




Breeding Angus Cattle in the Genomics Era

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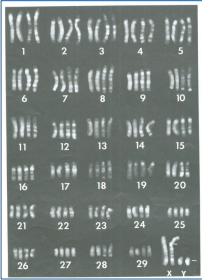
Road Map

- Genetics 101
- Mutation
- EPDs
- \$ Indexes
- Accuracy
- Genomic Trait Tests



Chromosomes

- Cattle are diploid
 - They have two copies of their genetic material (one from each parent)
 - 58 acrocentric autosomes
 - Submetacentric X
 - Submetacentric Y
- In meiosis and gametogenesis eggs and sperm cells are produced that have one copy of the genetic material.



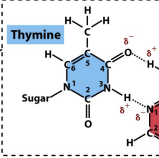
Karyotype by: Gallagher & Womack. 1992. J. Hered. 83: 287-298

Opposite polarity of the two strands

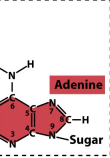
5' → 3' and 3' → 5'

Hydrogen bonding in A-T and G-C base pairs

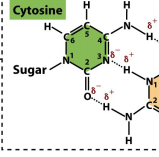
Thymine



Adenine



Cytosine



Guanine

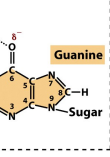


Figure 9-11 Principles of Genetics, 4/e © 2006 John Wiley & Sons

Central Dogma of biology

DNA

↓

RNA

↓

Protein

The Genetic Code*


		Second letter				
		U	C	A	G	
First (5') letter	U	UUU } Phe UUC } UUA } Leu UUG }	UCU } UCC } Ser UCA } UCG }	UAU } Tyr UAC } UAA } Ochre (terminator) UAG } Amber (terminator)	UGU } Cys UGC } UGA } Opal (terminator) UGG } Trp	U C A G
	C	CUU } CUC } CUA } Leu CUG }	CCU } CCC } Pro CCA } CCG }	CAU } His CAC } CAA } Gln CAG }	CGU } CGC } Arg CGA } CGG }	U C A G
	A	AUU } AUC } Ileu AUA } AUG } Met (initiator)	ACU } ACC } ACA } Thr ACG }	AAU } Asn AAC } AAA } Lys AAG }	AGU } Ser AGC } AGA } Arg AGG }	U C A G
	G	GUU } GUC } Val GUA } GUG }	GCU } GCC } Ala GCA } GCG }	GAU } Asp GAC } GAA } Glu GAG }	GGU } GGC } Gly GGA } GGG }	U C A G

*Each triplet nucleotide sequence or codon refers to the nucleotide sequence in mRNA (not DNA) that specifies the incorporation of the indicated amino acid or polypeptide chain termination.

Table 13-1 Principles of Genetics, 4/e © 2006 John Wiley & Sons


Types of Traits

- Simply Inherited Traits
 - Differences among animals are due to one or two genes
 - Example: Red vs Black, Genetic Conditions



Types of Traits (cont)


- Performance Traits
 - AKA Quantitative traits
 - Differences in animals are due to:
 - Difference in genotype at MANY loci
 - The environment
 - Examples: BW, REA, MARB, etc



MUTATION


Mutation/Mutant

- Mutation
 - A change in genetic material
 - The process by which the change occurs
- Mutants
 - Individuals that exhibit a phenotype that is the result of a genetic mutation

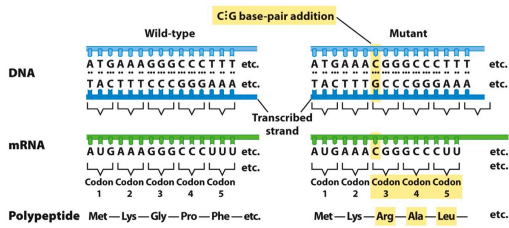


Types of Mutations

- Changes in chromosome number or shape
- Point mutations
 - Changes at specific sites in a gene...



Example of a Mutation



The diagram illustrates a frameshift mutation caused by a C:G base-pair addition. In the DNA, the wild-type sequence is ATGAAAGGGCCCTTT, and the mutant sequence is ATGAAACGGGCCCTTT. The mutant sequence has an extra 'C' at the 7th position. This results in a frameshift in the mRNA, where the wild-type sequence AUGAAAGGGCCUUU is changed to AUGAAACGGGCCUUU. The polypeptide sequence for the wild-type is Met-Lys-Gly-Pro-Phe, while the mutant sequence is Met-Lys-Arg-Ala-Leu. The mutation shifts the reading frame, changing all subsequent amino acids.

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Result of Mutation?

- Varies: No phenotypic change → Lethality
- We're All Carriers of Something!
- **All** animals (humans and cattle included) carry multiple lethal mutations within their genome
 - Most are recessive



Importance of Mutation

- Creates new raw material for evolution and thus is the source of all genetic variation.



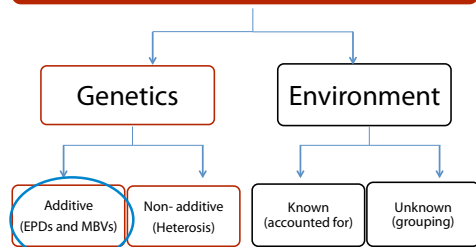
HOW DOES THIS APPLY TO CATTLE?

Many Genetic Selection Tools!

- Simply Inherited Traits
 - DNA Tests for Genetic Conditions
- Performance Traits
 - EPDs
 - DNA Trait tests



Performance



Expected Progeny Difference

- **Expected difference** in **future progeny** performance of one individual **compared** to another.
- Used to **compare** cattle within a breed.
- EPD ≠ actual performance



Birth Weight Example

BW EPD	
Bull A	-1.0
Bull B	4.0

On average, Bull A's calves are expected to weigh 5 pounds less than Bull B's.

But what will my calves weigh?

EPDs do not predict actual performance

Heifer Calving Ease

Calving Ease Direct

Bull A **+10%**

Bull B **+3%**

Difference **+7%**

- Use as a tool in choosing sires mated to first-calf heifers.
- Increase the chance of easier calving.

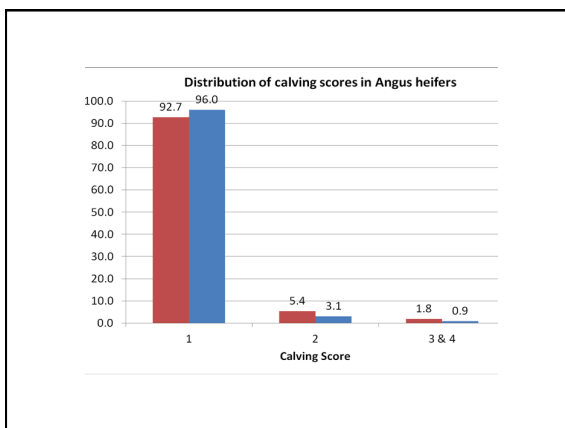
Calving Ease Maternal

Bull A **+8%**

Bull B **+3%**

Difference **+5%**

- Use as a tool to choose sires of replacement heifers.
- Increase first-calf daughters easier calving.

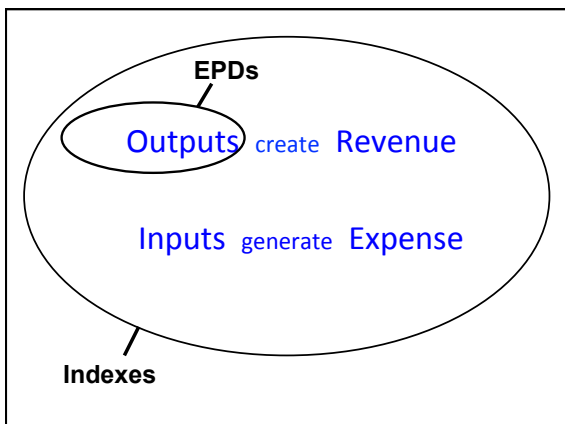


AAA \$VALUE INDEXES

Production										Maternal					
CED Acc	BW Acc	WW Acc	YW Acc	RADG Acc	YH Acc	SC Acc	Doc Acc	HP Acc	CEM Acc	Mk Acc	Mk Mid	MW Acc	MH Acc	SEN	
+14	-1.4	+54	+99	+11	-1	+1.73	+21	+4.3	+13	+25	3637	+28	+3	+4.87	
-.97	-.99	.98	.97	.81	.97	.94	.94	.68	.92	.94	7055	.91	.91		

Carcass					
CW Acc	Marb Acc	RE Acc	Fat Acc	Carc Grp	Usrd Grp
+21	+68	-.06	+0.19	54	6777
.77	.80	.79	.79	119	20739

\$Values					
\$W	\$F	\$G	\$QG	\$YG	\$B
+42.72	+36.68	+27.16	+29.14	-1.98	+56.04




What ARE indexes?

- Multiple traits and their economic impact combined into one value:
 - Challenging to develop
 - Simplistic to use
 - Directional change in multiple traits.

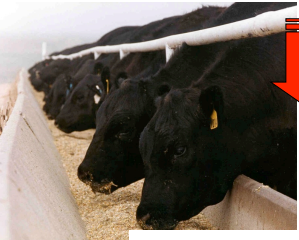
Weaned Calf Index (\$W) ...

Economic Impact


- Birth
- Weaning Direct
- Maternal Milk
- Mature Cow Size



Feedlot Value (\$F)



Grid Value (\$G)



Beef Value (\$B)



\$ per head difference

Accuracy and Possible Change

BW EPD of 1.8	Production		Maternal	
	ACC	Possible Change	ACC	Possible Change
Bull A	.05	2.49		
Bull B	.80	.53		

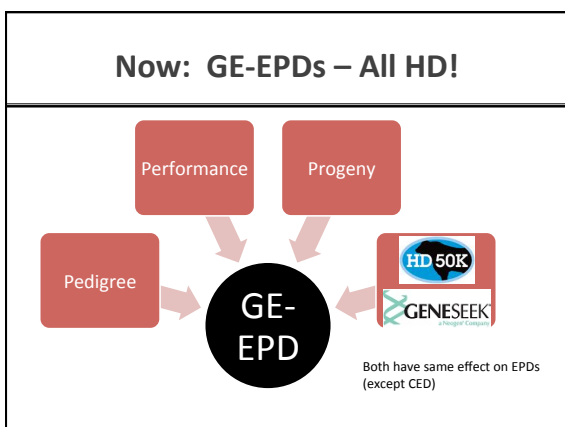
85	12	39	17	28	013	00	11	28	1.0	1.5	1.5	6	10
90	8	20	12	17	009	04	07	1.8	7	1.0	1.0	4	06
95	4	13	6	9	004	02	04	1.1	4	5	5	2	03

Importance of Accuracy

Bull A
1.8 BW EPD ± 2.49
-0.69 to 4.29

Bull B
1.8 BW EPD ± .53
1.27 to 2.33



HD-tests for Angus Breeders

HD 50K

- \$75 (includes Parentage)
- Allows for GMX Sire-Match
- CED Correlation is .61 (GV 37%)

GENESEEEK
GGP-HD

- \$75 (includes Parentage)
- Discounts on selected GC's
- CED Correlation is .34 (GV 11.5%)

HD 50K for Angus – Impact on EPDs, Accuracy Values and Associated Progeny Equivalents


Trait	Average EPD Change (+/-)	Average Accuracy	Progeny Equivalents
CEM	3	.31	21
BW	.8	.35	11
WW	3	.29	19
YW	5	.32	22
DMI (RADG)	.03	.26	10
YH	.13	.35	9
SC	.23	.36	11
Doc	5	.30	10
Milk	2	.20	15
MW	11	.25	7
CW	5	.19	6
Marb	.12	.31	16
RE	.10	.25	9
Fat	.01	.25	11

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FOR ANIMALS. FOR HEALTH. FOR YOU.

FOR COMMERCIAL PRODUCERS

GeneMax™
What it IS

- DNA test for Marbling and Post-weaning Gain
- Intended Use:
 - By commercial cattlemen
 - On Angus-sired cattle
- Selection, Marketing & Decision tool
 - Commercial replacement heifers
 - Feeder cattle


Simple • Affordable • Profitable

GMX™ Results




Tag	Sex	Assn Num	GMX™ Score	GMX™ Marbling	GMX™ Gain	Most Likely Sire
						Tag Reg. Num.
1281	C	BIR 622055017	99	4	5	2417 AAA 16004857
X908	C	BIR 622055019	97	5	5	
X838	C	BIR 622055018	97	4	5	67S AAA 15705880
046Y	C	BIR 622055013	96	4	5	10277 AAA 15956868
054Y	C	BIR 622055014	95	4	5	5050 AAA 13728513
003Y	C	BIR 622055012	82	5	2	
1007C	C	BIR 622055016	79	3	4	454 AAA 14675445
067Y	C	BIR 622055015	63	1	5	2417 AAA 16004857

GMX™ Score	Description	GMX™ Marbling and Gain	Description
99	Top 1%	5	Top 20%
75	Top 25%	4	61-80%
50	Average	3	Middle 20%
25	Top 75%	2	21-40%
1	Top 99%	1	Bottom 20%

Five Rivers GENEMAX Results

GMX Assigned A.I. Sires	Daughters Assigned	Daughters Selected
Mytty In Focus	149	99
S A V Final Answer 0035	48	29
21AR Roundup 7005	41	19
H A Image Maker 0415	29	11
G A R Ultimate	15	11
Connealy Contrast	7	5
Total	289	174 (60%)

Summarized by Dr. Kent Andersen with Zoetis

Thank You

ANGUS
THE BUSINESS BREED