


**2016 BIF Annual Meeting
& Research Symposia,
Manhattan, KS
June 14-17, 2016**

**Genetics of meat science: what traits can we
improve genetically that affect the value/
sensory desirability of beef?**


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Animal Breeding Class

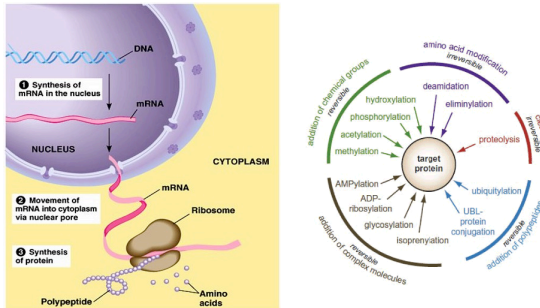
Environment + Genotype = Phenotype

What is this?



Source: Choi, H. (2008) DNA sequencing technologies key to the Human Genome Project. Nature Education 1(1):215

Complexity of Phenotypic Expression:
Transcription, Translation, Protein Synthesis & Post-Translational Modifications



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Next Generation Sequencing Technology


HUMAN GENOME PROJECT

Human Genome Project (1990-2003):

- >13 Years
- ~\$3 Billion
- 3 Billion BP

Our metagenomics AMR study:

- 1 week
- \$900
- >8 Billion BP



NBQA-2011: How Do Market Sectors Define/Describe¹ "Eating Satisfaction"?




Retailers BW Rank = 2	Foodservice BW Rank = 2	Packers BW Rank = 2	Feeders BW Rank = 6	Government & Allied Industry BW Rank = 2
Flavor	Flavor	Tenderness	Tenderness	Tenderness
Tenderness	Tenderness	Flavor	Marbling	Flavor
Consistency	Customer satisfaction	Marbling	Customer satisfaction	Customer satisfaction

¹ Based on the number of times that each characteristic was mentioned as a response to the question.

NBQA-2011: Top Priorities to Reduce Variation in Eating Quality

Premium value could be captured if tenderness & flavor were provided consistently

We will be penalized in the market if we don't provide these two attributes



Factors Influencing Beef Eating Quality



• Beef Tenderness

- Marbling
- Maturity
- Structural Differences
 - ✓ Amount & Solubility of Connective Tissue (Age)
 - ✓ Sarcomere Length (Chilling & ES)
 - ✓ Density/Lubrication (Marbling)
 - ✓ Protein Degradation (Calpains)
 - ✓ Stress and Handling

• Flavor (carbonyl compounds)

- Species Specific
- Amount of Marbling
- Grain-fed vs. Grass-fed
- Dry Aged vs. Wet Aged

• Juiciness

- Amount of Marbling
- Endpoint Degree of Doneness
- Water-holding Capacity (Ultimate pH)

Genetically Controlled? Estimated Fresh Muscle Tenderness Ranking at Optimal Postmortem Aging Time

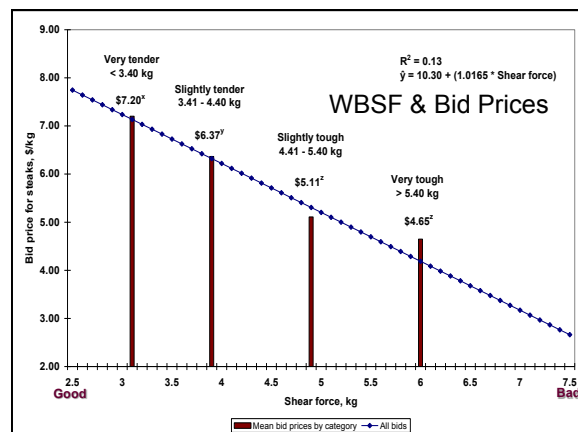
Ranking of combined USDA Select and upper $\frac{1}{2}$ USDA Choice muscles from lowest to highest WBSF at optimum aging time^a derived from expected means on exponential decay curve

Rank	Muscle	WBSF, kg	Rank	Muscle	WBSF, kg
1	Pectineus	2.96	11	Rectus femoris ^a	4.06
2	Psoas major ^a	3.26	12	Triceps brachii ^a	4.09
3	Infraspinatus ^a	3.32	13	Gracilis	4.17
4	Serratus ventralis ^a	3.54	14	Complexus ^a	4.18
4	Teres major ^{ab}	3.54	15	Gluteus medius ^a	4.49
5	Adductor	3.62	15	Supraspinatus ^a	4.49
6	Spinalis dorsi ^a	3.64	16	Vastus lateralis ^a	4.50
7	Gastrocnemius	3.68	17	Biceps femoris ^a	4.75
8	Tensor fasciae latae ^a	3.88	18	Semitendinosus ^a	4.79
9	Vastus medialis ^a	3.89	19	Semimembranosus ^a	4.86
10	Longissimus dorsi ^a	4.02	20	Superficial digital flexor ^c	NA

^aValues derived from Gruber et al., 2006 study.

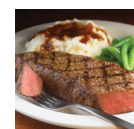
^bUSDA Select Teres major showed no improvement with aging to 28 d, so value represents premium USDA Choice samples.

^cNo improvement in WBSF with aging to 28 d occurred in the Superficial digital flexor.

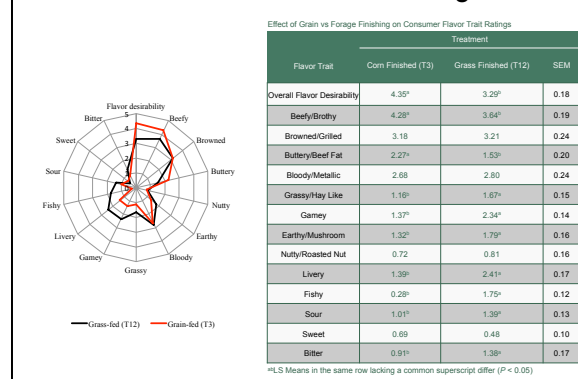


Importance of Beef Flavor

- Numerous studies have cited tenderness as the most important trait affecting beef eating satisfaction (Dikeman, 1987; Savell et al., 1987; Miller et al., 1995; Savell et al., 1999)
- However, several studies have shown that when tenderness reaches an acceptable level, flavor becomes the most important driver of beef eating satisfaction (Goodson et al., 2002; Killinger et al., 2004; Behrends et al., 2005).



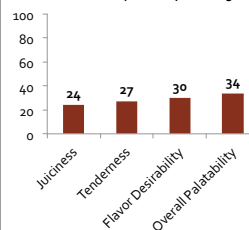
Results – Grain vs Grass Finishing



Variation in Beef Sensory Attributes Explained by Differences in Marbling

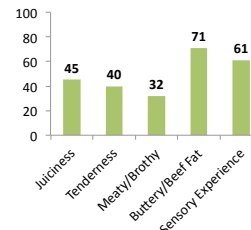
TAMU "1005-Head Study" Smith et al. (1980)

% Variation Explained by Marbling




CSU Study Emerson et al. (2013)

% Variation Explained by Marbling



Genetic Selection Techniques



CONNEALY IRISH 0204
1AN01215 - 16761484

- Set the ranch calving ease ranking in the top 10% makes him popular for heller projects. Yet, he still sires above average growth and carcass traits.
- Irish pedigree is unique, offering mating flexibility to many heller programs.

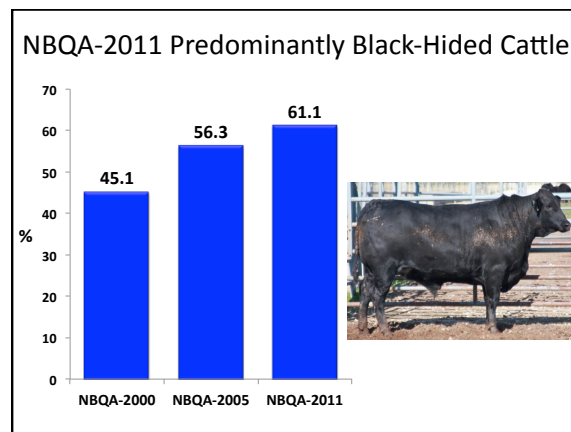
Born: 01-26-2010	
Birth Weight: 69 lbs.	Yrig Frame: 6.3
205 Days: 824 lbs.	Mature Frame: 6.2
365 Days: 1426 lbs.	Scrotal: 40.0 cm.
Mature: 2030 lbs.	Tattoo: 0204
Owned By: TC Ranch, NE, Genex, WI	

Calving Ease Rating: ✓✓✓✓
EPCs as of 4/8/16


Support Photos Support Photos Slideshow **BUY NOW** PregCheck 100 Rel 85%

TRAIT	CED	BW	WW	YW	RADG	SCR	DOC	HPG	CEM	MILK	MKH	MW	MH	SEN	CW	MARB	RE	FAT	Carf	UH	HP	SW	5F	5G	5B
EPD	9.0	-0.8	50	101	0.33	1.17	20	9.7	13	22	61	25	0.2	-6.6	35	0.62	0.68	-0.060	6	141	49.03	68.03	41.29	174.31	
ACC	.83	.92	.88	.82	.42	.81	.67	.33	.55	.64	.61	.55	.41		.83	.38	.37	.54		13	356				


Myty In Focus
 Connealy Wrangler — Connealy Cowboy
 Kelly of Connealy 577 Black Crest of Connealy 5640 Black Crests of Connealy 3314



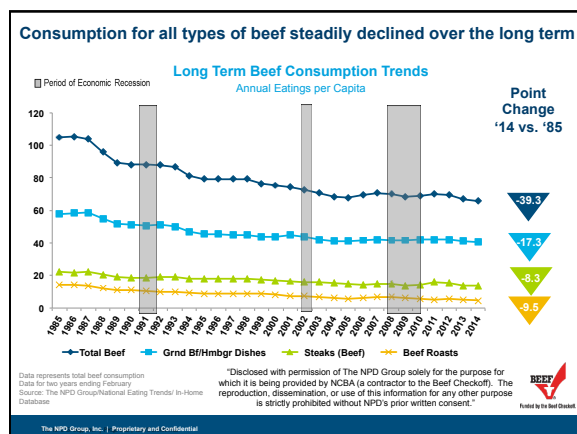
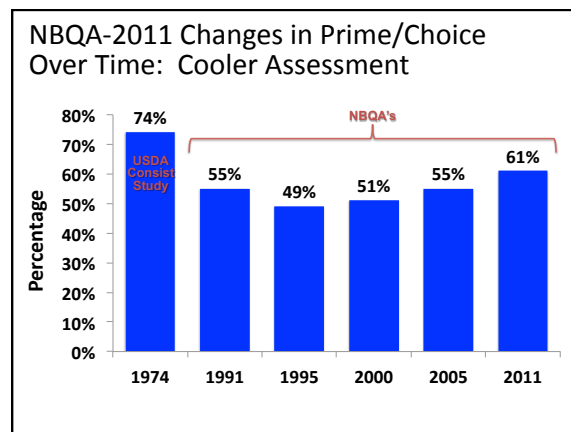
Changing Optimal Types




1958 Grand Champion Steer San Antonio Livestock Exposition



2016 Grand Champion Steer Denver National Western Stock Show



NBQA-2011 Lost Opportunities: Value Losses Using 2011 Prices, Preferred Consist & Logic



Opportunity is missed by most people because it is dressed in overalls and looks like work.
— Thomas A. Edison

	1991	1995	2000	2005	2011
Quality Grade	\$ (24.01)	\$ 7.35	\$ 1.49	\$ (19.82)	\$ (25.25)
Yield Grade	\$ (14.17)	\$ (2.55)	\$ (7.54)	\$ (9.39)	\$ (5.77)
Carcass Weight	\$ 0.56	\$ (1.08)	\$ 1.62	\$ (0.79)	\$ (6.75)
Hide/Branding	\$ (0.85)	\$ (0.95)	\$ (0.87)	\$ (0.69)	\$ (0.74)
Offal	\$ (2.24)	\$ (2.89)	\$ (5.46)	\$ (5.17)	\$ (5.15)
Total	\$ (40.71)	\$ (0.12)	\$ (10.76)	\$ (35.86)	\$ (43.66)

Excess Fat



Trait	NBQA 1991	NBQA 2011
Average Yield Grade	3.2	2.9
Fat thickness < .3 in. (%)	10.6	14.1
Carcass trimmable fat (%)	14.6	14.0

*Reduction in fat yields of at least 5 lb/carcass.

- The industry **has** been able to capitalize on this Economic Opportunity.
(Progress – “War On Fat;” quarter-inch trim)



NBQA-2011: Carcass Weights, Instrument Data

Average	818.5 pounds
Minimum	300 pounds (Steer YG 1, no-roll, .05 in. fat thickness, 9.1 in ² ribeye area)
Maximum	1358 pounds (Steer YG 5, Choice, 1.2 in. fat thickness, 13.0 in ² ribeye area)

Human Microbiome Project

(SOURCE: Foxman & Rosenthal, 2013, AJE)

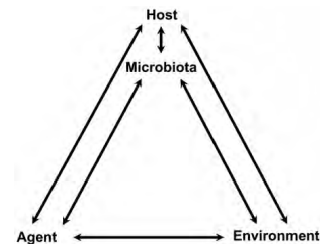


Figure 1. Microbiota can modify the effects of agent and environment on the host and indicate host changes in response to agent and environmental exposures.

Animals in a bacterial world, a new imperative for the life sciences

Margaret McFall-Ngai^{1,2}, Michael G. Haddad^{3,4}, Thomas C. G. Bosch⁵, Hannah V. Carey⁶, Tomislav Domest-Loise⁷, Angela E. Douglas⁸, Nicola Dhillon⁹, Gerard Elser¹⁰, Tadeusz Fiksdal¹¹, Scott F. Gillert¹², Heide Hentschel¹³, Nicole King¹⁴, Stefan Kjellevang¹⁵, Andrew H. Knud¹⁶, Natascha Kreymer¹⁷, Sarkis K. Mazmanian¹⁸, Jessica L. Metcalf¹⁹, Kenneth M. Nelson²⁰, Naomi E. Pierce²¹, John F. Rawls²², Ann Reid²³, Edward G. Ruby²⁴, Mary Rumba²⁵, Jon G. Sanders²⁶, Christian Tiedje²⁷, and Jennifer L. Wernegreen²⁸

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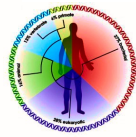


Fig. 3. The diversity of human microbiota in the genome. A phylogenetic analysis of the human genome reveals the relative percentage of the genome that encodes a set of genes in human and other species.

In the last two decades, the widespread application of genetic and genomic approaches has revealed a bacterial world astonishing in its ubiquity and diversity. This review examines how a growing knowledge of the vast range of animal-bacterial interactions, whether in shared ecosystems or intimate symbioses, is fundamentally altering our understanding of animal biology. Specifically, we highlight recent technological and intellectual advances that have changed our thinking about the questions: how have bacteria facilitated the origin and evolution of animals; how do animals and bacteria affect each other's genomes; how does normal animal development depend on bacterial partners; how is homeostasis maintained between animals and their symbionts; and how can ecological approaches deepen our understanding of the multiple levels of animal-bacterial interactions. As answers to these fundamental questions emerge, all biologists will be challenged to broaden their appreciation of these interactions and to include investigations of the relationships between and among bacteria and their animal partners as we seek a better understanding of the natural world.

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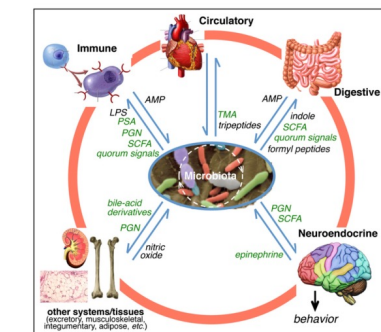


Fig. 3. Signaling within and between the animal and its microbiota. Members of the microbiota, such as those in and on the gut, oral cavity and skin, communicate among themselves and exchange signals with the animal's organ systems, participating in the body's homeostasis. Some of the signals promoting this balance are mentioned in the text (green), whereas other representatives are not (black, Tables S1 and S2). The microbiota also influences animal behavior, creating a direct interface with other organisms. AMP, antimicrobial peptides; LPS, lipopolysaccharide; PGN, peptidoglycan; PSA, polysaccharide A; SCFA, short-chain fatty acids; TMA, trimethylamine oxide.

Pan-genomes comprise the core genome, which comprises the genes found in all members of a group of interest, & the accessory genome — genes that are present in only one or a few members of the group.

Strain-specific genes

Accessory

Core

Accessory

a) Conjugation

b) Cell lysis

c) Transduction

d) Gene transfer agents

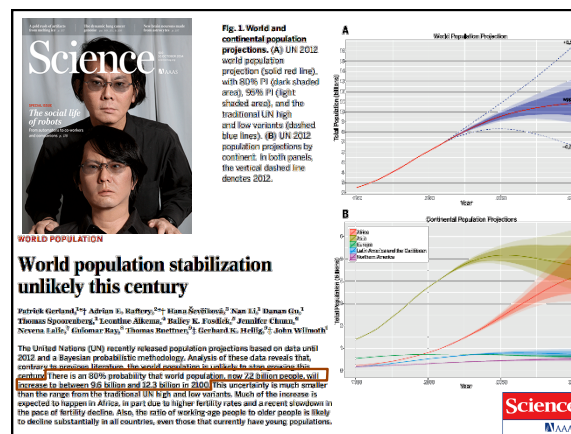
e) Transposons

f) Intoxin-like endonuclease gene transfer

g) Integrations

h) Bacteriophages

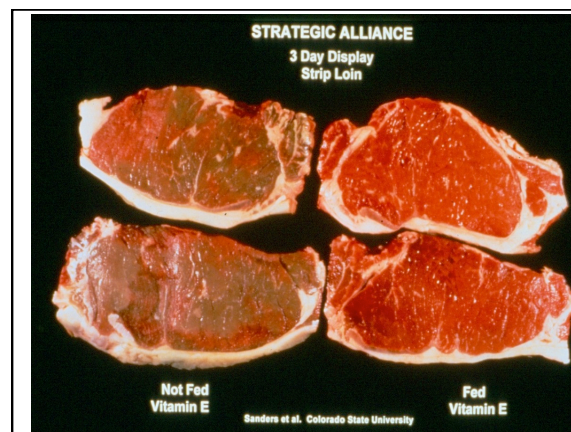
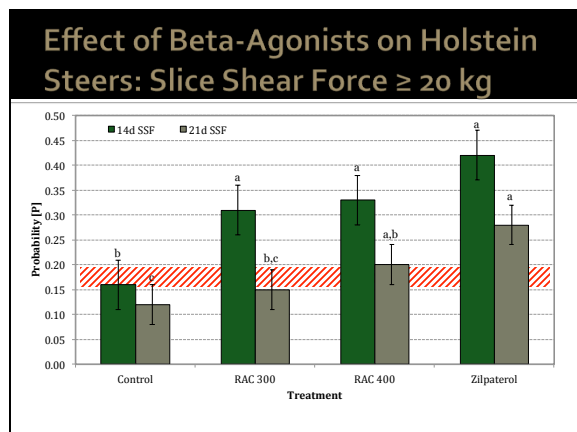
Source: *Nature Reviews Genetics*, Soucy et al., 16:472–482 (2015)



NBQA-2011 Offal Condemnations

A bar chart comparing offal condemnations between NBQA-2005 and NBQA-2011. The y-axis represents the percentage of condemnations, ranging from 0.0 to 30.0 in increments of 5.0. The x-axis has two categories: NBQA-2005 and NBQA-2011. For each category, there are five bars representing different types of offal: Liver (blue), Lung (red), Viscera (grey), Head (yellow), and Tongue (green). The values for each bar are labeled on top. In NBQA-2005, the values are Liver: 24.7, Lung: 11.5, Viscera: 11.6, Head: 6.0, and Tongue: 9.7. In NBQA-2011, the values are Liver: 20.9, Lung: 17.3, Viscera: 9.3, Head: 7.2, and Tongue: 10.0.

Category	Liver	Lung	Viscera	Head	Tongue
NBQA-2005	24.7	11.5	11.6	6.0	9.7
NBQA-2011	20.9	17.3	9.3	7.2	10.0



Emerging & Problematic Zoonotic Diseases

- > *Salmonella* spp. (especially in cattle & swine).
- > Verotoxin-producing *Escherichia coli* (especially in cattle & swine).
- > *Campylobacter jejuni* (often in poultry).
- > *Yersinia enterocolitica* (usually in swine).
- > *Listeria monocytogenes* (mainly in cattle and sheep).
- > *Staphylococcus aureus* (in cattle udders; on swine skin).
- > *Streptococcus suis*
- > Avian influenza
- > vCJD (new variant Creutzfeldt-Jakob)
- > HIV/AIDS
- > Nipah virus
- > West Nile virus
- > Hantavirus pulmonary syndrome
- > Sars

Pandemic Potential

