Reproduction

Female Reproduction System:

A. Gonads = Ovaries (2)
Primary Reproductive Organ (analogous to testes)
Female gamete → ovum (egg/oocyte)

Monotocous: One ovum produced each estrous cycle and birth to usually one young per gestation period

Produce female sex hormones:

1) Estrogen
2) Progesterone

Shape:

Cow → almond-shaped

Stages of Follicle Growth:

1) Primary Follicle - microscopic; surrounded by a single layer of follicular cells
*Females born with a lifetime supply

2) Secondary Follicle - microscopic; 2+ layers of follicle cells;no cavity (antrum)

3) Tertiary (Antral) Follicle - characterized by a fluid-filled cavity (antrum)

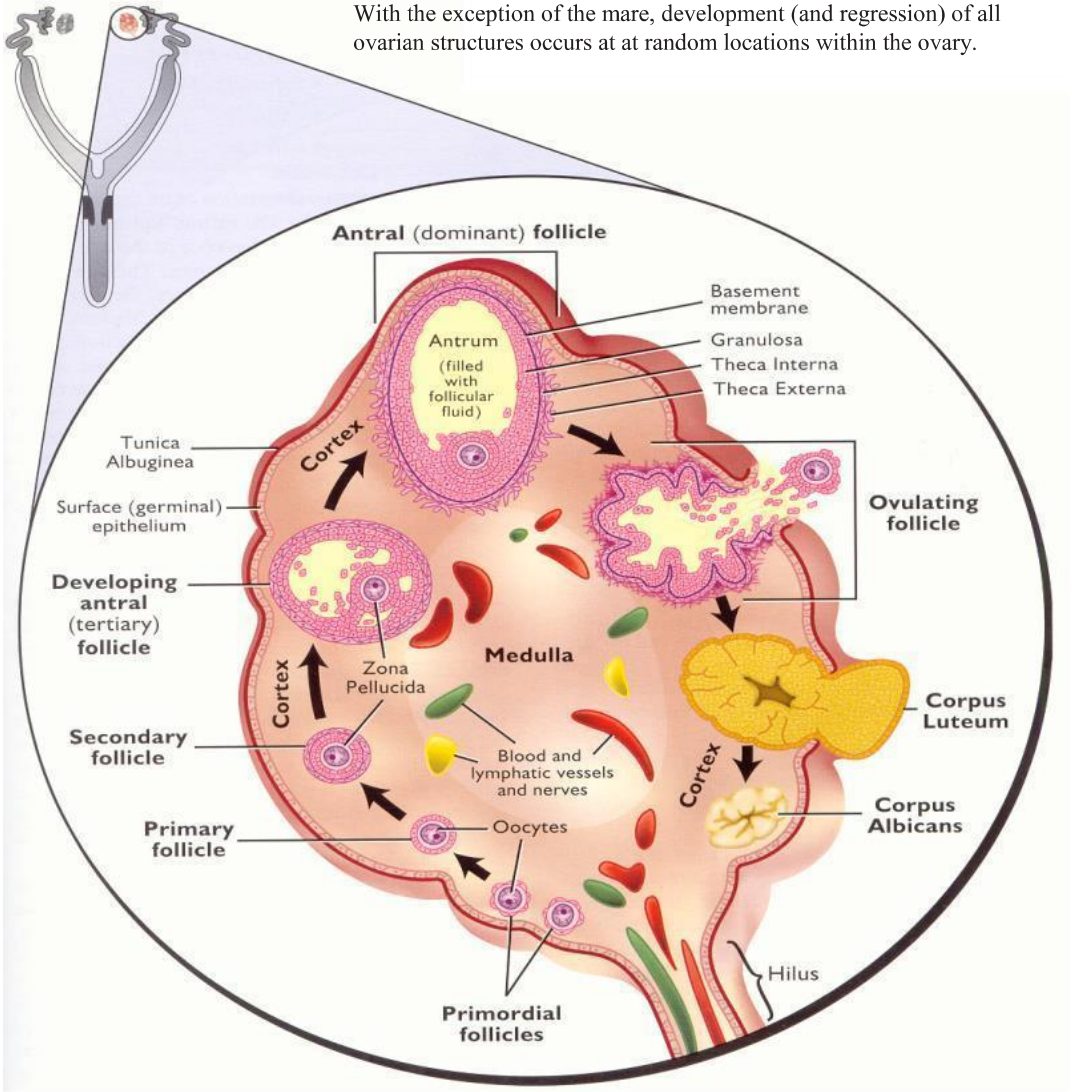
4) Graafian Follicle - dominant pre-ovulatory follicle; looks like a blister; if ovulation does not occur, the follicle will be broken down

5) Corpus Hemorrhagicum - "bloody body"; when Graafian follicles ovulate, small blood vessels rupture (hemorrhage) resulting in a blood-filled cavity

6) Corpus Luteum - solid mass of yellow-colored cells (luteal cells); produces progesterone and is essential to maintain pregnancy; formed 4-5 Days post-estrus; 13 Day life span if no pregnancy occurs; luteolysis (degeneration of C.L.)

7) Corpus Albicans - "white body"; regression of C.L.; degeneration of luteal cells

*In general, all types of follicles are present within the ovary at any point in time. However, developing and functional corpora lutea may or may not be present depending on the stage of the estrous cycle. With the exception of the mare, development (and regression) of all ovarian structures occurs at at random locations within the ovary.



Female Reproductive System:

B. Oviduct (Fallopian Tubes)
Paired, coiled tubes
Extends from near ovaries to the tips of the uterine horns
Transports the ovum and spermatozoa (opposite directions)
Site of fertilization

Three Segments:

1) Infundibulum -
funnel shaped opening near ovary with fimbria that capture ovum after ovulation

2) Ampulla (neck) -
middle segment; longitudinal folds increase surface area of lumen; ciliated cells aid movement of ovum
Ampullary-Isthmic junction (AIJ) → actual site of fertilization

3) Isthmus -
aids in transport of motile sperm to AIJ; joins the uterus at the uterotubal junction

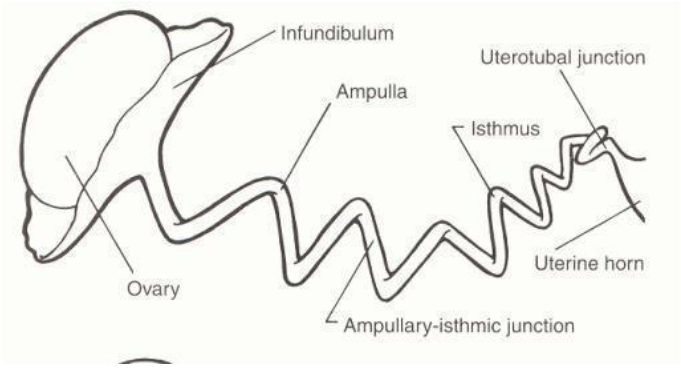
C. Uterus (The Organ of Pregnancy)

House the fetus
Two horns with a common body
Extends from uterotubal junctions to the cervix

Type of Placental Attachment

Cotyledonary
Caruncles---button like projections that allow fornutrient flow to the fetus; highly vascularized

Anatomy of the Oviduct



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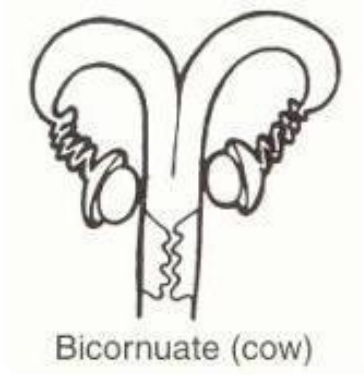
UTERINE CLASSIFICATION

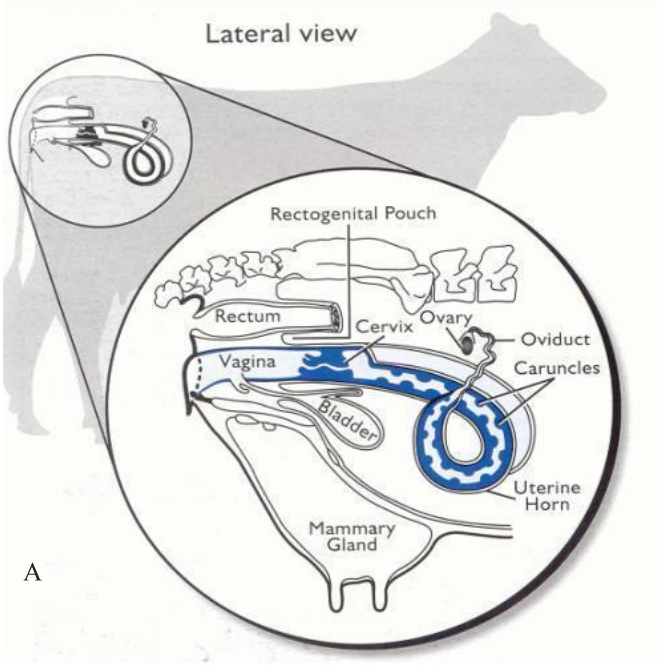


Female Reproduction System:

D. Cervix

Thick walled and inelastic
Major function → prevent microbial contamination of the uterus
Posterior end protrudes into vagina (fornix → "blind pouch")
Cervical plug protects fetus

Types of Structure:
1) Ruminants →
transverse interlocking annular rings
Cow—4 to 5 rings



A

E. Vagina (Organ of Copulation & Birth Canal)
Tubular, thin-walled, elastic
Anterior vagina →
site of semen deposition by bull

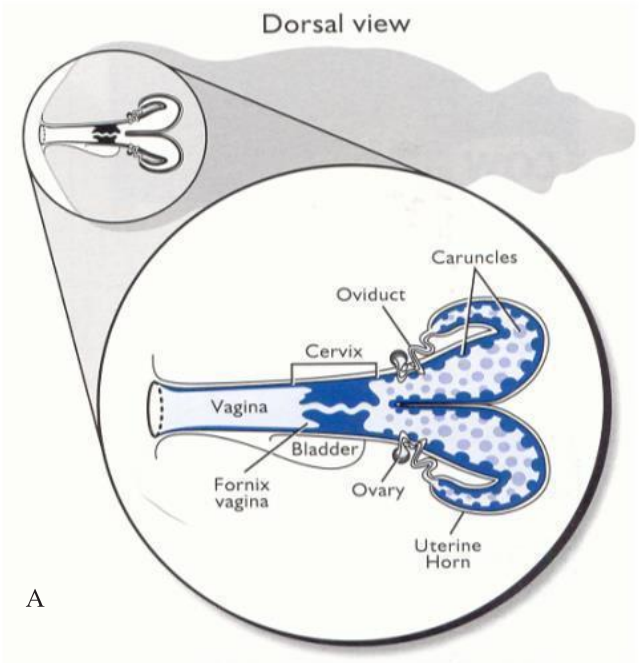
F. External Genitalia

1) Vulva
External entrance of female reproduction organs

Vestibule - portion of female duct system that is common to both the reproductive and urinary systems

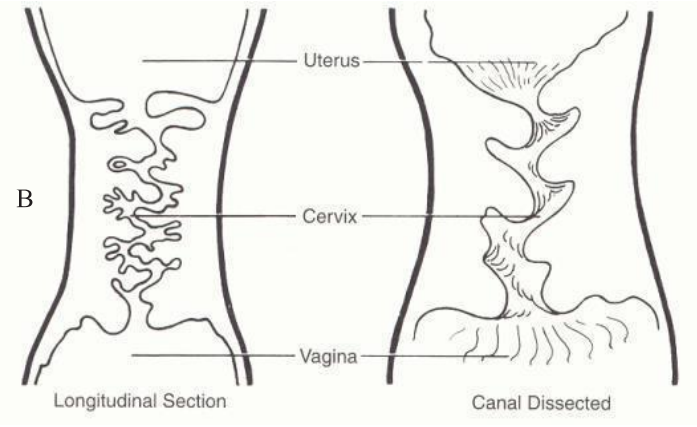
Labia - lips of the vulva

2) Clitoris
Analogous to the penis
Stimulates hormone release
For Artificial Insemination (AI), a 3 to 5 second message after semen deposition can enhance conception rate



A

G. Support, Nerves, & Blood Supply
Broad Ligament. Suspends ovaries, oviducts, & uterus from dorsal pelvic wall. Contains arteries, veins, and nerves for the female reproductive system



B

A - Senger, P.L. 2003. Pathways to Pregnancy and Parturition, (2nd edition) Current Conceptions, Inc., Pullman, Washington.

B - Bearden, H.J., J.W. Fuquay, S.T. Willard. 2004. Applied Animal Reproduction, (6th edition), Pearson Education, Inc. Upper Saddle River, New Jersey.

Male Reproductive System:

A. Gonads = Testes (2)
Primary Reproductive Organ (analogous to ovaries)
Produce male gamete → sperm (spermatozoa)
Produce male hormones → testosterone
Lie in the Scrotum

Cryptorchidism (heritable trait)

1) **Bilateral cryptorchid** -
both testes retained in body cavity→sterile

2) **Unilateral cryptorchid** -
one testis retained in body cavity→usually fertile

B. Seminiferous Tubules
Produce Sperm Cells

1) Sertoli cells -
line the seminiferous tubules and under the influence of FSH, nurture the development of sperm cells and help form the blood-testis barrier

2) Leydig cells -
sit across the blood-testis barrier from the sertoli cells and produce testosterone, under the influence of LH to aid in development of the sperm cells

C. Scrotum
Two-lobed sac that house the testes
Lined with tunica dartos muscle fibers

D. Spermatic Cord
Connects testes to their "life support mechanisms"
1) Arteries
2) Veins
3) Nerves
Muscle Fibers (Support and Temperature Control)
Contains:
1) Deferent duct (vas deferens)
2) Blood vessles
3) Nerves (support)
4) Cremaster muscle

E. Temperature Control
Temperature of testes should be ~ 4 degrees Celsius below body temperature

1) Increased temperature →
sperm cell abnormality and/or death

2) Decreased fertility

MECHANISMS FOR REGULATION
1) Scrotum -
tunica dartos muscle will contract when temperature falls → skin wrinkles

2) Cremaster muscle -
temperature falls and muscle contracts →
pulls testes closer to the body

3) Pampiniform plexus—complex network of blood vessels that cool the blood entering the testes

F. Rete Testes
Tubules which transport spermatids from seminiferous tubules to the head of the epididymis

G. Epididymis
Three Segments
1) Caput (head)
2) Corpus (body)
3) Cauda (tail)

Functions
1) Transports spermatozoa
2) Concentration of spermatozoa →
increased (caput and corpus)
3) Storage of spermatozoa (mostly in cauda)
4) Maturation of spermatozoa (caput and cauda)

H. Vas Deferens (Deferent Duct)
Transports sperm from cauda of epididymis to the pelvic urethra in preparation for ejaculation

I. Accessory Glands
Contribute to fluid volume of semen (seminal plasma)
Buffers, nutrients, and other substances needed to assure optimum motility and fertility of semen

1) Vesicular Glands (seminal vesicles)
"Knobby Appearance"
"Cluster of Grapes"
Nutrients and Buffering
2) Prostate Gland
Produces thin, watery fluid to cleanse the urethra before ejaculation
Urine is highly detrimental to sperm
3) Bulbourethral Glands (Cowper's Glands)
Account for gel-like portion of semen in boars
Helps force semen from urethra at the time of ejaculation

J. Pelvic Urethra
Passage way for semen and urine

Male Reproduction System:

K. Penis (Organ of Copulation in Males)
Glans penis → free end of penis

Different Types

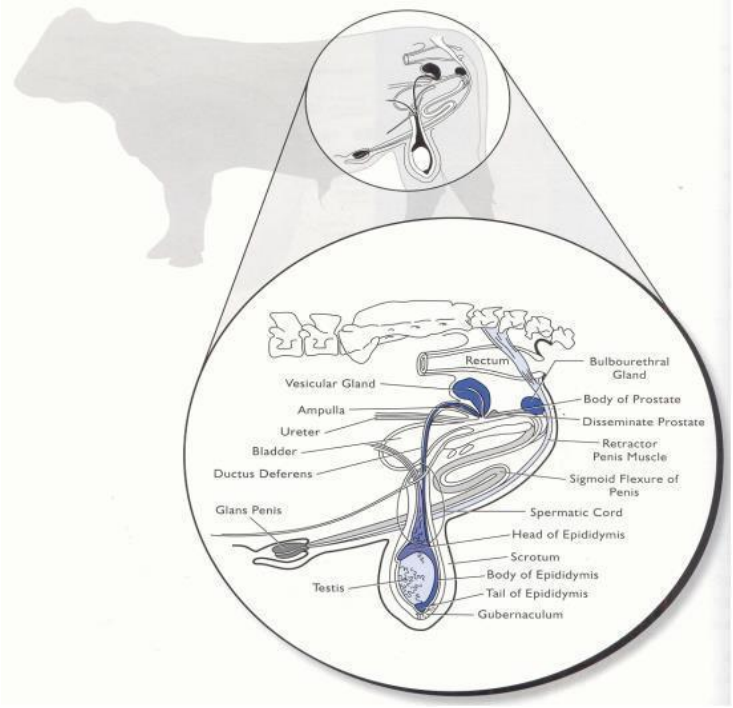
Fibroelastic Penis -
the retractor penis muscle relaxes to allow the rigid penis to extend from the prepuce, then contracts to pull the penis into the prepuce

1) Bull → Twisted groove containing the external urethral orifice

L. Prepuce (Sheath)

Completely encloses free end of the penis.
Surrounded by long and tough preputial hairs

Anatomy of the Male Reproductive Tract



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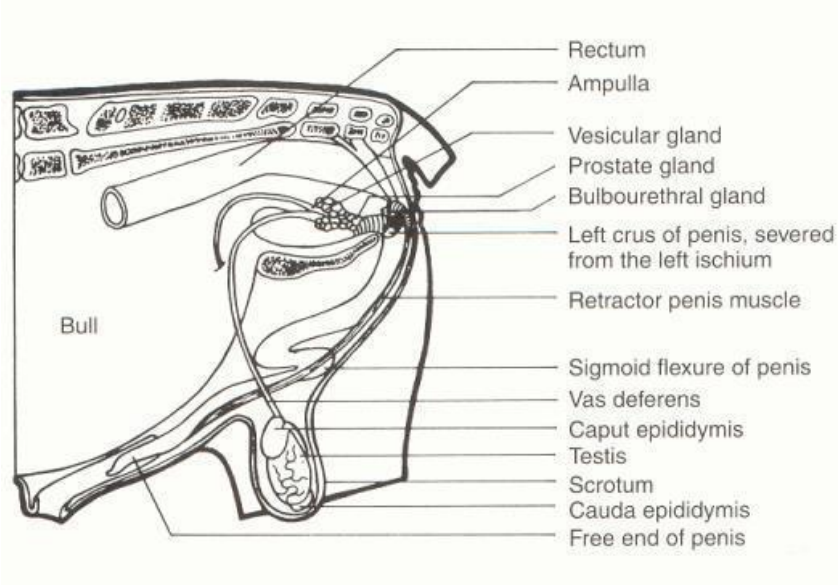


Reproductive Hormones:

A. Gonadotropin Releasing Hormone (GnRH)
Neuropeptide
Released by Hypothalamus
Controls the release of FSH and LH from its target tissue (anterior lobe of the pituitary)

B. Lutenizing Hormone (LH)
Glycoprotein
Released from the anterior lobe of the pituitary in response to GnRH

Female:
Target tissues → ovaries (cells of theca interna and luteal cells)
Actions 1) Ovulation
2) Formation of corpora lutea
3) Progesterone secretion

Male:
Target tissues → Testes (Leydig cells)
Acts to stimulate testosterone production

C. Follicle Stimulating Hormone (FSH)
Glycoprotein
Released from the anterior lobe of the pituitary in response to GnRH
Female:
Target tissues → ovaries (granulosa cells)
Actions 1) Follicular development and growth
2) Estradiol synthesis

Male:
Target tissues → testes (sertoli cells)
Stimulate sperm cell production

D. Oxytocin (OT)
Neuropeptide
Synthesized by the hypothalamus and in some species by the corpus lutuem
Stored in the posterior lobe of the pituitary

Female:
Target tissue → myometrium and endometrium of the uterus, myoepithelial cells of the mammary gland
Actions: 1) Induces milk letdown
2) Released during parturition to cause uterine contractions to aid in fetal and placental expulsion

Male:
Target tissue → Smooth muscle of epididymal tail, ductus deferens and ampulla
Actions 1) PGF2a Synthesis
2) Pre-ejaculatory movement of spermatozoa

E. Estrogen (Estradiol/E2)
Steroid
Released from granulosa cells of the mature follicle and placenta; Sertoli cells of the testis

Female:
Target tissue → Hypothalamus, entire reproductive tract and mammary gland
Actions: 1) Responsible for sexual behavior during estrus
2) Responsible for secondary sex characteristics at time of puberty
3) Relaxes cervix and increased uterine motility during estrus
4) Elevates secretory activity of entire reproductive tract

Male:
Target tissue → brain
Inhibits long bone growth
Sexual behavior
Specific function unknown, but present in all males
Especially high in stallions

F. Progesterone (P4)
Steroid
Released from the corpus luteum and placenta
Target tissues → uterine endometrium, mammary gland, myometrium and hypothalamus
Actions: 1) Endometrial secretions and prepare uterus to receive embryo
2) Inhibits GnRH release
3) Inhibits reproductive behavior
4) Maintains pregnancy

G. Testosterone (T)
Steroid
Released by Leydig cells in male and theca interna cells in female

Female:
Target tissues → brain, skeletal muscle and granulosa cells
Actions: 1) Substrate for estrogen synthesis
2) Abnormal masculization (hair patterns, behavior, voice, muscling, etc.)

Male:
Target tissues → accessory sex glands, tunica dartos muscle, seminiferous epithelium, and skeletal muscle
Actions: 1) Responsible for secondary sex characteristics in the male
2) Promotes spermatogenesis
3) Responsible for sexual behavior (libido) in the male
4) Promotes secretions from accessory sex glands

Reproductive Hormones:

H. Inhibin
Glycoprotein
Released from granulosa cells in the female; sertoli cells in the male
Target tissue → gonadotrophs of anterior lobe of the pituitary
Inhibits FSH production and secretion

I. Prostaglandin (PGF2a)
Lipid
Produced by the uterine endometrium in the female and vesicular glands in the male

Female:
Target tissues → corpus luteum, uterine myometrium and ovulatory follicles
Actions: 1) Promotes regression of CL (luteolysis) and ovulation
2) Causes uterine contrations at parturition or for cleansing the uterus

Male:
Target tissue → epididymis
Affects metabolic activity of spermatozoa and causes contractions of the epididymis

Artificial Insemination:

A bull may produce enough sperm for up to 40,000 breeding units/year; therefore, one bull could produce >300,000 units in his lifetime, especially if he was collected on a regular schedule

B. Major advantages of AI

Genetic improvement through increased use of superior sires
Disease control, especially sexually transmitted diseases (STD's)
Improved record keeping
Eliminates need for bulls kept on farm
May be more economical than natural service

C. Major disadvantages of AI

Time required for estrous detection
Percent of cows in estrous during the breeding season
Trained personnel required: 1) Service and semen supplier 2) Training as AI technician
Overuse of inferior sires

D. AI Method

1) Rectocervical - (rectovaginal) The preferred method used for breeding cattle. This method requires one hand in the rectum to guide the cervix onto the catheter passed through the vagina.

E. Recommended times for insemination (Timing is most critical for successful AI)
Cattle → AM/PM Rule. Universally accepted time for insemination. Cows detected in estrus in the morning are bred that same afternoon, those found in the afternoon are bred the next morning.

Artificial Insemination:

G. Insemination Procedures

For maximum conception, the sperm and ova must be at the site of fertilization (AJI) at the peak of their fertility.

Beef Cattle

Fertile life of the ovum

Estimate 6-12 hours; therefore, ovum is fertile 30-36 hours after the onset of estrus

Fertile life of the sperm

Sperm survival approximately 24 hours in female tract

12 hours required for capacitation

Fertility limited to the last 12 hours

Time for transport is approximately 5 minutes

H. Thaw procedures for cattle AI

Ampules (older method of semen storage): Due to the slower freezing rate, an ice water thaw is usually recommended for ampules. (Place in ice water for approximately 10 minutes)

Straws: Thaw is accomplished in a 32-35 degrees C water bath for 30 seconds. This should bring the straw to approximately 5 degrees C.

Site of insemination: The optimum site for insemination has been determined to be the body of the uterus. Second service site must be anterior to the mid-cervix to avoid possible abortion of early pregnancy.

Clitoral massage: A 5 second massage of the clitoris has been shown to improve conception as much as 8%.

Embryo Transfer:

Embryo Transfer is the movement of preimplantation embryos from the reproductive tract of the genetic/ biological mother (donor) to the reproductive tract of the surrogate mother (recipient). (The first mammalian embryo transfer was performed using rabbits in 1890 by Walter Heape.)

Objectives of ET

1) Increase productivity of genetically valuable females
2) Maximize use of valuable semen
3) Transport genetics across long distances
4) Production of identical offspring by embryo splitting

Limitations of ET

1) Expensive
2) Labor intensive
3) Requires extensive training and experience

Steps in the ET Process

1) Superovulation
2) Insemination
3) Synchronization of Recipients
4) Collection of Embryos
5) Location, Grading and Storage of Embryos
6) Deposition of Embryos into Recipient Reproductive Tract

Embryo Transfer:

Superovulation - "Follicular Rescue": The induction of follicular development in excess of the normal number. Follicle Stimulating Hormone (FSH) is the hormone used to induce superovulation in most species (4 days of treatment). The donor's estrous cycle must be controlled using synchronization agents such as Lutalyse (prostaglandin), Synchromate B (progesterone), or CIDR (progesterone vaginal implant)

Artificial Insemination of Donor: The donor should be bred with two units of semen 12 hours post estrus and with one unit of semen 24 hours post estrus.

Synchronization of Recipients: The recipients must have synchronous estrous cycles with the donor to achieve pregnancy. The cycle should be within 24 hours of the donor for the best results; however, they can be within 48 hours and still produce a pregnancy.

Effect of Recipient Synchrony on Pregnancy Rate

Donor/Recipient Synchrony	Pregnancy Rate
-36 hrs	59%
-24 hrs	61%
-12 hrs	68%
0 hrs	59%
+12 hrs	61%
+24 hrs	58%
+36 hrs	41%

Collection of Embryos: The embryos should be collected 7 days post estrus in the bovine (range 6-8 days). An epidural block is given to prevent rectal contractions by the donor. A foley catheter is inserted into the uterus and held in place by an inflated cuff. The embryos are then flushed out of the uterus using a phosphate buffered saline (PBS) solution enriched with calf serum and an antibiotic/antimycotic (1%). The solution is collected into a concentrating filter, which is ultimately rinsed into a searching dish.

Location, Grading and Storage of Embryos: The embryos are located using a dissecting microscope and then transferred into a small holding dish where they are graded based on quality. The good quality embryos are then loaded into sterile straws for transfer or freezing in nitrogen.

SUCCESS OF ET

Cattle: Average 7 transferable embryos/collection
50-60% pregnancy rate non-surgically
1/3 of collections yield 0-1 pregnancy
1/3 of collections yield 2-4 pregnancies
1/3 of collections yield 5 or more pregnancies

Evaluation

Market Animal Evaluation:

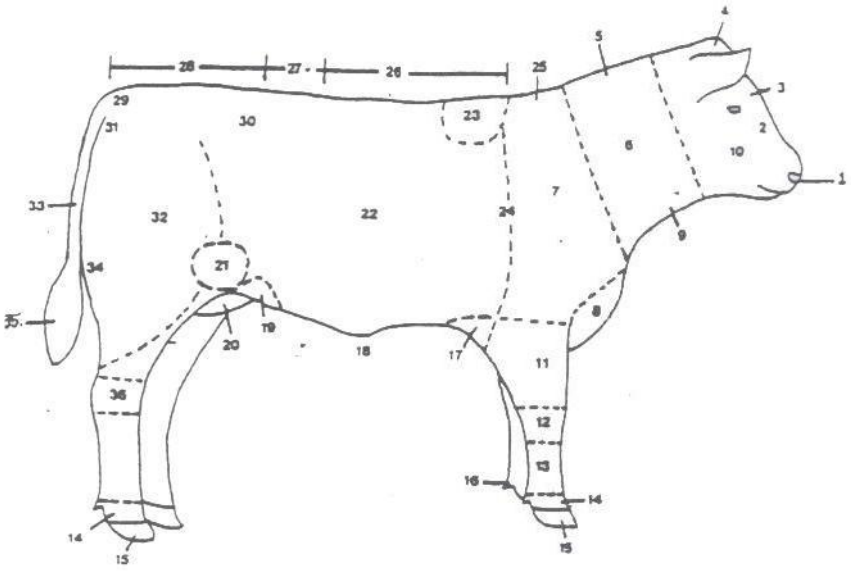
The objective of live animal evaluation is to utilize visual indicators of muscling and finish of an animal to project its carcass composition. In addition, growth rate and feed efficiency are important parameters to evaluate from the economic standpoint.

Live animal are viewed to determine carcass traits such as muscling and fat deposition. These traits are then used to calculate yield grades that determine the cutability and quality grades that determine the palatability of a carcass.

Fat thickness is the most important in determining yield grades. Young animals are shallow bodied, tucked in the rear flank and more expressive in their musculature than older animals. Fat is deposited from the front to the rear of the animal so with advancing age the brisket becomes fuller, the area behind the shoulder or elbow pocket becomes smoother, the rear flank becomes fuller and distended, the twist and flank becomes deeper, pones become noticeable and fat fills the cod and udder. Fat animals are smoother appearing and develop a **wider flatter shape to their topline**.

Muscle content of the carcass is closely related to the ribeye or loineye areas, and since muscles are proportional, **greater muscle mass or expression in one area signifies greater muscularity overall**. Ribeye or loineye area is primarily used as an indicator of carcass muscle due to ease of measurement on ribbed carcass. Visual indicators of muscularity include thickness and shape of forearm, width and fullness of the stifle as observed from the rear view, base width between hind legs when standing and walking, a rounded and expressive shape to the ribeye or loineye area located over the back and loin of lean animals, and prominent, well defined muscles in the shoulder and quarter as viewed from the side.

Light muscled animals tend to be **narrow standing and walking**. They also have minimal muscle expression to their tops and quarters, and tend to be wider across the rump than through the stifle region. Fatter animals within the light muscle designation appear wider on top and taper toward a narrow base. See body parts of market animals for locations of muscle and fat determination.



LEGEND OF PARTS

1.Muzzle	13.Cannon bone	25.Top of shoulder
2.Face	14.Pastern	26.Back
3.Forehead	15.Foot, Hoof	27.Loin
4.Poll	16.Dew claw	28.Rump
5.Crest	17.Foreflank	29.Tailhead
6.Neck	18.Sheath	30.Hook or hip bone
7.Shoulder	19.Rear flank	31.Pin bone or Pones
8.Brisket	20.Cod	32.Quarter or Round
9.Dewlap	21.Stifle	33.Tail
10.Jaw	22.Ribs	34.Twist
11.Forearm	23.Crops	35.Switch
12.Knee	24.Heart girth	36.Hock

Areas to evaluate muscle include: Forearm, Shoulder, Back, Loin, Stifle, Quarter

Areas to evaluate fat cover include: Brisket, Shoulder/Elbow Pocket, Rear Flank, Twist, Cod/Udder, Pones

Live Cattle Evaluation:

CLASSES OF SLAUGHTER CATTLE: (determined by age and sex)
Steer - Male castrated prior to development of secondary physical characteristics of mature, intact male.
Bullock - Male under approximately 24 months of age that has begun development of secondary physical characteristics of mature male (crests, thicker shoulder and quarter).
Stag - Male castrated after development of mature male characteristics.
Bull - Mature, uncastrated male.
Cow - Female that has developed (either through reproduction or age) the physical characteristics of mature female (prominent hips, large middle).
Heifer - Immature female that has not developed characteristics typical of cows.

Determining Yield Grade and Quality Grade on Live Animals:

Objective of live cattle evaluation is **to utilize visual indicators of muscling and finish of animal to project its carcass composition**. In addition, growth rate and feed efficiency are important factors to evaluate from the economic standpoint.

Yield grades reflect **cutability** and the four factors mentioned before combine to determine this value.
One of the most important factors is **fat thickness** because of its significant effect on cutability.
Young animals are shallow bodied, tucked in the rear flank, and more expressive in their musculature than older animals.
Fat is deposited from the front to the rear of the animal so with advancing age the brisket becomes fuller, the area behind the shoulder or elbow pocket becomes smoother, the rear flank becomes fuller and distended, twist and flank deepens, pones become noticeable, and fat fills the cod and udder.
Fat cattle are **smoother appearing** and develop a wider flatter shape to their topline.

A skeletal reference point to distinguish fat is the sternum.

The sternum is located approximately 3/4ths of the distance up the forearm or in other words 3/4ths of the distance from the knee to the elbow joint.
If a line is extended from this point anteriorly and posteriorly and running parallel to the ground, everything below the line would represent fat deposition.

Cattle possessing **.2 to .5 inch** of fat are generally considered acceptable.

Carcasses with **less than .2 fat** cover may encounter problems with dehydration resulting in excessive shrinkage and possible discoloration.
Cattle **exceeding .5 in. fat yield** carcasses with excessive fat trim and poorer cutabilities. In addition, the excess fat represents inefficient utilization of feedstuffs.

Muscle content of the carcass is closely related to ribeye area and since muscles are proportional, greater muscle mass or expression in one are signifies greater muscularity overall.

Ribeye area is primarily used as an indicator of carcass muscle due to ease of measurement on ribbed carcass.
Visual indicators of muscularity include thickness and shape of forearm, width and fullness of the stifle as observed from the rear view, base width between hind legs when standing and walking, a rounded and expressive shape to the ribeye located over the back and loin of lean cattle, and prominent, well defined muscles in the shoulder and quarter as viewed from the side.
Light muscled cattle tend to be narrow standing and walking, have minimal muscle expression to their tops and quarters, and tend to be wider across the rump than through the stifle region.
Fatter animals within the light muscle designation appear wider on top and taper toward a narrow base.
Average muscled cattle weighing 900-1250 lbs. possess approximately 1.1 in.2 of ribeye area/100 lb. Adjustments can be made up or down to accommodate varying degrees of muscularity.

Continued on next page.

Determining Yield Grade and Quality Grade on Live Animals:

Live Weight, lbs	Average REA, in^2
1300	14.3
1200	13.2
1100	12.1
1000	11.0

At the same weight, bullocks have 1.0 in2 more than steers and heifers have 1.0 in2 less than steers.

Kidney, heart and pelvic fat percentages are obviously impossible to determine on live cattle but due to its moderate correlation with fat thickness at 12th rib, an estimated KPH can be derived based on subcutaneous fat estimates from this table:

Estimate of Fat Thickness	Estimate of % KPH
.1	< 2.0
.2	2.5
.4	3.0
.6	3.5
.8	4.0

At the same weight, bullocks would be expect to have 1.0% less KPH fat and heifers 1.0% more KPH fat than steers. Dairy breeds average 1.5% more KPH fat than beef breeds of similar weight.

Marbling:

The **fat thickness measurement at the 12th rib** is generally utilized to **predict quality grade** even though it is well documented in scientific data from numerous studies that the relationship between the two factors is minimal. It is assumed that fatter cattle have greater marbling and vice versa for leaner cattle. However, **days on feed is a stronger prediction of marbling** as cattle fed concentrate for longer periods of time possess increased amounts of intramuscular fat relative to cattle fed shorter periods of time.

Dressing Percentage:

Dressing percentage of the live animal is best predicted by the relationship to quality grade as both are influenced by finish. It is calculated by dividing carcass weight by live weight. Average dressing percentage values for the 8 quality grades are listed below:

Quality Grade	Dressing Percentage
Prime	64
Choice	62
Select	60
Standard	57
Commercial	57
Utility	53
Cutter	49
Canner	45

Factors that affect dressing percentage include:

- Amount of fill
- Degree of finish
- Weight of hide, head, and shanks
- Muscling
- Mud

Average dressing percent for cattle is 62%.

Cutability:

The USDA beef yield grades determine cutability or the yield of boneless, closely trimmed retail cuts from the **round, loin, rib and chuck**. USDA yield grades range from 1 to 5 with a number 1 representing a high cutability and a 5 representing a low cutability carcass. Therefore, an inverse relationship exists between yield grade and cutability. The expected yield of boneless, closely trimmed retail cuts for each of the yield grades are shown on next page.

Beef yield grades are determined by using four factors:

1. External fat thickness over ribeye at 12th rib
2. Ribeye area
3. Kidney, pelvic, and heart fat
4. Carcass weight

Cutability:

USDA Yield Grade	% Boneless Closely Trimmed Retail Cuts
1	>52.3
2	50.0-52.3
3	47.7-50.0
4	45.4-47.7
5	≤45.5

A method for determining yield grade is presented below:

1) First determine a preliminary yield grade (PYG) by measuring the fat thickness over the ribeye at a point three-fourths of the length of the ribeye from the chine bone. This measurement is adjustable either upward or downward based on amounts of subcutaneous fat on other parts of the carcass.
The base PYG is 2.00, which correlates with no fat cover and increases .25 with each .1 inch increase in fat measurement.

Fat Thickness Over Ribeye	PYG
.1	2.25
.2	2.50
.4	3.00
.8	4.00
1.0	4.50
1.2	5.00

2) Next adjust for **carcass weight** deviation from **base of 600 pounds**. Adjustment is **.4 for 100 pound increments**. The adjustment is added to the PYG if the carcass weight is heavier than 600 and the adjustment is subtracted if lighter than 600.

Adjustment to PYG	Carcass Weight
-.8	400
-.4	500
-.2	550
-0-	600
+.2	650
+.4	700
+.8	800
+1.2	900

3) The adjustment for muscle content of the carcass is made by measuring or estimating ribeye area. The base is 11.0 in2 and the adjustment factor is .33 for each square inch deviation from the 11.0 in2. Subtract the.33 adjustment to the PYG for each square inch of ribeye exceeding 11.0 in2 and add.33 in the ribeye area is less than 11.0 in2.

Think about adjustment in this way, if the animal has a larger ribeye, it indicates heavier muscling and this would improve or reduce the yield grade toward 1. Conversely, a smaller ribeye and lighter muscling would raise the yield grade toward 5. A ribeye area adjustment table follows:

Ribeye Area, in^2	Adjustment to PYG
9.0	+.67
10.0	+.33
10.5	+.17
11.0	-0-
11.5	-.17
12.0	-.33
13.0	-.67
14.0	–1.00

4) The final adjustment to PYG is for percentage kidney, heart, and pelvic fat. The base is 3.5 percent and a 1 percent change from the base results in a .20 change in the yield grade. If KPH is greater than 3.5%, add adjustment, and if less than 3.5%, subtract adjustment.

% KPH	Adjustment to PYG
1.0	-.5
1.5	-.4
2.0	-.3
2.5	-.2
3.0	-.1
3.5	-0-
4.0	+.1
4.5	+.2
5.0	+.3

Cutability:

Calculate the final yield grade to the nearest .1 of a grade adding and/or subtracting adjustments to or from PYG.

Example Calculation of Yield Grade:

Fat Thickness	0.4
Carcass Weight	785.0
Ribeye Area	13.8
% KPH	2.0

PYG based on .4 fat thickness 3.00
2.0 + 1 (adjustment for fat thickness)

Adjustment for carcass weight
785 – 600 = 185
185/100 = 1.85
1.85 * .4 = +0.74

*Adjustment of .74 is ***added*** to PYG because carcass weight > 600 lbs.

Adjustment for ribeye area
13.8 – 11.0 = 2.8
-2.8 * .33 = -0.93

**Adjustment of .93 is subtracted from PYG because REA > 11.0.*

Adjustment for % KPH
2.0 – 3.5 = -1.5
-1.5 * .2 = -0.3

Adjustment of .3 is **subtracted from PYG because % KPH < 3.5%.*

Final Yield Grade 2.51

In the commercial industry, USDA graders visually evaluate carcasses and place a whole number yield grade on the carcass. The number appears inside a shield and under this system a USDA yield grade 2 denotes anything from 2.01 to 2.99. The system works similarly for the other grades.

Second Example:

Fat Thickness	0.5”
Carcass Weight	850 lbs
Ribeye Area	14.8
% KPH	4.0%

Final Yield Grade 3.10

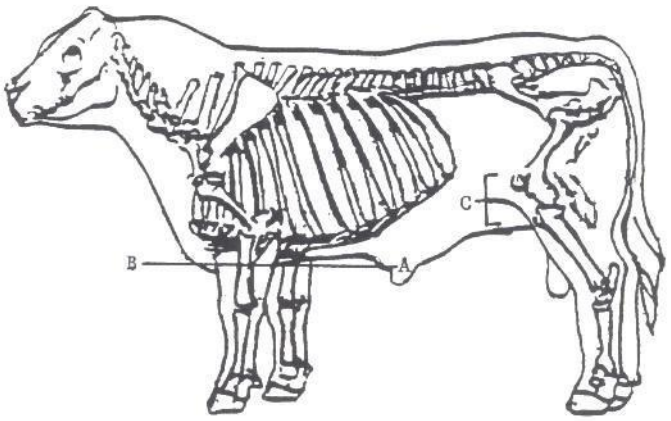


Figure A. Skeleton showing outline of trim bull.

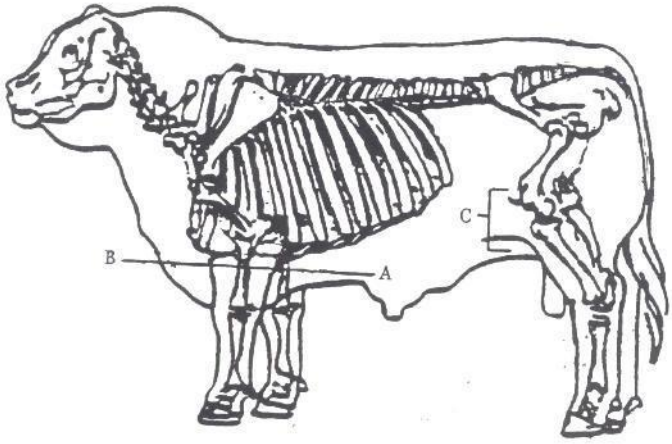


Figure B. Skeleton showing outline of wasty bull.

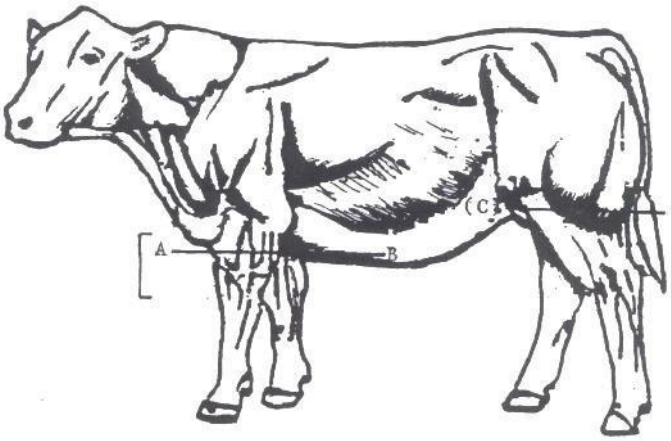


Figure C. Musculature after removal of hide and fat

Slaughter Cattle Yield and Quality Grading:

EXPLANATION OF FACTORS USED IN SLAUGHTER CATTLE YIELD AND QUALITY GRADING

Grades of slaughter cattle are intended to be directly related to the grade of the carcasses they produce. To accomplish this they are based on two factors: (1) quality or palatability indicating characteristics of the lean referred to as "quality grade" & (2) quantity or cutability based on the indicated carcass percent of trimmed boneless major retail cuts referred to as "yield grade".

Quality Grade: Slaughter cattle quality grades are based on palatability factors. Quality is evaluated primarily by finish, age & quality (marbling, maturity, color, firmness & texture of lean). Estimate to nearest 1/3 of grade (Prime or Choice), 1/2 grade (Select or Standard) & Utility.

Yield Grade: The yield grades for slaughter cattle (U.S. #1, U.S. #2, U.S. #3, U.S. #4, U.S. #5) are based on the same factors as used in the official yield grade standards for beef carcasses. Those factors are as follows:

1) Fat Thickness at the 12th Rib: One measurement over the ribeye at the 12th rib. Range from 0.1 to 1.0 inch.
2) %KPH: Kidney, pelvic and heart fat expressed as a percent of carcass weight. Range from 1% to 6%.
3) Carcass Weight: Live Weight X Dressing Percentage
4) Ribeye Area: Estimate in sq. inches at 12th rib. Average is 1.1 sq. inches per 100 pounds live weight.

USDA PERCENT FACTORS CHANGE REQUIRED YIELD RETAIL AFFECTING TO MAKE ONE YIELD GRADE CUTS CUTABILITY GRADE CHANGE

1 = ≥52.4%	Fat over the ribeye	.4 inch
2 = 50.1% thru 52.3%	%KPH	5%
3 = 47.8% thru 50.0%	Ribeye area	3 inches sq.
4 = 45.5% thru 47.7%	Warm carcass weight	250 pounds
5 = ≤45.4%		

Dressing Percentage: Range from 57% to 67%.
Mainly affected by the amount of fill; degree of finish; weight of hide, head and shanks and muscling.

Percent Cutout: percent retail cuts or carcass percent of boneless, closely trimmed retail cuts from the loin, rib, round and chuck. Range from 43% to 55%. Mainly influenced by percent trimmable fat. (Base: 1,000 lb. steer; .4 inch fat; 3.5% KPH; 11.0 square inch ribeye = 3.0 yield grade = 50% cutout.

GUIDE TO EVALUATION OF SLAUGHTER CATTLE
U.S. SLAUGHTER STEER GRADES

U.S. YIELD GRADES

Yield Grade 1 Yield Grade 2

Yield Grade 3 Yield Grade 4

Yield Grade 5

U.S. QUALITY GRADES

Prime Choice

Select Standard

Utility

Document Revised by D. B. Griffin and L. L. Boleman, August, 2004
Photos: USDA Agricultural Marketing Service, July 2001

LIVE CATTLE EVALUATION

STEER 1	EST	ACT	STEER 2	EST.	ACT.
Description			Description		
Live Weight			Live Weight		
Dressing %			Dressing %		
Carcass Wt.			Carcass Wt		
Fat Thickness			Fat Thickness		
Rib Eye Area			Rib Eye Area		
Percent KPH			Percent KPH		
Yield Grade (to nearest tenth)			Yield Grade (to nearest tenth)		
Quality Grade (to nearest third)			Quality Grade (to nearest third)		

STEER 3	EST	ACT	STEER 4	EST.	ACT.
Description			Description		
Live Weight			Live Weight		
Dressing %			Dressing %		
Carcass Wt.			Carcass Wt		
Fat Thickness			Fat Thickness		
Rib Eye Area			Rib Eye Area		
Percent KPH			Percent KPH		
Yield Grade (to nearest tenth)			Yield Grade (to nearest tenth)		
Quality Grade (to nearest third)			Quality Grade (to nearest third)		

USDA Beef Yield Grades Short Cut Method

Best 1 2 3 4 5 Worst

Yield Grade 3.0 = 0.4" FT - 600 # cw - 11.0 sq" REA - 3.5% KPH

•PYG - Preliminary Yield Grade-Starting Point for every 1 increases in adjusted 12-13th rib fat thickness, PYG increases by .25

12-13th Rib Fat	PYG
0.00	2.00
0.10	2.25
0.20	2.50
0.30	2.75
0.40	3.00
0.50	3.25
0.60	3.50
0.70	3.75
0.80	4.00

• Adj. 1 - Adjustment 1-Carcass Weight For every 100 pound change from a 600 pound carcass weight adjust the PYG by ± .4

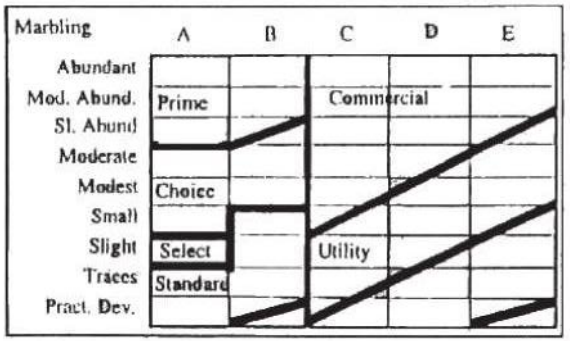
Carcass Weight	Adj. 1
850	+ 1.0
800	+ .8
750	+ .6
700	+ .4
650	+ .2
600	none
550	- .2
500	- .4

•Adj. .2 - Adjustment .2 - Ribeye Area For every 1 square inch from an 11.0 sq in. ribeye area adjust the PYG by ± .33

Ribeye Area	Adj. 2
14.0	- .99
13.5	- .82
13.0	- .66
12.5	- .49
12.0	- .33
11.5	- .16
11.0	none
10.5	+ .16
10.0	+ .33
9.5	+ .49

• Adj. 3 - % Kidney, Pelvic & Heart Fat (KPH) For every 1.0% change in Kidney, Pelvic, and Heart Fat (KPH) from 3.5% adjust the PYG by ± .2

% KPH	Adj. 3
1.0	- .50
1.5	- .40
2.0	- .30
2.5	- .20
3.0	- .10
3.5	none
4.0	+ .10
4.5	+ .20
5.0	+ .30



Nutrition

Comparative Digestive Systems:

Ruminants

Cud chewing animals with a multi-compartment stomach. By means of microbial fermentation in the rumen, such animals are able to utilize high fiber feeds.

Mouth:
No upper incisors, upper dental pad and lower incisors, chew with lateral jaw movements.
Salivary glands secretion is relatively continuous, 12 gallons per day in an adult bovine, and 2 gallons per day in sheep.
Contains no enzymes, but provides a source of nitrogen (urea), phosphorus, and potassium, which are utilized by rumen microbes.
Saliva is highly buffered which aids in maintaining an appropriate pH in the rumen.

Esophagus:
Ingested material moves via a series of muscular contractions, capable of moving both ways in the ingestion and cud chewing process.

"Stomach": (Divided into four compartments)

1. Reticulum (Honeycomb Pattern):
Most cranial compartment, not completely separated from the rumen
Walls are lined with mucous membrane containing many intersecting ridges, which subdivide the surface into a honeycomb surface.

2. Rumen (largest compartment in mature bovine):
Large, hollow, muscular compartment which extends from the diaphram to the pelvis and nearly fills the left side of the abdominal cavity. Up to 55 gallons capacity in the large dairy cow.
Walls of the rumen lined with papillae.
Walls secrete no enzymes.

Functions include:

- Storage
- Soaking
- Physical mixing and breakdown
- Fermentation chamber – provides an ideal environment for microbial activity (bacteria and protozoa) as it is anaerobic, warm (102^{o}F), dark, and has a desirable pH of 5.5~6.5

This extensive pregastric fermentation results in:
Bacterial synthesis of water soluble vitamins and vitamin K
Bacterial synthesis of amino acids and protein. Bacteria combine nitrogen, or a nonprotein nitrogen source with a carbohydrate skeleton from carbohydrate sources to form their own body protein. These bacteria are then digested by the host animal.
Breakdown of fibrous feeds. Bacteria contain enzymes that break the cellulose bonding. The end products are VFAs, or volatile fatty acids, (acetic, butyric, and propionic) which are absorbed through the rumen wall and serve as a source of energy to the hose animal.

3. Omasum (Manyplies):
Located to the right of the rumen and reticulum. A spherical organ filled with muscular lamine which are studded with short papillae.
Function appears to be reduction of particle of particle size and water absorption.

4. Abomasum (True Stomach):
First glandular portion of the ruminant GIT
Located ventral to the omasum and extends caudally on the right of the rumen.
Essentially the same as the stomach in a non-ruminant

Ruminant Stomach Development

	Birth	4 Months	Mature
Rumen	25%	75%	80%
Reticulum	5%	5%	5%
Omasum	10%	9%	7%
Abomasum	60%	11%	8%

Small Intestine and Large Intestine:
These areas of the ruminant GIT are similar in structure and function to the pig.

Additional peculiarities of the ruminant digestive system:
Gastric or esophageal groove: in young ruminants
A passageway extending form the cardia (esophageal opening) to the omasum, formed by two heavy muscular folds.
Functions to allow milk consumed by the suckling animal to bypass the reticulo-rumen and thus escape bacterial fermentation.

Comparative Digestive Systems:

Ruminant Digestive Tract

Rumination:
Cattle average 8 hours per day ruminating.
One cycle requires about one minute.
Permits animal to graze quickly, then complete chewing later.

Eructation (belching of gas):
Microbial fermentation in the rumen produces large amounts of CO2 and methane.
If these gasses are not released the animal will bloat, which can result in death. In most cases of bloat, a stable foam is produced in the rumen thus the animal cannot eliminate the gasses.

RUMEN FUNCTION

Rumination – Involves the following processes:

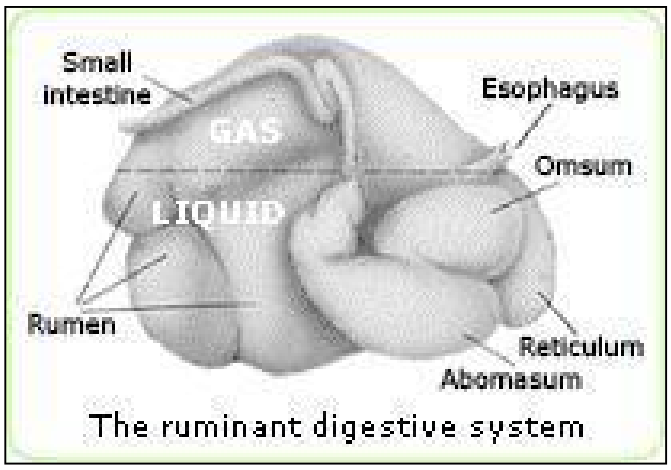
Regurgitation
Controlled form of vomiting, which enables the ruminant to pass semi-liquid rumen contents from the rumen through the esophagus back to the mouth

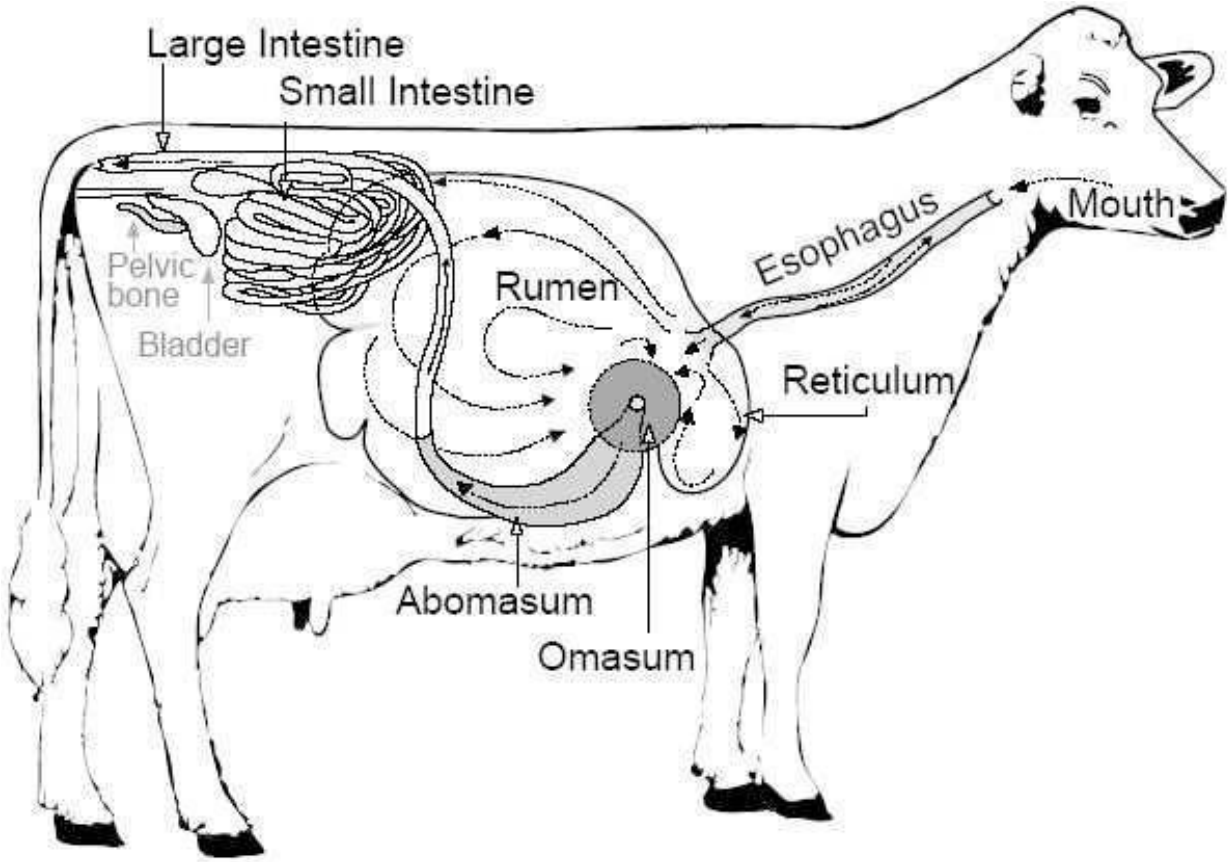
Remastication
Process of rechewing. During this process, feed particles are further reduced and mixed with saliva.

Rensalivation
This process involves secretion of more saliva.

Deglutition
Reswallowing

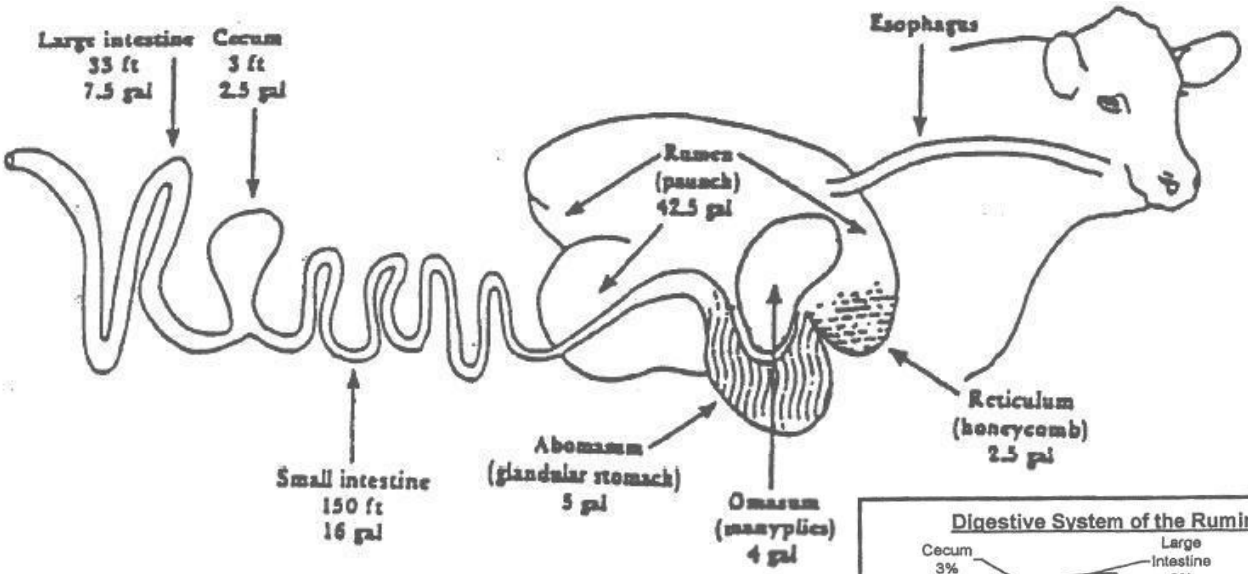
Eructation
Process of expelling gases (i.e. CO2, CH2, H2) from the rumen

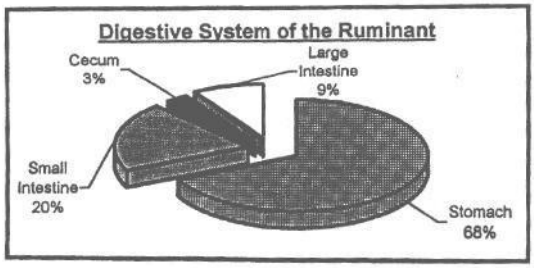




Comparative Digestive Systems:

Ruminants





Ration Balancing:

Simultaneous Equations - Energy and Protein

Step 1. Nutritive Requirements - NRC Tables

Step 2. Available Feeds

CP, DE content
cost / lb.
NRC table lists nutrient content of feeds

Step 3. Determine if any fixed amounts

Fixed ingredient - subtract lbs. of CP and mcals of DE from daily requirement of animal

Step 4. Set up two separate equations, one for CP and one for DE

% CP feed 1 (x) + % CP feed 2 (y) =
lbs. CP per day
mcal DE feed 1 (x) + mcal DE feed 2 (y) =
mcal DE per day

Formulate a ration to meet daily CP and DE needs of a 1320# horse utilizing corn and alfalfa hay.

Requirements: 2.57 lbs. CP, 29.1 mcal DE
Corn:
10% CP, 1.8 mcal DE / lb.
Alfalfa Hay:
17% CP, 1.2 mcal DE / lb.

Example

$.10x + .17y = 2.57$
$1.8x + 1.2y = 29.1$

Step 5. Solve for y, then x.

$1.8\ (.10x + .17y) = (2.57)\ 1.8$
$-.10\ (1.8x + 1.2y) = (29.1)\ -.10$

$.18x + .306y = 4.626$
$-.18x - .120y = -2.910$
$.186y = 1.716$
$y = 9.23$ lbs. Alfalfa Hay

Step 6. Substitute in y, solve for x.

$.10x + .17\ (9.23) = 2.57$
$.10x = 2.57 - 1.57$
$.10x = 1.0$
$x = 10$ lbs. Corn

Step 7. Check

		CP	mcal DE
9.23 lbs	Alfalfa Hay	(17%) * 1.57#	(1.2) = 11.1
10.0 lbs	Corn	(10%) * 1.00#	(1.8) = 18.0
		2.57#	29.1

Processing & Products

Harvest Section:

TEN BASIC STEPS OF COMMERCIAL HARVEST OF MEAT ANIMALS

A. Stunning or Immobilization

Methods of stunning (all are approved humane methods)

1. Mechanical
   (hammer, humane stun gun or pistol - captive bolt)

Stunning - A method used to render an animal unconscious, but the circulatory and respiratory systems still function. (Animal does not feel pain)

1. Purpose is to permit the heart to continue to pump and therefore remove the majority of blood from the carcass.
   a. Blood is excellent media for microbial growth.
   b. Provides for a more wholesome product.

B. Bleeding

1. Severing the carotid artery or jugular vein or both.
   a. The most humane way of dying.
   b. Same procedure for cattle and swine
   c. Sheep are stuck behind the lower jawbone (mandible).

C. Head removal

1. Atlas Joint (all species) -
   Between atlas vertebra and occipital condyles

D. Hide removal

1. Cattle (hide puller)
   a. Skin and hair are removed by using a knife, blade or electrical hide puller (hide puller typically used in major packing plants)

(1) Aids in the prevention of shrinkage in the cooler

E. Removal of feet and toenails

1. Cattle - Removed at the knee and hock

F. Evisceration

Removing the digestive, respiratory and circulatory organs from the abdominal and thoracic cavities. Contents of these two cavities are known as VISCERA (abdominal) and PLUCK (thoracic - trachea, lungs and heart). Weasand rod is used to loosen the esophageal attachment.

Open the abdominal & thoracic cavities along the ventral center of carcass.

G. Splitting

Cattle are split.

Harvest Section:

H. Washing

125 lbs minimum pressure
Removes bone, dirt and some microbes

I. Inspection

State - sales within the state
Federal - Interstate sales
Municipal - Within the city
Inspectors
Veterinarians
Lay

Antemortem - Look at animals live within 24 hours of harvest. Classified as US Passed, US Suspect or US Condemned.

Postmortem - View lymph nodes, internal organs and lean tissue to ensure wholesomeness.

J. Cooling or chilling (removing body heat)

1. Blast chilled first at 28°F
2. Cooler storage at 36°F

II. DRESSING PERCENT - DIGESTIVE SYSTEMS - DRESS-OFF - BY-PRODUCTS - CARCASS COST - LIVE COST

A. Dressing Percent

1. Ratio of carcass weight to live weight
2. Calculation - carcass weight x 100
   live weight
3. Factors that influence dressing %
   a. Fill (abdominal and thoracic contents)
   b. Digestive tract type
   c. Fat
   d. Muscle
   e. Manure and mud

B. Digestive Systems

1. polygastric (ruminant) -
   4 compartments, cattle and sheep

C. Offal or dress-off Items (any organ or body part which does not remain with the carcass)

1. Blood
2. Feet and shanks
3. Hide (most valuable by-product)
4. Viscera
5. Head
6. Liver
7. Heart

D. By-products

1. Edible - Heart, liver, tongue, ox-tail, blood, kidneys, thymus and stomach (tripe)
2. Inedible - Hide, shanks, feet, head, viscera contents, blood, stomach and intestines

E. Carcass cost = live value per hundred pounds
   dressing percentage

F. Live cost = carcass value per 100 pounds x
   dressing percentage

Glossary of Meat Evaluation and Grading Terms:

I. Definitions of General Terms:

A. Cutability - Ratio of retail cut weight (trimmed, boned or partially boned) to carcass weight. It is related to carcass fatness and muscling. It is the proportion of the carcass that is salable as trimmed (boned or partially boned) retail cuts.

B. Quality - Those desired characteristics of lean, fat and bones associated with palatability, acceptability and marketability. These characteristics can include marbling, color, firmness, texture and bone maturity.

C. Leanness - Ratio of total muscle to total fat.

D. Muscling - Ratio of total muscle to total bone.

E. Trimmable Fat - That fat which exceeds the maximum level which could be sold on a retail cut.

II. Definitions of Specific Terms:

A. Quality Terms:

1. Marbling - Intermingling of fat (intramuscular fat) within the lean, observed in the rib eyes of beef and lamb carcasses and loin eyes of pork carcasses. It is a major quality factor. Marbling has three components: amount or degree, texture and distribution of flecks. In beef, prime has the least variation in eating quality; standard has most variation for A and B maturity carcasses.

Glossary of Meat Evaluation and Grading Terms:

II. Definitions of Specific Terms:

A. Quality Terms (continued):

2. **Color -** Usually refers to the color of lean observed in the rib eyes of beef and lamb carcasses and loin eyes of pork carcasses; between the ribs or in the flanks of pork and lamb carcasses, in the face of the ham of pork carcasses and in the cut surface of beef wholesale cuts and hams. It is also a major quality factor. In pork, two-toned color is considered undesirable.

(Color can also refer to subcutaneous fat. A white fat is preferable to yellow fat.)

The color of lean in beef is bright, cherry red to dark red.
The color of lean in pork is grayish pink to grayish red.
The color of lean in lamb is light pink and in mutton bright red.

3. **Firmness -** Firmness is the straight edged appearance of the cut surface of rib, loin eyes and wholesale cuts. Also, it refers to freedom from muscle separation or sagging in wholesale cuts. It is a quality indicating factor.

4. **Texture -** Texture is the coarseness or fineness of the grain of the lean as observed in rib and loin eyes and cut surfaces. Fine texture feels like velvet to the touch and appears smooth and glossy to the eye; whereas, coarse texture feels like a turkish towel and dull in appearance. Fine texture is associated with tenderness. It is a quality-indicating characteristic.

5. **Feathering -** Fine streak of fat intermingled with the lean between the ribs (intercostal muscles) of beef, lamb and pork carcasses. It is a quality factor in lamb grading and judging.

6. **Flank lacing or streaking -** Lacing or streaking of fat within the lean tissue in the flank region of beef and lamb carcasses. It is an important quality factor in lamb grading.

7. **Youthfulness (age or maturity) -** Chronological age of the carcass or cut as determined by the physiological appearance of bone and cartilage. It is a factor of importance in lamb and beef quality and grading. There are four general maturity group classifications:

Very young is the most youthful maturity group. It is characterized by very red and porous bone and the redness is displayed in the entire rib or in the feather bone. Buttons are always present and they are very soft and easily dented.

Young is the second maturity group. It is characterized by red and porous bone, but slight evidence of the disappearance of the redness in the ribs and feather bones. Buttons are always present and they are soft and easily dented.

Intermediate is the third maturity group. It is characterized by only slight redness in the rib and feather bones. Buttons are always present, but they may show slight evidences of ossification. The buttons are not always easily dented.

Mature is the oldest maturity group. It is characterized by hard, white, flinty feather bones and ribs lacking redness. Buttons are seldom distinguished but rather appear as ossified tips of the feather bones.

8. **Buttons -** Soft cartilage tips on the outside of the chine bones that ossify as an animal matures.

9. **Chine bone -** Split spinous processes that extend from the vertebrae or backbone toward the dorsal side of the back.

10. **Thoracic vertebrae -** Vertebrae of the backbone anterior to the lumbar vertebrae and posterior to the cervical vertebrae. The maturity of the thoracic vertebrae are important in beef grading.

11. **Cervical vertebrae-** Vertebrae of the backbone anterior to the thoracic vertebrae. The first cervical vertebra is commonly called the atlas point. This is the location for head removal in the slaughter operation.

12. **Lumbar vertebrae-** Vertebrae of the backbone posterior to the last thoracic vertebrae (last rib) and just anterior to the sacral vertebrae. They are useful in determining carcass maturity, especially between B and C maturity beef carcasses.

13. **Sacral vertebrae -** Vertebrae of the backbone posterior to the lumbar vertebrae. They are used in determining maturity.

14. **Break joint -** Evidence of youthfulness in lamb carcasses. It is the rough or jagged edge of the fore shank, or trotter, of lamb used to differentiate lamb from mutton carcasses. This is opposed to a spool joint (looks like a spool) found on yearling lamb and mutton carcasses.

Glossary of Meat Evaluation and Grading Terms:

B. Fat:

1. **Backfat** - Deposit of subcutaneous (outside) fat over the back of a carcass. The amount of backfat on a carcass is an excellent means of determining the yield of percentage trimmed retail cuts.

2. **Backfat Thickness** - 10th or last rib on pork, 12th - 13th rib on beef and lamb. It is a strong direct measurement of fatness and a strong inverse measurement of carcass leanness.

3. **Fat Thickness over the Rib Eye** - Measured three-fourths the length of the rib eye between the 12th and 13th ribs in beef carcasses. It is measured at the midpoint of a rib eye between the 12th and 13th ribs of a lamb carcass. An important measurement made in estimating muscling for yield grade determination in beef and lamb.

4. **Fat Thickness over the Loin Eye** - Measured three quarters of the length of the loin eye between the 10th and 11th ribs in pork carcasses. An excellent measure of carcass fatness and muscling.

5. **Seam fat** - Deposits of fat between muscles (intermuscular fat). Usually observed in wholesale cuts and large amounts are undesirable. There is more seam fat present in the anterior portion of a carcass than in the posterior.

C. Muscling

1. **Eye Muscle** - The large muscle (longissimus dorsi) along the backbone found in ribeyes and in the rib and loin cuts. It is used to evaluate quality (marbling, color firmness and texture), muscling and trimness.

D. Sex

1. **Gracilis Muscle** - It is the muscle over the aitch bone which is bean shaped in heifer carcasses and diamond shaped in steers.

2. **Pizzle Eye** - It is the white disc-like tissue immediately behind the aitch bone from which the penis was removed from the carcass. It is used to distinguish steers from heifer carcasses.

3. **Aitch Bone** - The split pelvic bone of beef and pork carcasses.

4. **Udder Fat** - It is the deposit of fat in the mammary region of a female carcass. It can be distinguished from cod fat because it contains mammary tissue and appears smooth. Excessive amounts are undesirable.

5. **Cod Fat** - It is the deposit of fat in the scrotum region of a male carcass. It has a rough appearance. Excessive amounts are penalized.

E. Equipment

1. **Captive Bolt** - Mechanical method of stunning

Beef Harvest:

1. Withhold feed for 12-24 hours prior to harvest. (Note: Fresh, clean water shuld be provided at all times, as this provides for brighter colored lean, and enhances bleeding.)
2. Antemortem Inspection (Before Death): Done by either state or federal inspector within 24 hours of harvest in order to identify healthy and wholesome animals for harvest. Animals are classified by the inspector as Passed for Harvest, Suspect, or U.S. Condemned (applies to all species.)
3. Stunning: Captive Bolt Used at RMSTC
4. Bleeding (sticking)
5. Skin and remove head
6. Remove foreshanks and hindshanks (Note: difference between cattle and hoter species)
7. Hide removal (Hide pullers)
8. Remove pizzle and split brisket
9. Weasand (esophagus) and weasand rod
10. Bunging
11. Skin and Remove Tail
12. Evisceration
13. Split Carcass (Done to enhance body heat dissipation and ease of movement)
14. Post Mortem Inspection
15. Wash, Weigh, and Place Carcass in 28° Blast Chill Cooler

Beef Carcass Evaluation:

DETERMINATION OF CLASS

Steers: Steer carcasses can be distinguished from those of other sexes by the rough, marble-shaped fat deposits in the cod region. In addition, presence of a pizzle eye (white disc caudal to aitch bone, attachment of penis), curved aitch bone and the exposed diamond-shaped gracilis muscle on inside round indicate the carcass was from a male.

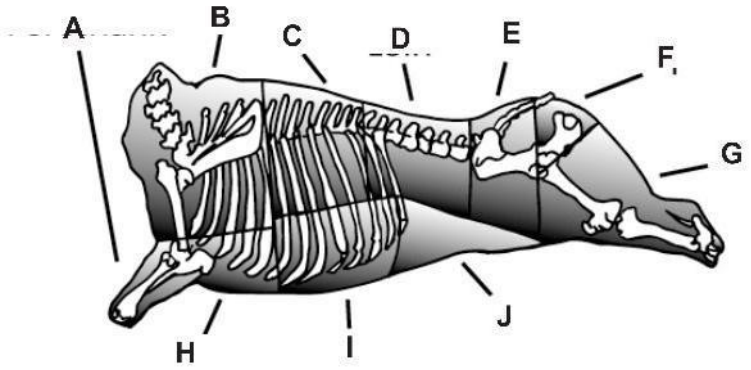
Bulls/Bullocks: Both bulls and bullocks possess more pronounced development of musculature in the round and chuck and a heavier crest than steers and heifers. They also possess a more prominent pizzle eye and jump muscle (muscle above hip) than steers. The fat deposition in the scrotal area is rough, similar to that found in steers, but less quantity is present. Lean is generally coarser textured and darker colored than that of steers. Bullocks are younger than bull carcasses so must possess A skeletal maturity and therefore the bull classification encompasses carcasses of B maturity or older.

Heifers: Heifer carcasses have a smooth, uniform fat deposition in the udder region which differs from rougher shape of cod and scrotal fat. No pizzle eye is present and the aitch bone has a straighter shape in heifers than males. Also, the gracilis muscle of heifers is bean shaped with less fat covering than steer carcasses. Heifer carcasses are generally less muscular and more angular in shape than male carcasses.

Cows: The udder fat of cows is rougher shaped than that of heifers. It is generally removed from the carcass because of appearance. If the udder remains on the carcass, often it will be exudative, showing signs of lactation (i.e., wet). The pelvic bones are prominent due to many calvings and the aitch bone is straight. Cows are normally older when marketed so possess greater skeletal maturity than heifers and often possess yellowish colored fat from being grass fed.

Wholesale Cuts of the Beef Carcass:

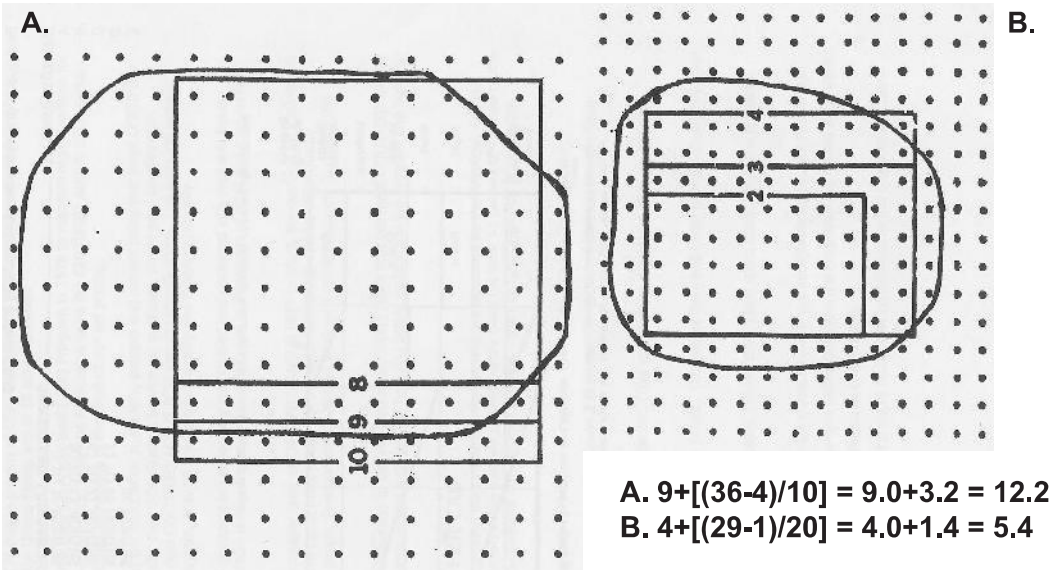
A. Foreshank
B. Chuck
C. Rib
D. Short Loin
E. Sirloin
F. Rump
G. Round
H. Brisket
I. Short Plate
J. Flank



Measuring Ribeye Area:

In using the dot grid to measure a ribeye, place it on the cut surface of the ribeye and count all squares in which lean touches a dot. Divide the number of squares counted by 10. The resulting number is the area of the ribeye in square inches. The heavy black lines outlining blocks labeled 8, 9, and 10 enclosing 80, 90, and 100 squares, respectively, increase the ease and rapidity of counting. In the accompanying example, the ribeye area includes 102 squares or 10.2 square inches.

Measuring Rib/Loin Eye Area Examples:



A. 9+[(36-4)/10] = 9.0+3.2 = 12.2
B. 4+[(29-1)/20] = 4.0+1.4 = 5.4

Beef Carcass Grading:

Beef carcasses must be split (ribbed) between 12th and 13th ribs to expose the rib eye or longissimus muscle for determination of fat thickness and rib eye area for yield grading and amount of marbling for quality grading. The lean is a darker purplish color when first ribbed and blooms to characteristic cherry red color within 1/2 to 3/4 hour. Color change brought about by oxygenation of muscle pigment (myoglobin). If lean remains dark in color, carcass is referred to as “dark cutter”.

YIELD GRADES

Beef yield grades are based on 12th rib fat thickness, carcass weight, percentage kidney, heart and pelvic fat and rib eye area.

1. Fat thickness at 12th rib is measurement of subcutaneous fat cover over the rib eye at 3/4 of the lateral length of the rib eye from the backbone. Measurement can be adjusted due to fat deposition on other parts of carcass and adjustment is normally upward.

2. Rib eye area is measured using either grid or planimeter. Most meat graders estimate REA visually. The plastic grid has rectangles within it labeled 8,9, or 10 square inches. Use the largest of the three rectangles entirely covering the longissimus but not adjacent muscles. Divide the total number of dots counted by 10 (10 dots/in2).

3. The carcass weight used in the industry is the hot carcass weight value obtained immediately after slaughter with hide, head, viscera and feet removed.

4. Kidney, pelvic, and heart fat (KPH) represents estimate of pounds of internal fat as percentage of total carcass weight.

**Methods for yield grade determination in beef cattle explained in market animal evaluation chapter.*

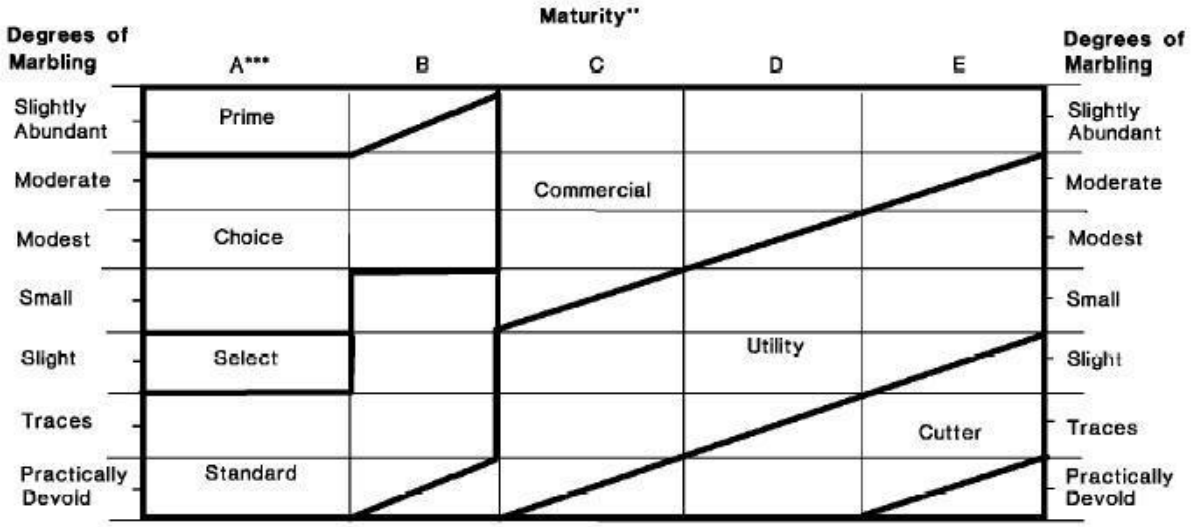
Beef Carcass Grading:

QUALITY GRADES

Beef Quality Grades are based on Maturity and Marbling

Maturity Group	Approximate Chronological Age
A	9 TO 30 MONTHS
B	30 TO 42 MONTHS
C	42 TO 72 MONTHS
D	72 TO 96 MONTHS
E	> 96 MONTHS

Relationship Between Marbling, Maturity, and Carcass Quality Grade*



* Assumes that firmness of lean is comparably developed with the degree of marbling and that the carcass is not a "dark cutter."

** Maturity increases from left to right (A through E).

*** The A maturity portion of the Figure is the only portion applicable to bullock carcasses.

Certified Angus Beef:

PROGRAM BRIEF

Today's consumer demands great-tasting, consistent, high quality beef, and CERTIFIED ANGUS BEEF products meet these expectations. During fiscal 1994, more than 174 million pounds of CERTIFIED ANGUS BEEF product were marketed by Program licensees to consumers throughout the United States and in 18 other countries.

The American Angus Association established the Certified Angus Beef (CAB) Program in 1978 to maintain high standards for beef and increase the demand for registered Angus bulls. While the Association owns the CERTIFIED ANGUS BEEF marks and provides promotional support, it does not take ownership of the product nor set pricing.

Packing plants and distributors are licensed by the Association to identify, process and market cattle that meet CERTIFIED ANGUS BEEF product specifications. Additionally, the USDA Grading Service, an unbiased, third party, certifies each identified Angus-type carcass that meets the rigid CERTIFIED ANGUS BEEF carcass specifications. This licensing system, coupled with an intense product monitoring system, ensures both product quality and Program Integrity.

Upon completion of the certification process, carcasses are separately cut, labeled and packaged into bags and boxes bearing the CERTIFIED ANGUS BEEF marks. From there, the product is distributed to thousands of retail and food service outlets around the world.