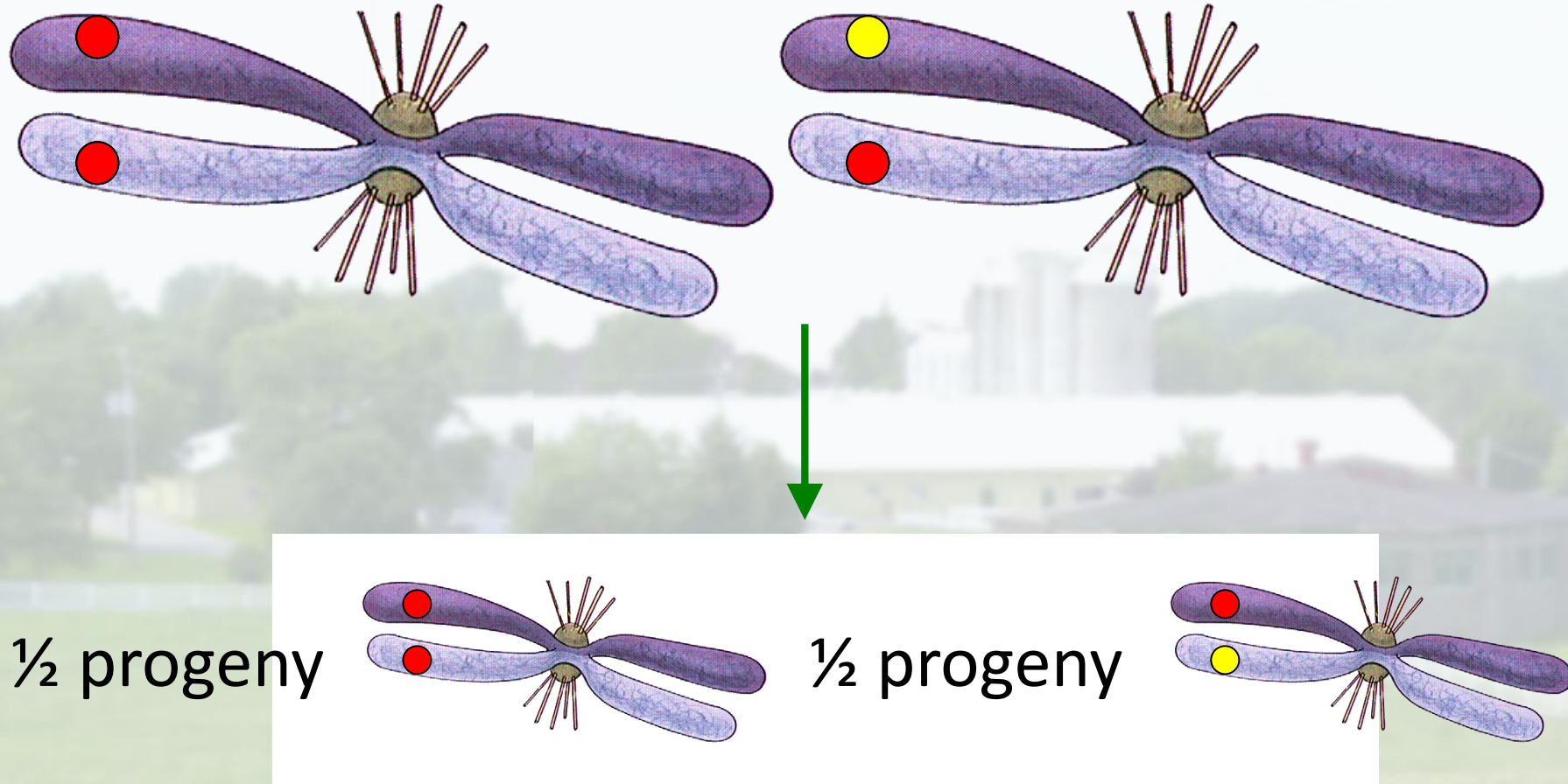
“The Six (6) Basic Crosses” 2



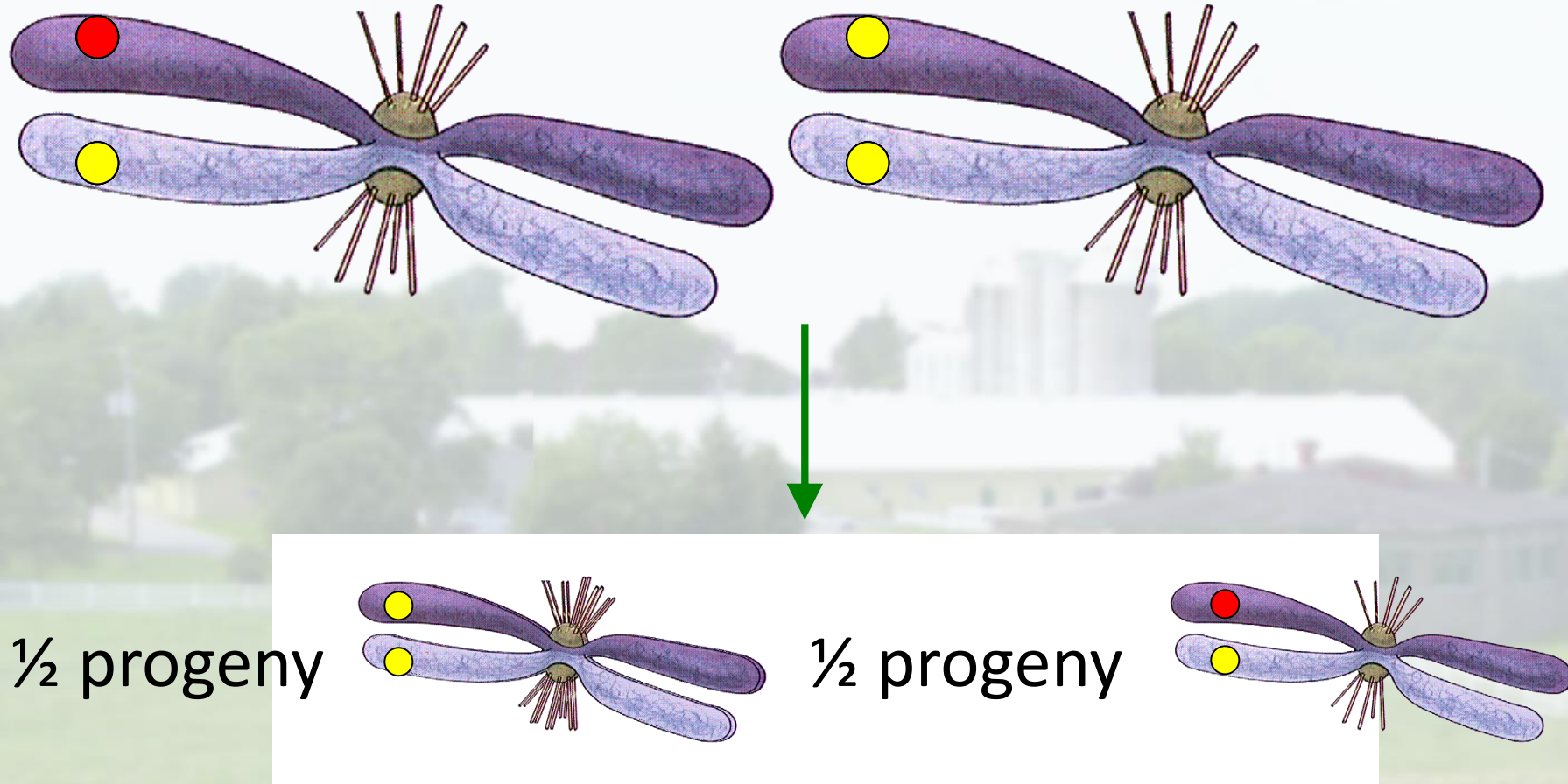
“The Six (6) Basic Crosses” 3



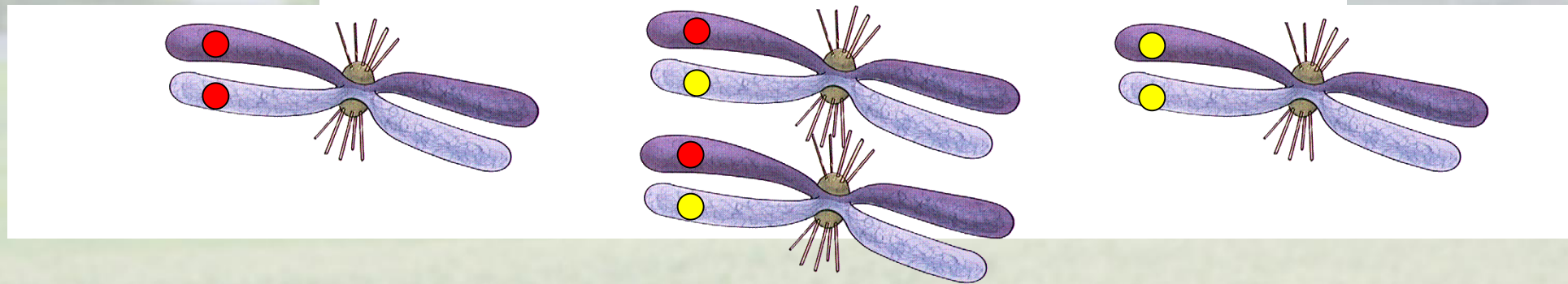
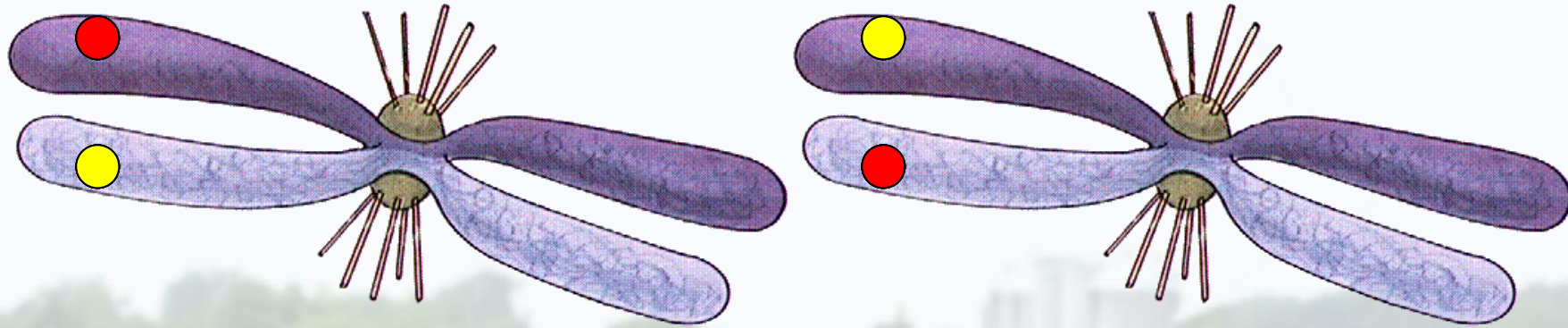
“The Six (6) Basic Crosses” 4



“The Six (6) Basic Crosses” 5



“The Six (6) Basic Crosses” 6



$\frac{1}{4}$

$\frac{1}{2}$

$\frac{1}{4}$

Remember...
Black-and-White is dominant to Red-and-White

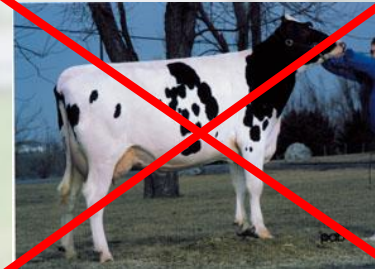


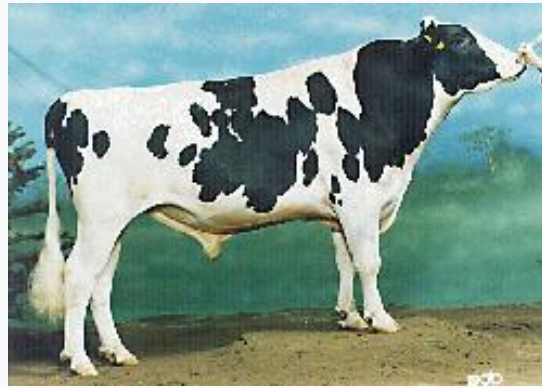
bb

x



bb





BB



bb

X





Bb



bb

X



50%



50%



X



BB or Bb

BB or Bb



BB

X

BB ?

BB

X

Bb ?

Bb

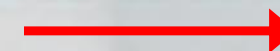
X

BB ?

Bb

X

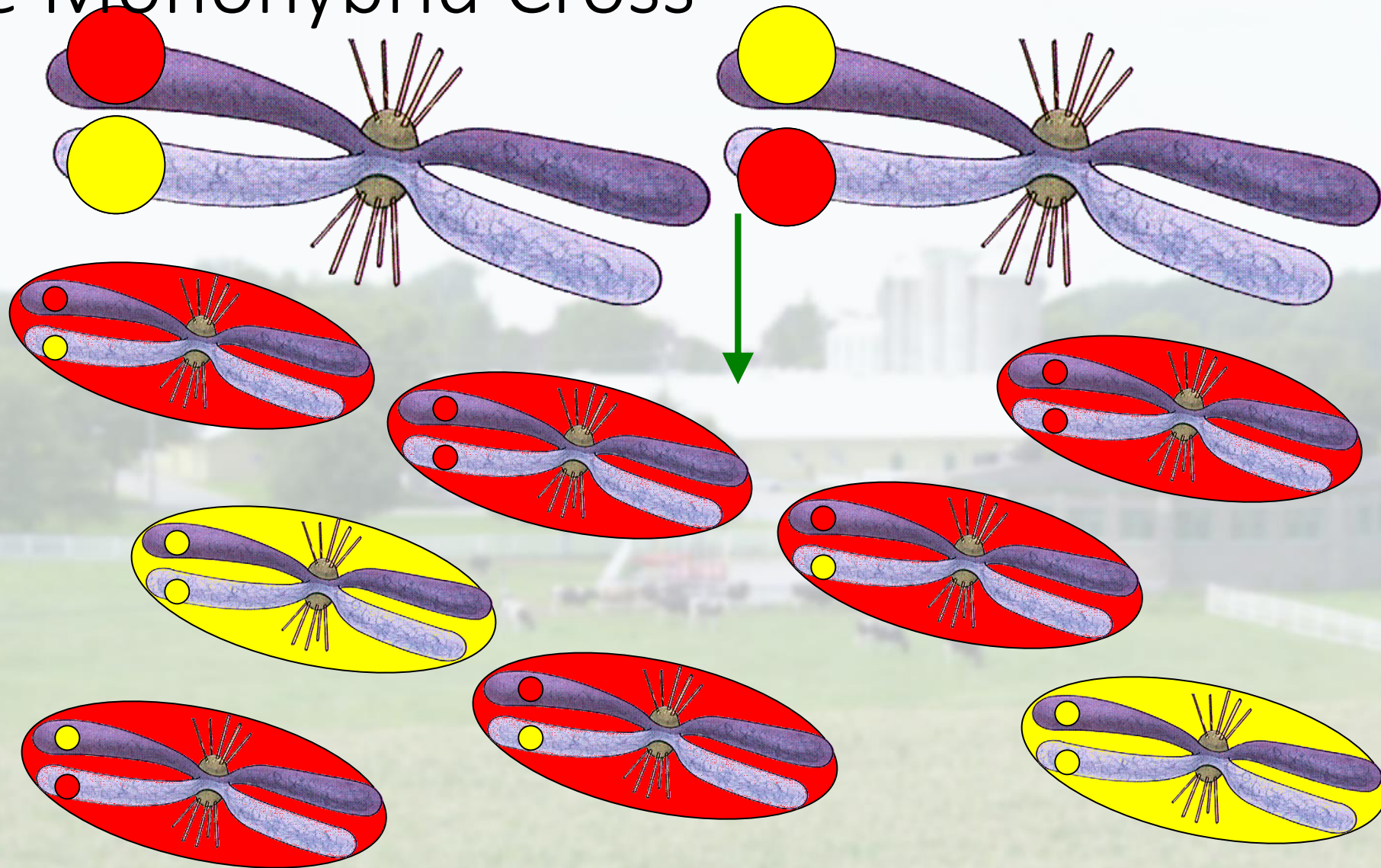
Bb ?



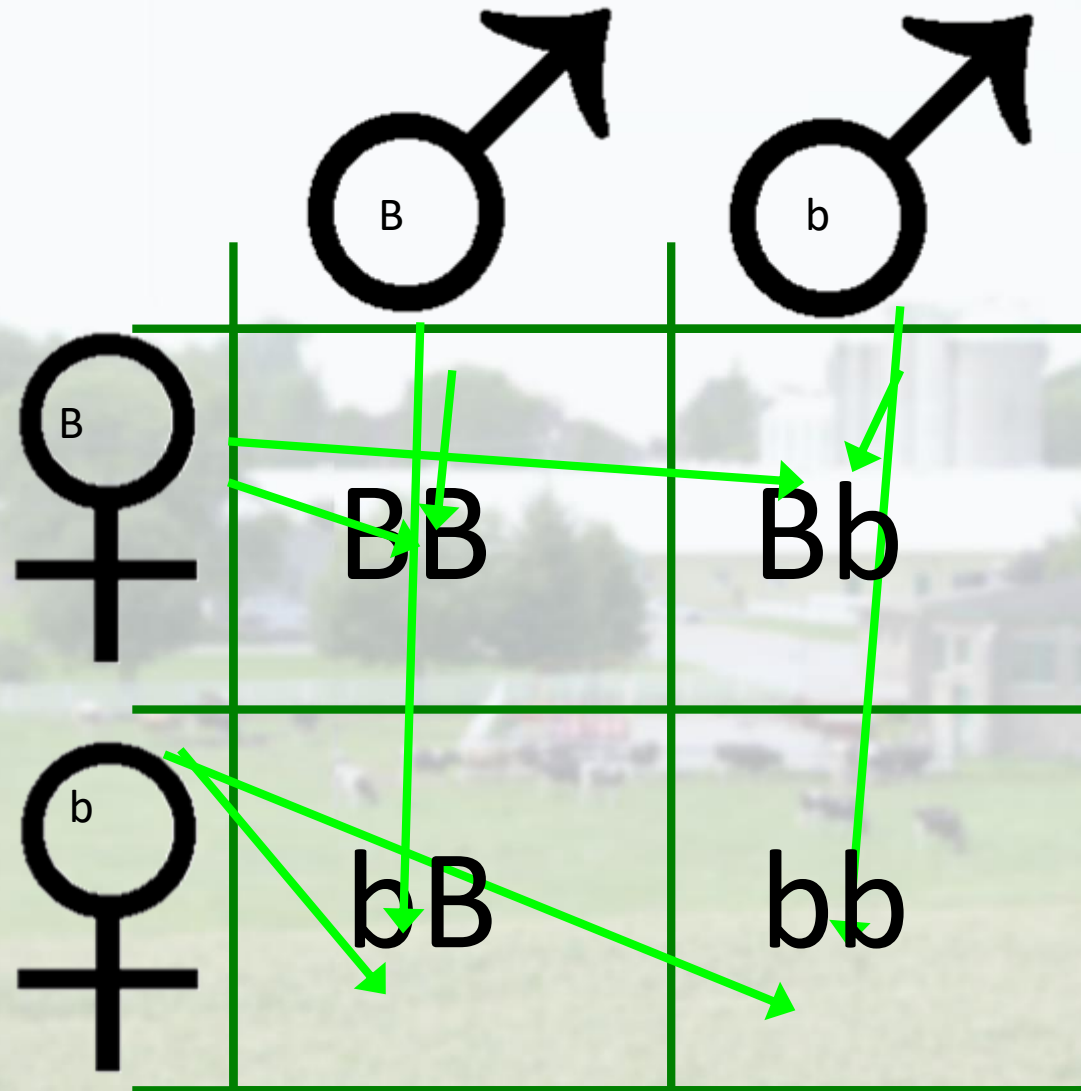
??



The Monohybrid Cross

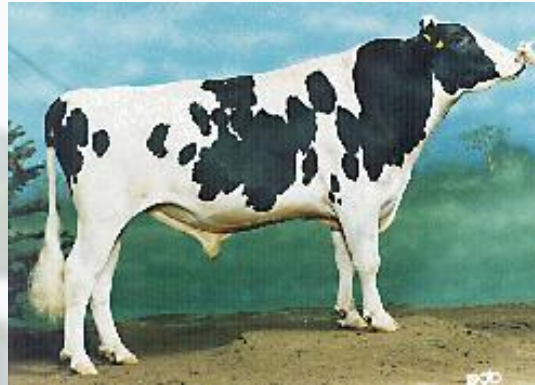
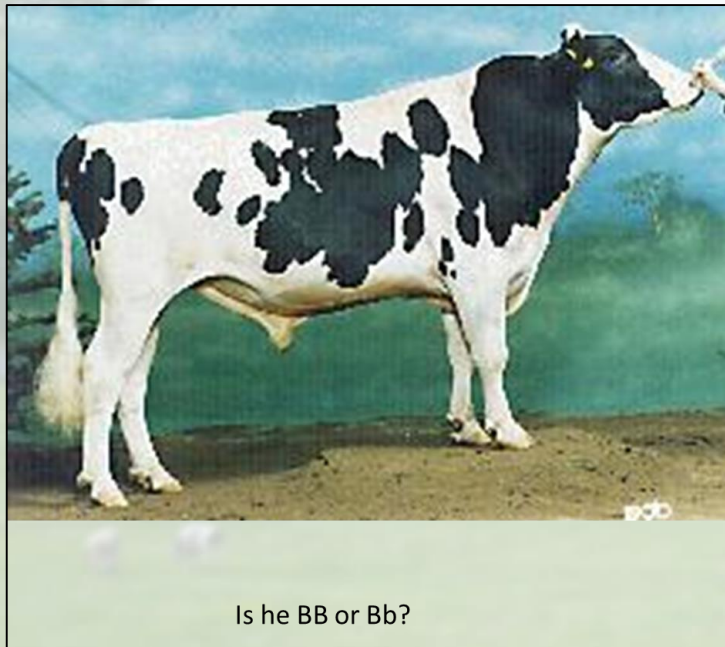


Punnett Square ("B" and "b" alleles)



Test Cross

Determining the genotype of a dominant phenotype by crossing the unknown with a known genotype (usually the homozygous recessive)



X

Bb

BB or Bb ?

