Breeding

- Domesticated 10,000 – 12,000 years ago
- Major changes have been genetic (to benefit man)
- Increased production can be achieved through environment but must be repeated daily, seasonally or at least annually. Whereas Genetic change tends to be permanent.
- From a Hairy coat to 15 lbs of Wool
- From one kid per year to multiple births
- Environmental effects on Genetics
- Genotype vs Phenotype

Breeding

- Change is inevitable but progress is optional
- To make progress some type of mating and selection program is necessary
- Balance in Selection
  - Meat
  - Wool
  - Milk
  - Reproduction
  - Carcass Merit
  - Size
- Technologies such as AI (intrauterine and transcervical) Embryo Transfer and Cloning have greatly increased the rate of genetic change

Breeding

- Individuals that perform well or poorly for a particular trait pass on a portion of that good or poor performance to their progeny
- DNA (deoxyribonucleic Acid) is the genetic material that controls how an animal looks and performs
- DNA molecules are organized into chromosomes

Breeding

- Chromosomes
  - present in every cell of the body
  - Found in pairs that resemble one another in size and shape

An individual has the exact same set of chromosomes (and DNA) in every cell of its body

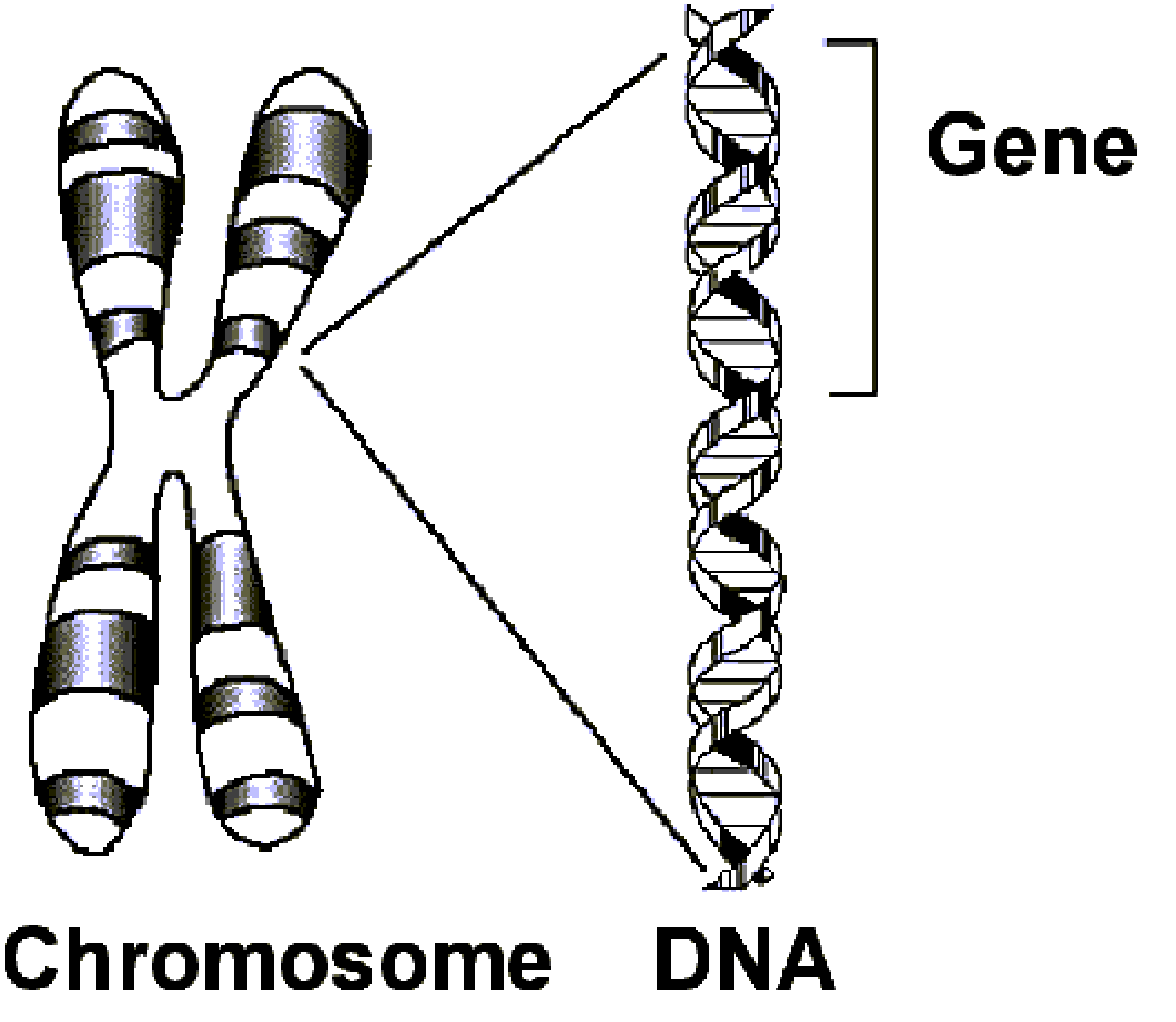
Species differ in number of chromosomes per cell

Sheep have 54 chromosomes or 27 pair

Goats have 60 chromosomes or 30 pair

Breeding

- DNA in the chromosomes is organized into segments – Genes
- Gene – coding system that dictates the production of enzymes and proteins which influence
  - Development
  - Performance
  - Appearance
- The sequence of the DNA molecules within the gene determines the structure of the enzyme or protein produced
- The location of a gene on a chromosome is called a locus (loci)
- Alleles – alternating forms of the gene (due to diff in DNA)


Gene
Chromosome
DNA

Breeding

- Chance - which chromosome of a pair that end up in the sperm or egg is determined purely by chance.
- One Allele of each gene pair
- 50% Sire, 50% Dam
- Genetic variation - 134,217,728 possible combinations

Breeding

- The 2 Alleles of a gene pair act together to determine structure and function
- The Alleles may be the same or different
  - If Alleles are the same – Homozygous
  - If Alleles are different – Heterozygous for that specific gene pair

Breeding

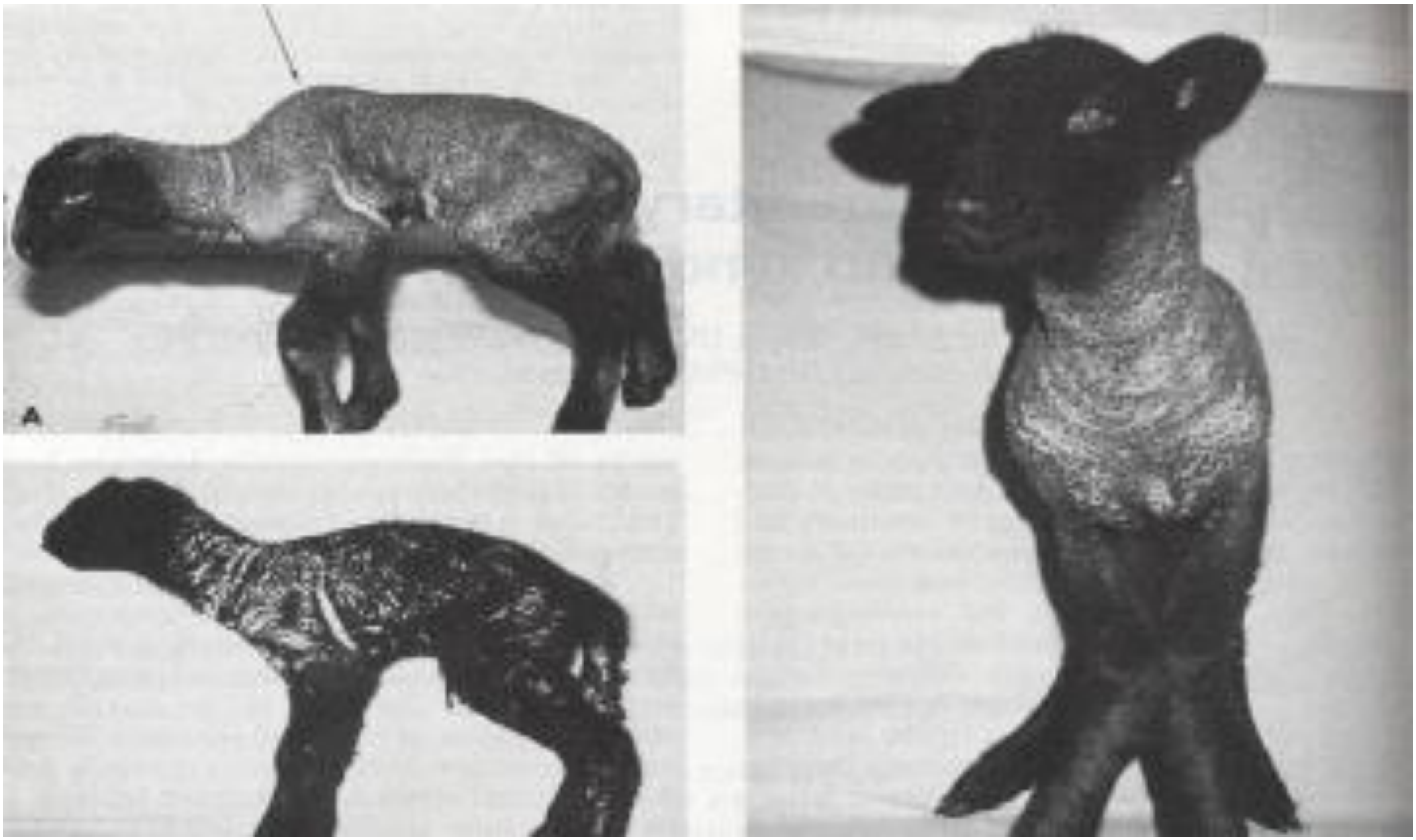
- Heterozygous Gene Pair
  - One allele may express itself in total exclusion of the other allele – expressed allele is Dominant
  - Allele that is not expressed is Recessive
  - *In animal genetics, Complete dominance of one allele over another is exception rather than the rule*
  - *In most cases each allele of the pair expresses itself to a certain extent*

Breeding

- Spider Syndrome – due to a single allele (s) which is recessive to the dominant allele (S) for normal skeletal development

Since no producer would keep a spider lamb for breeding they result from a mating of two normal appearing but heterozygous individuals

Spider Gene in Sheep



SPIDER GOAT

Breeding

- Codominant – when both alleles of a heterozygous gene pair express themselves equally
- Incomplete or Partially Dominant - when one allele of a heterozygous gene pair expresses itself to a greater extent than the other
- Expression of an allele can be influenced by the other member of its gene pair *and* by alleles at different loci. This interaction is called Epistasis

Breeding

- <u>Inbreeding</u> – when males and females are mated that are more closely related than the average of the population
- Genetic effect
  - Increases homozygous gene pairs
  - Decreases heterozygous gene pairs
- Does not change the frequency of the genes in the population, but the frequency of genotypes

Breeding

- An allele that causes abnormalities is generally recessive to the "normal" allele
- Must be homozygous for the abnormal allele to be expressed.
  - *Inbreeding increases homozygosity, hence increases incidence of genetic abnormalities*
- Most genetic abnormalities are controlled by genes at one or two loci.
  - Most production and performance traits are controlled by genes at several loci

Breeding

- Inbreeding Depression
- Whether the desirable or undesirable allele becomes homozygous at a particular locus is random.
- If the undesirable are expressed there will be a decrease in performance traits …
  - Inbreeding Depression

Inherited Defects

- Many defects are recessive in nature
- Selection pressure is exercised against certain traits, esp. lethals and fleece defects
- Dwarfism, Spider Syndrome, Jaw Defects, Rectal Prolapse, Inverted Eyelids, Cryptorchidism, Horns or Scurs, Face covering, Color, Skin Folds, Silky, Britch fibers, grey color, paralyzed limbs, earless, etc.

Breeding

Heterosis or Hybrid Vigor– the superiority of the "crossbred" animal relative to the average of the parents (rather than the best parent)

- Caused by increasing heterozygosity in genes with non-additive effects
- The degree of Heterosis depends on the degree of genetic diversity of the parents
- Highest degree of Heterosis occurs when crossing breeds

Breeding

Genotype – the genetic makeup of an individual or a listing of the alleles that an individual possesses

Phenotype – the expression of the genotype which can be observed or measured

Breeding

<u>Qualitative Traits</u>

- Controlled by few alleles at one or few loci
- Influenced little (if at all) by Environment
- Example: Spider, Horns, etc…
- With Qualitative Traits phenotype is a good indicator of genotype

Breeding

<u>Quantitative Traits</u>

- Controlled by many alleles at several loci, with any one allele having a relatively small effect
- Influenced by environmental factors
- Example: ADG, Feed Efficiency
- With Quantitative Traits phenotype is not a good indicator of genotype because of environmental influences

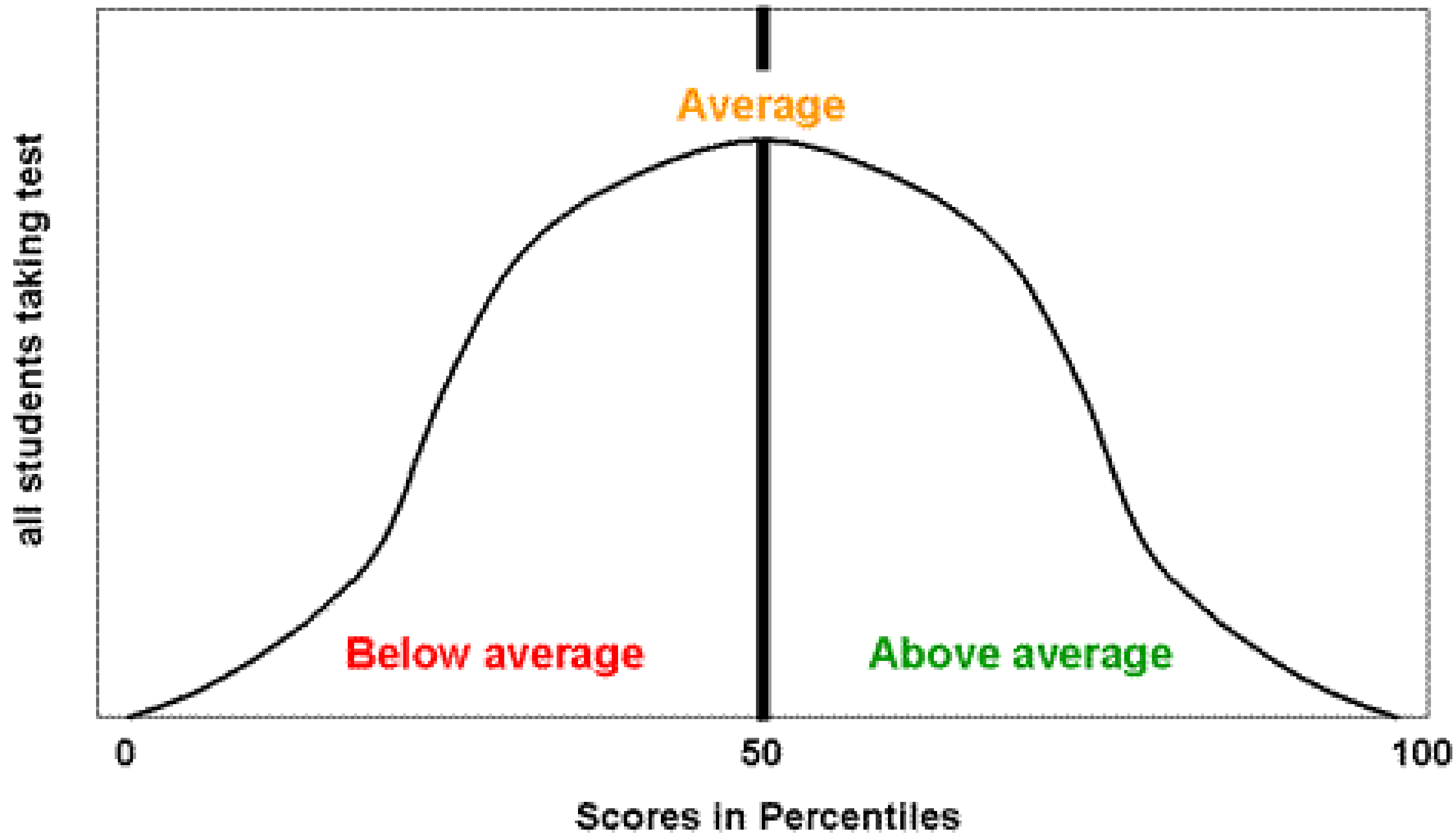
Breeding

Variability

- The raw material for genetic improvement
- Select animals that are different (vary) from the population to be the parents of the next generation

The Bell Curve

Norm-referenced Tests (NRTs) are designed to compare student performance to other students



Breeding

Genetic Correlation

- Quantifies a relationship between two variables
- Measured between zero and one

- Positive Correlation – some of the same genes affect more than one trait and a genetic increase in one trait results in a predictable *increase* in the other trait.
- Example: Fleece weight and fiber diameter
  ADG and feed efficiency

Breeding

Genetic Correlation

- Negative Correlation – some of the same genes affect more than one trait and a genetic increase in one trait results in a predictable genetic *decrease* in the other trait.
- Example: decrease in fat thickness as loin eye area increases

Breeding

Genetic Improvement Principles

- Selection is the process that increases the frequencies of desirable alleles and leads to genetic improvement
- Assume that selected animals are genetically superior, but the alleles that contribute quality cannot actually be observed
- Therefore the true genetic value of animal can only be estimated

Breeding

Animal Identification

- Accurate estimation of genetic value requires accurate animal identification
- Written records of measurements of economic important traits
- Use the records to assess the performance of individual animals

Breeding

Types of Records

1. Reproduction – age, number, ease
2. Maternal Ability – birth & weaning wt., # weaned
3. Growth – weaning & post-weaning weights
4. Wool – weight and quality
5. Carcass – dressing %, carcass wt, fat, quality grade, LEA, % retail product
6. Lactation – daily prod, length of lactation, fat and protein content

Breeding

Estimating Genetic Value

- Environmental variation
- Compare a “contemporary group”
  - Uniformly managed
  - Similar breed composition
  - Age
  - Sex

Breeding

Mating Systems

- Purebreeding- common genetic group
- Outbreeding- unrelated within a breed
- Inbreeding-closely related with one or more common ancestors (more than 50% related)
- Linebreeding-common ancestors, but not 50% related
- Crossbreeding- mating of different breeds
- Grading Up-enhanced concentration of crossbreeding to rams of a single breed

Breeding

Heritability

- Proportion of the total phenotypic variation that is due to the variation in additive gene effects
- In other words, the proportion of differences due to genetic effects and is important in the prediction of response rates from selection.
- The square root of the variance is the standard deviation, which is the average deviation of each individual in the population from the population Average

Breeding

Heritability Estimates (Goats)

Traits	Heritability Value, %
Doe Fertility	5-10
Kids born/doe	10
Scrotal Circ.	35
Age at Puberty	25
Kid Survival	5
Wt weaned/doe exposed	20
Birth Weight	15
Weaning Wt (90d)	25
Post-wean gain	40
Carcass wt	35
LEA	35
Dressing %	10
Milk Yield	30

Estimated Breeding Value (EBV)

- EBV = b, where b is the heritability of a particular trait
- Example; Ram A has a grease fleece weight of 15 lbs and the average flock grease fleece weight is 11 lbs, then 15-11 = a selection differential of 4
- 4 x .4 (h) = 1.6 lbs of grease fleece advantage for breeding Ram A

EPD's (Expected Progeny Differences)

- Simply ½ of the EBV
- The average EPD in a population is + or – from the average of the population
- Example: If a ewe has a +.3 for no. of lambs born, then one would expect the progeny to produce .3 more lambs per lambing than the progeny of average ewes.

EPD's

- Example: Rams A and B
- +.5 and +1.1 for fleece weight, respectively
- Ram B progeny would be expected to have .6 pounds heavier fleeces than Ram A
- Example: Ram has +1.0 and Ewe has +.5 for weaning weight, then the progeny will be 1.5 lbs more than the population average for WW

EPD's

Accuracy

- Gives an idea of reliability of the estimate
- Measured from 0-1
- An accuracy of .45 is not very reliable, whereas > .9 is considered reliable
- Low accuracies are a result of limited information known about the parents or low numbers of progeny occur

Generation Interval

- The time lapse between birth of an animal and the birth of its replacement
- A measurement of progress or rate of improvement
- Genetic Improvement per year = heritability x selection differential divided by the generation interval

Methods of Selection for Single Traits

- Individual selection-selection on their own performance
- Family selection-selection based on bloodlines; useful when (h) is low
- Pedigree selection-similar to family and is dependent upon how closely related the ancestors

Methods of Selection for Single Traits

- Progeny Test- observing the performance of the offspring. Must be mated to several ewes and then look at the offspring. Best when looking at carcass traits
- Combined Selection- uses more than one of the above mentioned methods

Methods of Selection for Multiple Traits

- Tandem Selection- focuses on multiple traits, yet one at a time. After the performance of one is achieved, then move to the next trait
- Independent Culling- Set minimum standards for more than one trait at a time for the individual. Cull any that does not meet the min. standards for any trait

Methods of Selection for Multiple Traits

- <u>Selection Index- </u>rank individual animals for two or more traits based on a combination effect
- One the farm testing:
- Primary focus is on the ewe flock
- Therefore, traits such as prolificacy, weaning weight and fleece weight

National Sheep Improvement Program

- Oversees the promotion, funding, development and implementation of a national genetic evaluation program for sheep
- Minimum criteria for record keeping
- Lamb records: ID #, sire and dam ID, date of birth, sex, type of birth, & type of rearing.
- Additional records are reproductive, growth and fleece traits

National Sheep Improvement Program

- Focuses on:
- Number of lambs born per ewe lambing
- Body weight at 30,60,90,120 & 240 days
- Grease &/or clean fleece wt.
- Staple length
- Fleece grade
- Pounds of lamb weaned per ewe exposed per year

Adj. Factors for No. of lambs born per lambing to a common ewe

Age of Dam	Adj. Factor
1	1.45
2	1.15
3	1.05
4	1.00
5	.96
6	.96
7	.95
8	.98
9+	1.00

Major Economically Important Traits

- Reproductive Efficiency
- Carcass Merit
- Milk Production
- Total Ewe Production- # lamb/ewe exposed
- Mature Size
- Hardiness & Adaptability
- Wool Production
- Growth Rate

Selection for Growth

- Growth is a very important trait, esp. for meat breeds
- Adjusted 90 day weaning weight
- If birth weight is known:
- [Actual wt. - birth wt. x adj. Days (90)/ actual age]+ birth wt.
- If birth wt. is not known:
- Actual wt. X adj. Age in days/age

Selection for Fleece Traits

- Grease and Clean Fleece Wts
- Yield
- Staple length- at least 3”/yr.
- Fiber diameter
- Crimp
- Color
- Density
- Belly Wool-undesirable on sides

Importance of Genetic Improvement in Seedstock Flocks

- Most produce their own replacements
- Therefore, genetic improvement from outside is by the Ram purchased
- Theoretically, Genetic merit increases at the same rate as the genetic merit of the rams, yet because of generation intervals and replacement production improvement usually lags two generations behind

Inbreeding Coefficients

- Full brother mated to sister = .25
- Sire on daughter = .25
- Half brother to half sister = .125
- Sire on Mother = .5
- Therefore; > .5 has to be compounded over time and added generation to generation

Crossbreeding Systems

- Two Breed Terminal(50% Heterosis)
- Three Breed Terminal (100%)
- Three Breed Rotational (86 %)
- Four Breed Rotational (93 %)
- Two Breed Rotational
- Roto-Terminal- combination of rotational and terminal systems. The poor ewes would still be used in a terminal crossing manner