Practical Camelid Reproduction

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Female Reproductive Tract Anatomy

- **Ovaries** produce gametes and hormones that act on other parts of the reproductive tract
- **Oviducts** provide optimum environment for fertilization and pre-attachment development of the embryo
- **Cervix** is a barrier that secretes mucus during receptivity and produces a mucus plug seal during pregnancy
- **Vagina** is the copulatory organ and produces lubricating mucus during receptivity

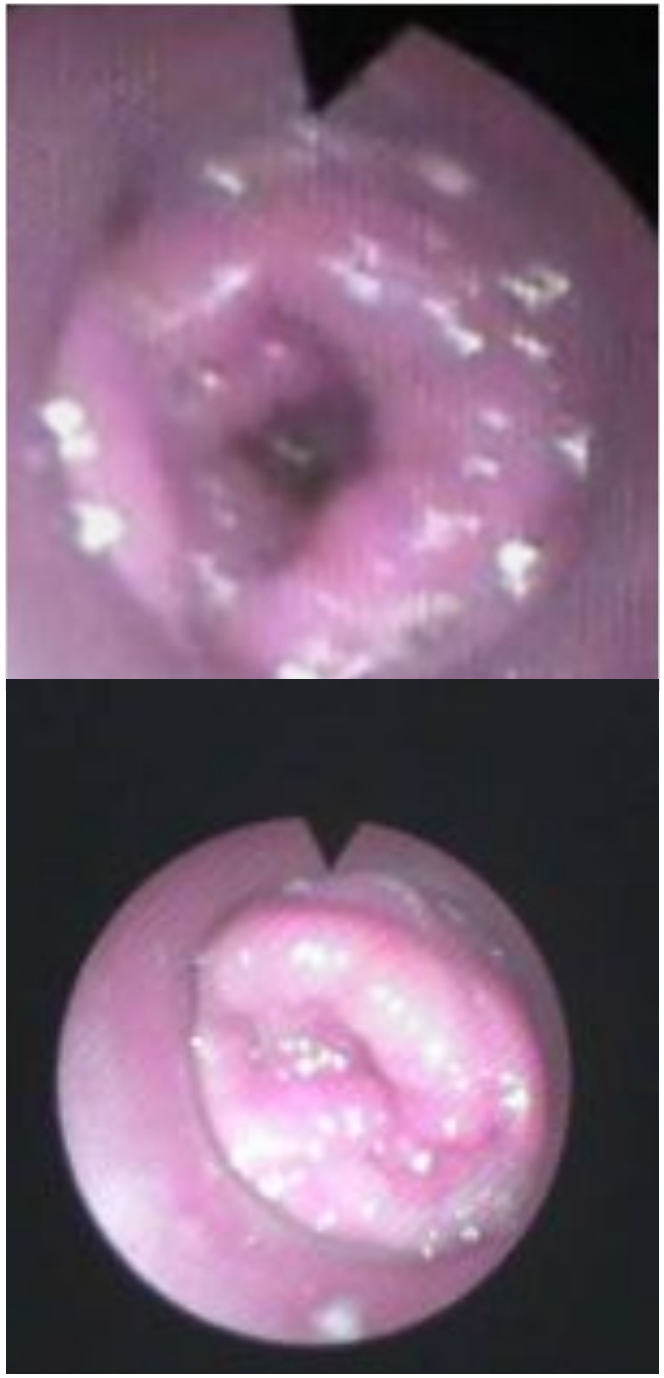

Ovary
Horn
Body
Ovary
Cervix

Vulva

- Normal vertical orientation
- May be slightly tipped forward at top
- Observe for discharge
  - also check tail for evidence of discharge
- Orifice 3-5 cm long (alpaca > llama)

Cervix

- The **external os** protrudes slightly into the vagina.
- 2 - 3 **cartilage rings** within
- The **cervix of a pregnant animal**
  - rigid and relatively dry compared to the relaxed moist cervix and vagina of the non pregnant female under estrogen stimulation
  - a **mucus plug** is seen protruding from the cervix on vaginal examination in advanced pregnancy

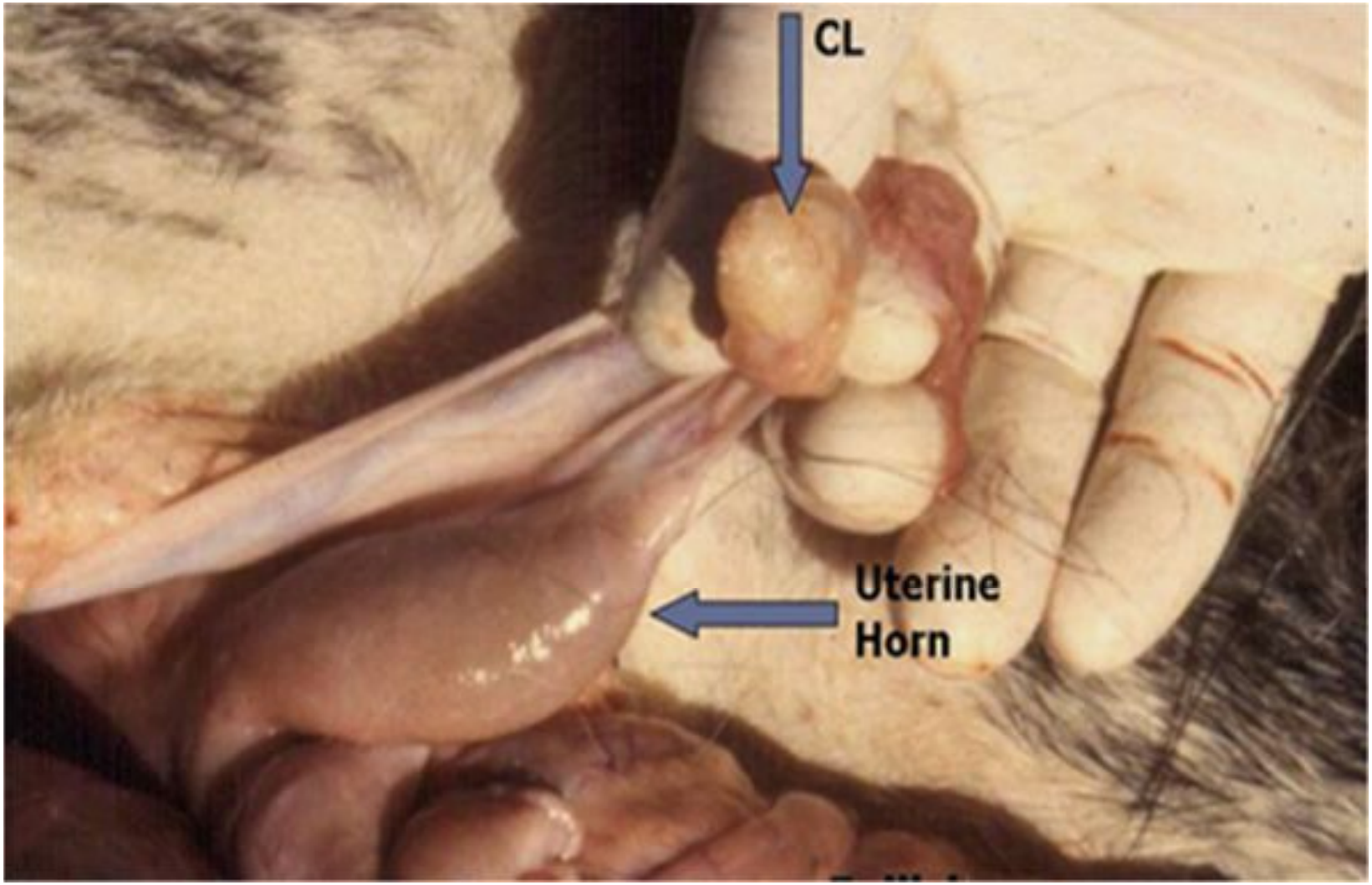


External cervical os

- Relaxed/closed depending on the stage of follicular cycle or pregnancy status
- Natural or exogenous estrogen influence causes relaxation
- Decide if cervix is damaged
  - Scarring- usually permanent
  - Incompetence = excessive dilation
    - predisposed to infection
    - recheck in 10 to 14 days to see if still dilated
    - may resolve over time

Major effects of estrogen on the camelid reproductive tract

- ↑ blood flow
- Relaxation of the cervix
- ↑ white blood cells within the reproductive tract to counteract the contamination which occurs at breeding time
- ↑ mucosal secretion of mucus
- Initiation of uterine gland growth
- ↑ uterine muscular tone
- Behavioral receptivity



- All types (maturation levels) of follicles are present in the ovary at all times.
- Corpora lutea (CLs) may or may not be present depending on whether ovulation has occurred.

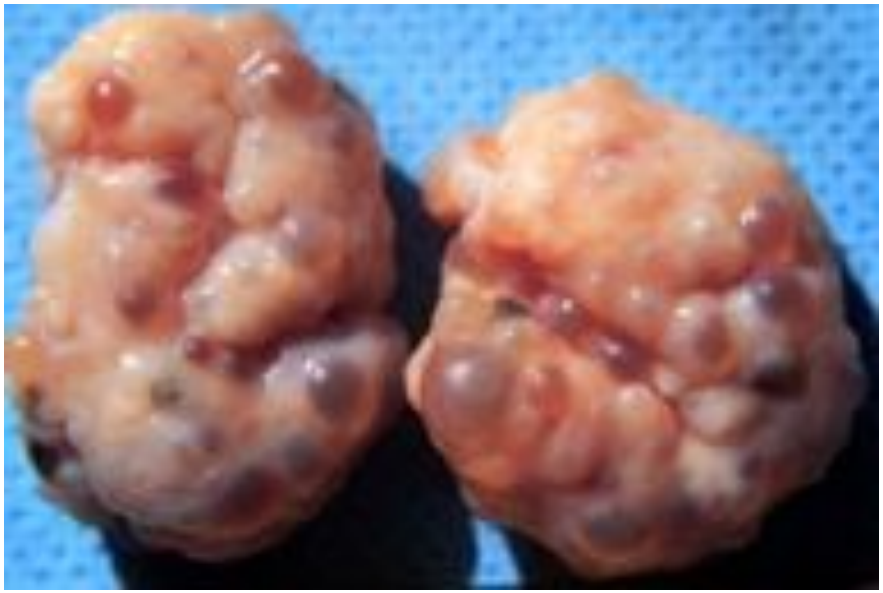
Ovarian physiology

- **Follicular Phase**
  - Follicles are fluid filled structures within the ovaries that contain the eggs (ova)
  - Camelids do not have estrous cycles as in other mammals
  - Camelids are termed "**induced ovulators"**
    - breeding causes ovulation= rupture of the follicle and release of the egg
    - **does not mean always receptive!!**
  - **Continuous in camelids**
  - Several small (< 3mm) follicles are present at all times on the ovaries
  - **Some** follicles grow and regress producing estrogen
  - Interrupted by ovulation after copulation or exogenous hormone stimulation

Follicles

- Located on the surface of the ovaries
- Protrude during the follicular phase
- “Waves of follicles” are said by some to occur on the ovaries with follicles appearing, growing and shrinking in size
  - has not been consistently seen by us at UMass!
- The follicles present on both ovaries contribute **estrogen**
  - results in female receptive behavior when it overwhelms the effect of progesterone

Follicles



Follicular Growth

- Multiple follicles
  - present on both ovaries at all times
  - common to have several of 3mm or less on **both** ovaries
  - often grow on one or both ovaries at the same time
- Follicles are capable of ovulation after a breeding at a **minimum 6 mm** diameter.

- 6-15 mm follicles burst releasing the ovum or egg approximately 24 hours after breeding
- If no ovulation occurs the follicle **regresses**, shrinking back down in size, **or disappears** within 2 days (unpublished, 2011)
- **Follicular sizes do not necessarily correlate with sexual receptivity**

Ovulatory Follicles

Tibary

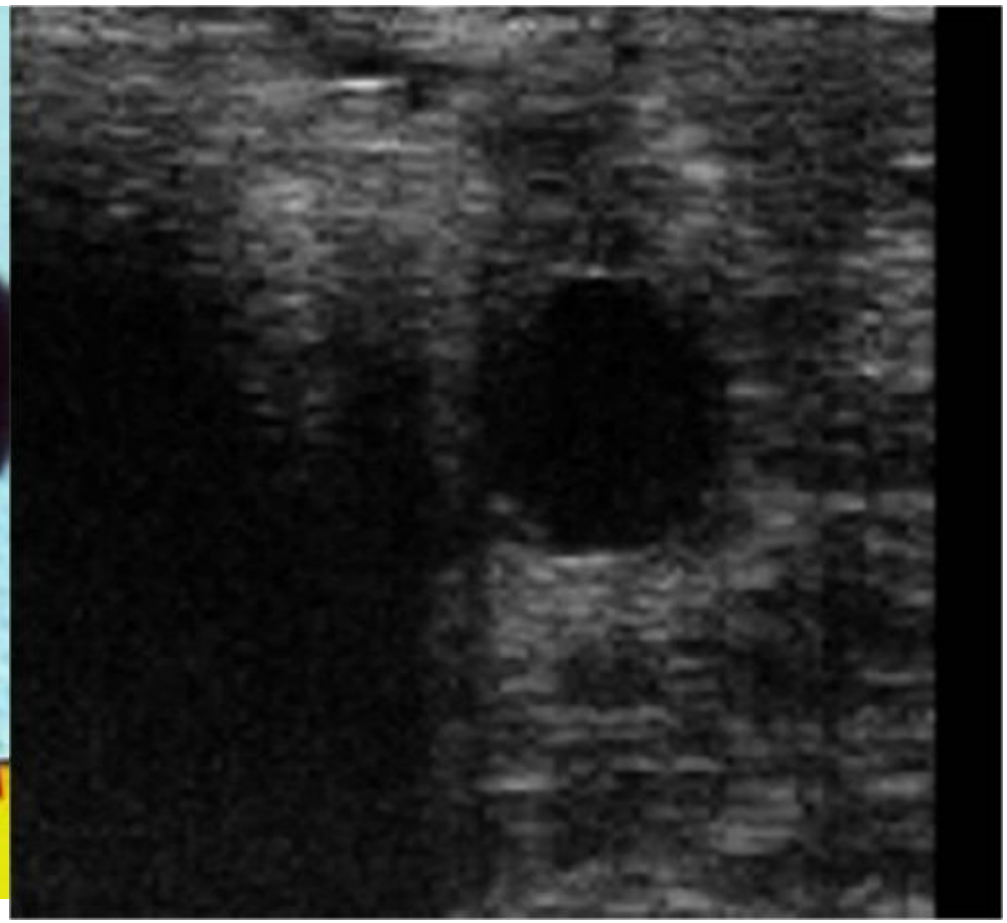
Luteal phase of the ovarian cycle

- Occurs after ovulation
- Lasts for months if the female is pregnant
- Ovulatory **Corpus Luteum (CL)** is responsible for progesterone production throughout pregnancy

Atretic/cystic/anovulatory/ hemorrahgic Follicles

- Follicles > 15 mm diameter are abnormal
  - most often are termed **atretic** and have no effect on sexual receptivity
  - will resolve without treatment
    - rupture during US exam or on their own
    - gradual decrease in size and disappear

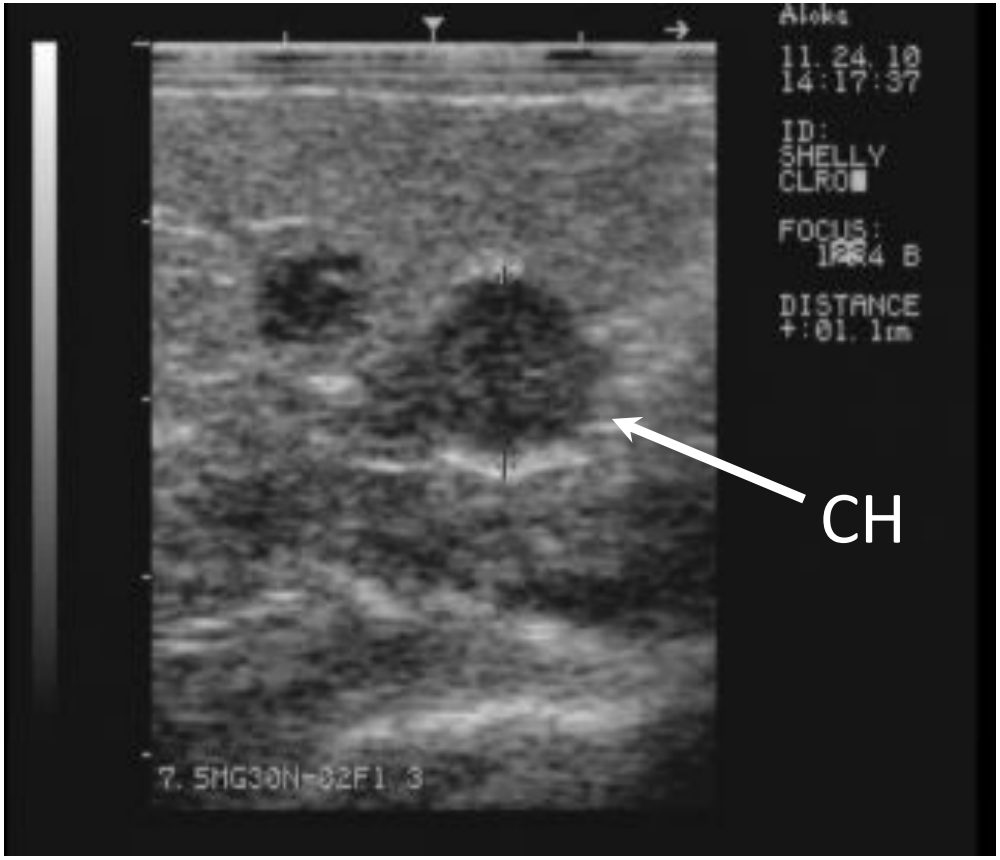
Cystic/hemorrhagic follicle



Tibary

Luteal phase of the ovarian cycle

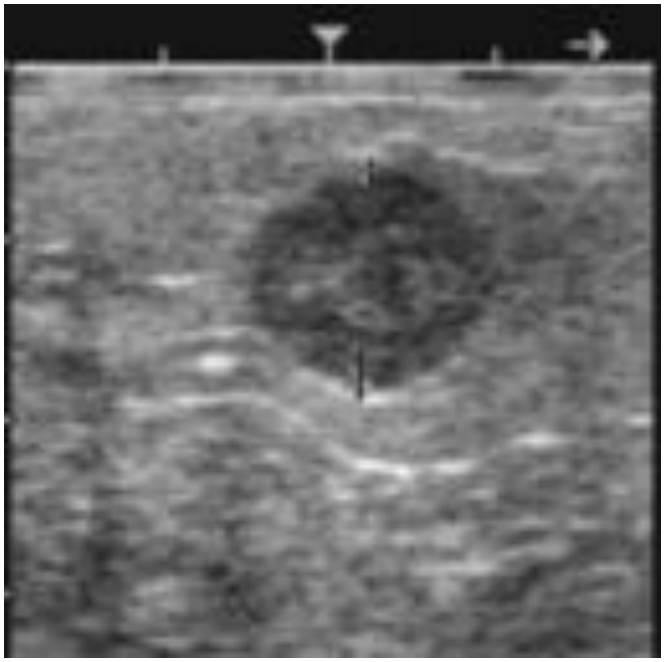
- Occurs after ovulation
- Lasts for months if the female is pregnant
- A transitory **corpus hemorrhagicum** is present for 36 – 48 hrs. after ovulation



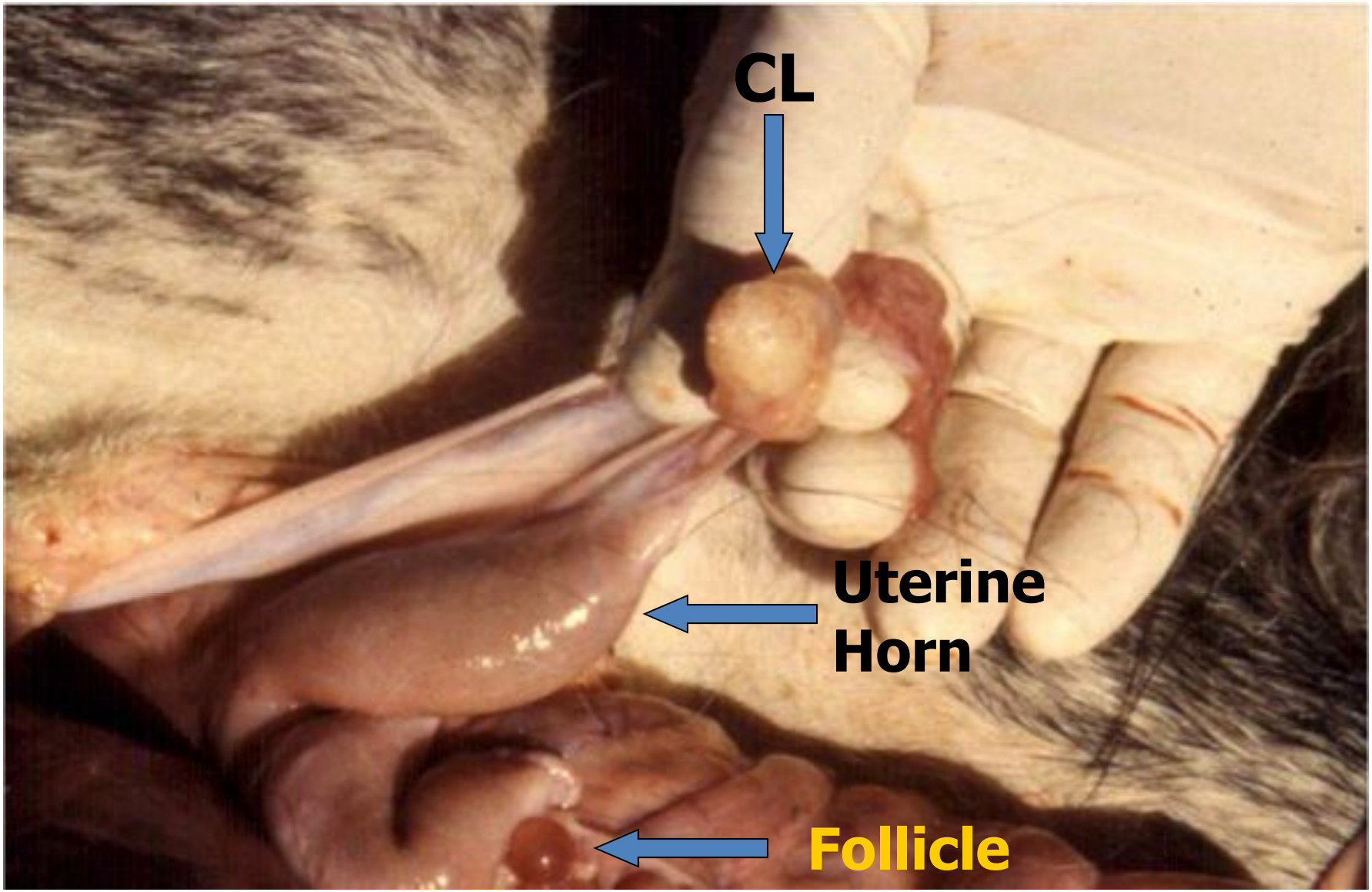
Corpus Luteum

- CH is replaced by the **corpus luteum** (CL)
- grows for 3 to 4 days and begins to secrete **progesterone**.
- May be cystic normally

Tibary



Ovary with Corpus Luteum (CL)



Return to Receptivity

- If no pregnancy is established expect in approximately 12 to 14 days
- A longer period of time is involved after loss of the CL if the female was pregnant and the animal experienced **early embryonic death**
- varies with each ovulation
- not necessarily consistent for a specific female

Retained CL

- Occasionally the CL remains functioning without a pregnancy resulting in **non receptive behavior**
  - called a retained CL
  - treatment with $PGF_2\alpha$ resolves
    - suggest 150 µg of cloprostenol sodium (0.6 ml of Estrumate®) SQ one time

Sexual receptivity in the female

- Extremely variable among female alpacas!
- In the presence of the male:
  - Immediate acceptance= **receptive (R)**
  - Female stands when mounted by the male, but does not drop= recheck later= **not receptive (NR)**
  - Refusal= not receptive (NR)
- Acceptance = dropping for breeding upon approach of, or mounting by, the male
- Refusal =standing, running away, spitting, and/or vocalizing

- Some females run with others and do not show receptivity unless cornered
- Females demonstrate preferences for different males on the same day
- Males and females get used to each other if housed in close proximity
  - will stop showing aggressive breeding and receptivity behavior

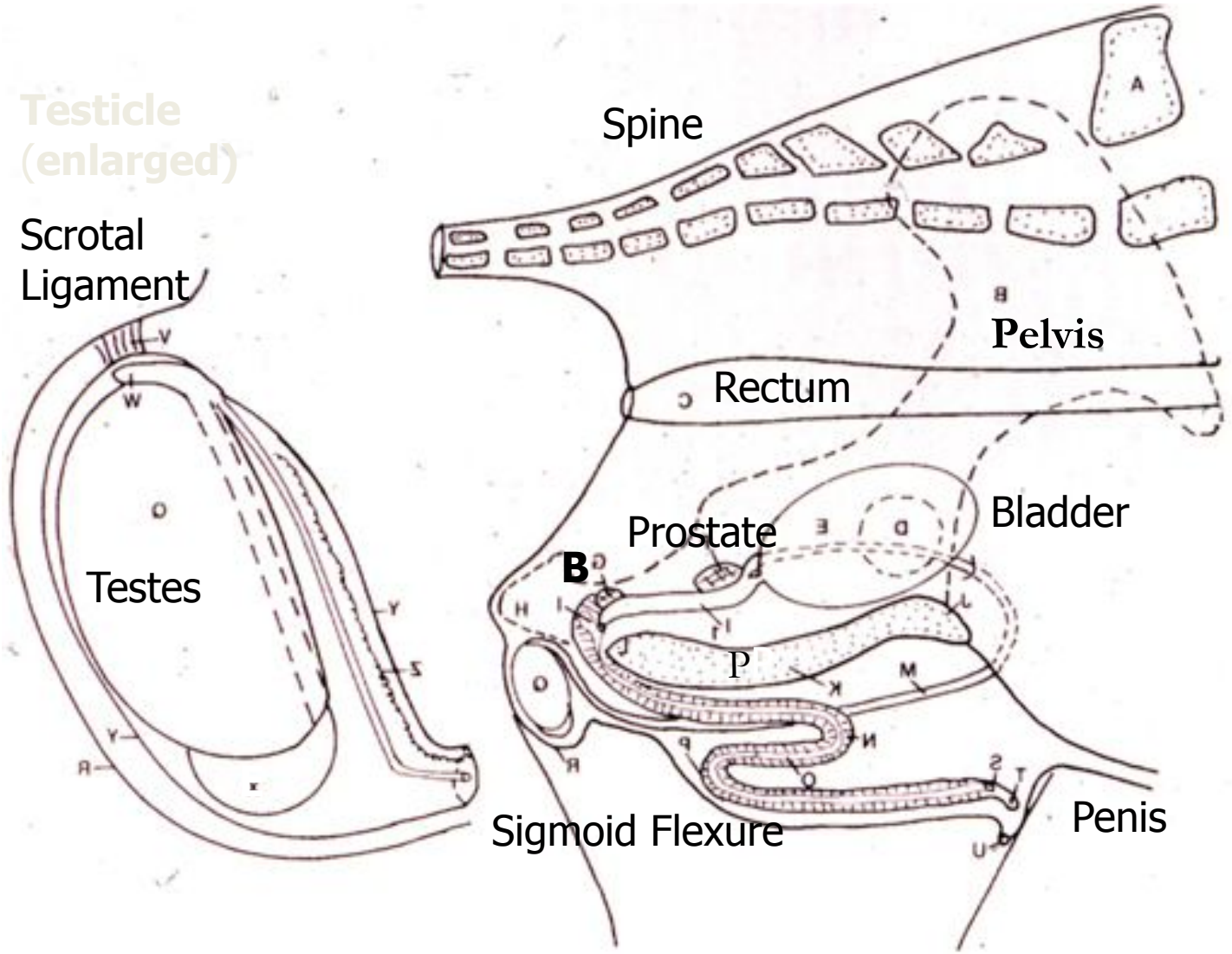
- A new male may have to be brought in to stimulate female sexual receptivity and male aggressive behavior
- Females will show receptivity as early as 24 hours after birthing.

- **The best fertility rates have been achieved by breeding between days 21 to 30 after birthing**

Male Camelid Reproductive Anatomy

- Two testicles of equal size located in the scrotum
  - much smaller than those of other species of comparable body size
    - length 3.5 to 5.0 cm
    - thickness 2.0 to 3.0 cm
    - measure with ultrasound or calipers
  - larger testicle = greater sperm production (in one study)
  - size does not vary with photoperiod length

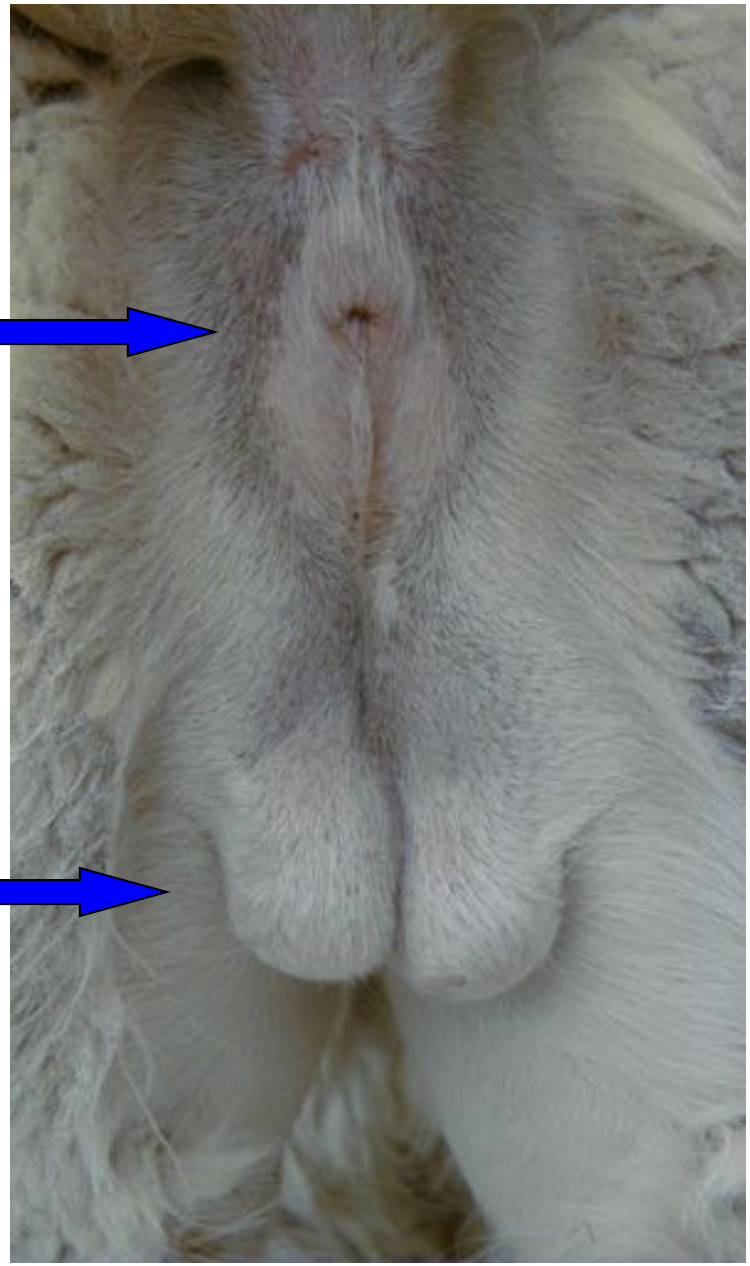
Male Camelid Genitalia



E = Epididymus

B = Bulbourethral Gland

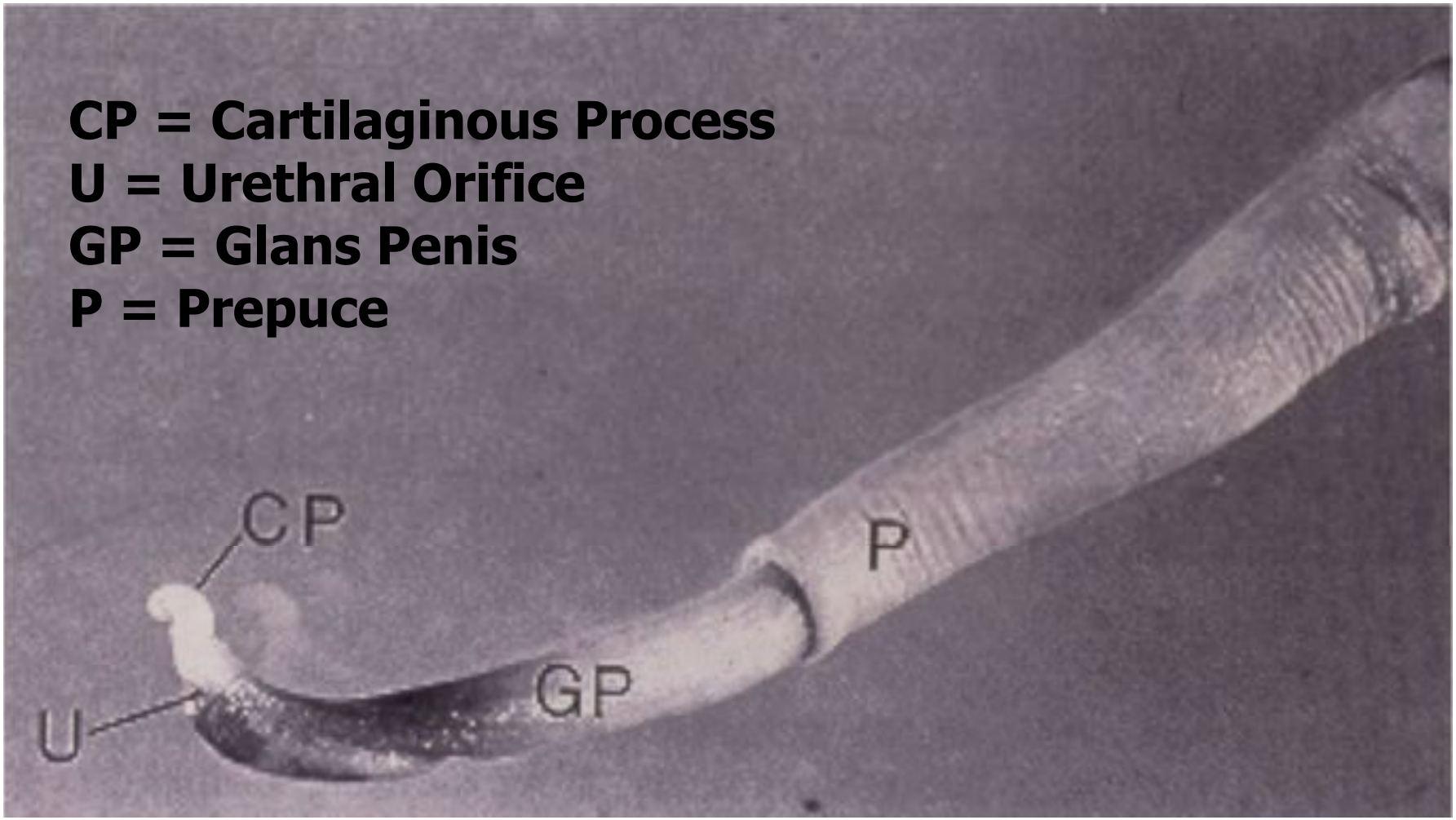
Alpaca Testicles



Penis is fibroelastic with a sigmoid flexure.

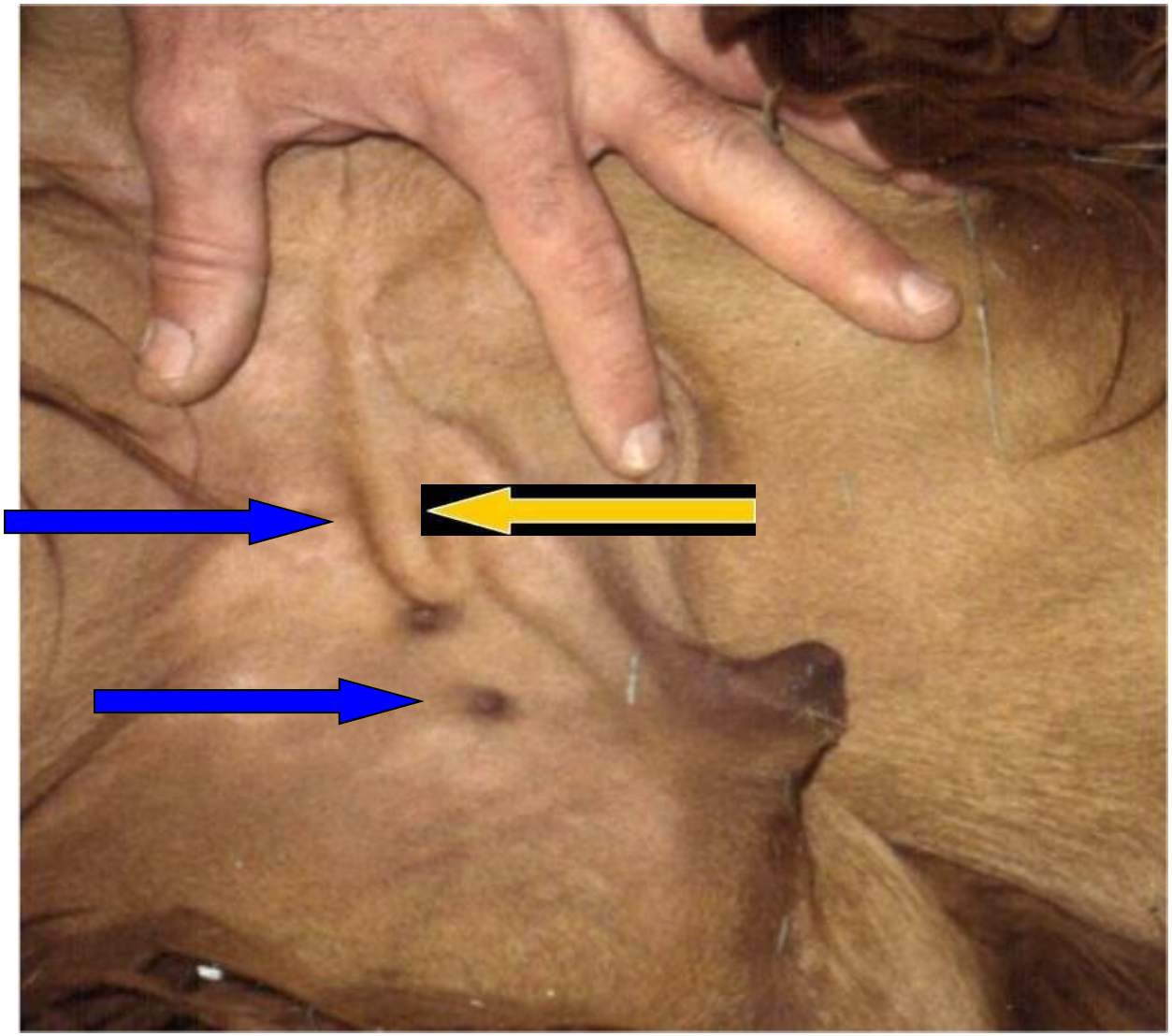
- Males urinate backwards between the legs since the tip of the sheath points caudally and the penis is not extended during urination
- Mature male camelids can partially extend the penis out of its sheath in the standing position when mounting receptive females
- The penis has a cartilaginous, corkscrew appendage at its tip that is used to dilate the cervix and enter the uterus during breeding
- Urethral opening is under cartilaginous appendage

Close-up of Camelid Penis



Johnson

Sigmoid Flexure of Camelid Penis



Purdy

Male Breeding Behavior

- Most male camelids will start breeding at 1+ years old if allowed but it is best to start at 2 to 3 years of age to achieve the best fertility.
  - If breeding is done earlier there can be vaginal or uterine problems with the female
  - The male may suffer penile injuries inflicted by mature females rejecting him

- Breeding usually lasts 10 to 45 minutes and is very noisy (orgling) in the down position.
  - The male camelid will creep forward to achieve the correct penile penetration into the uterine horns.
  - Produce a dribble ejaculate of small volume (0.5 to 7.5 ml collected in an artificial vagina) over the course of the breeding.
  - Hot humid weather reduces libido for males and females and is reported to reduce sperm output from the testes.

Male Infertility Problems

- **Won't breed**
  - Inexperienced
    - Train by observation of active males
  - Provide competition
  - Quiet environment- fewer people watching
  - Musculoskeletal problem in back or legs prevents assuming the correct copulatory position
- **Penis not working**
  - Check anatomy
  - Check libido

- **Semen problems**
  - Will not ejaculate- check postbreeding sample from vagina for sperm
  - Poor semen quality- perform semen evaluation from postbreeding or breeding dummy/artificial vagina collection
- **Abnormal testes**
  - Palpate
  - Ultrasound or calipers to measure
  - US to look for normal anatomy

Caliper Method

Ultrasound

Semen Evaluation

- Evaluate the male's starting fertility, along with the initial conception results of breeding females
  - During the breeding season
    - How he is doing?
    - Does he need a rest?
- Information is available immediately without waiting for the results of breedings and thus will save time and money.

Semen Collection

- **Two methods of collection**
  - Post breeding vaginal collection with a speculum just like a vaginal exam- Nunoa
  - Breeding dummy with sheep artificial vagina


NUNDA

Parameters evaluated during semen analysis:

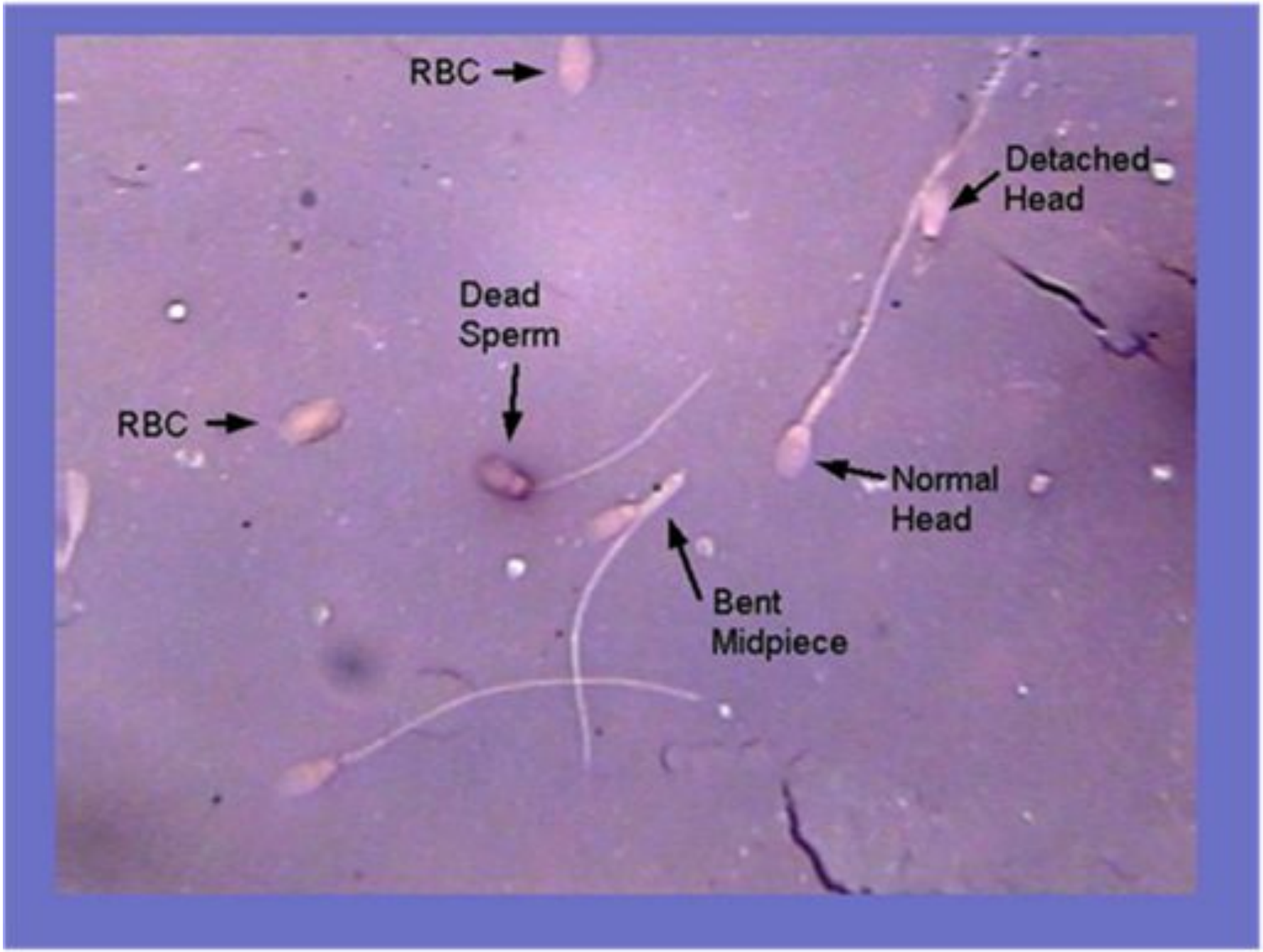
- **Semen Volume**
- **Sperm Activity** (not motility)
  - Camelid semen is very viscous
  - Sperm move in place rather than exhibiting progressive motility
- **Semen Viscosity**
  - Measured by drawing up some semen into a micropipette, dispensing half of it onto a slide, and then pulling upwards and measuring the height at which the semen thread breaks

- **Sperm Concentration**
  - observe one drop of semen on a slide and cover slip at 400X magnification
  - Estimate as high, medium, or low
  - Use hemacytometer to calculate sperm x 10^6 /ml after semen has liquefied- 12+ hours at room temperature

- **Percentage of live sperm**
  - Use Live-Dead stain (eosin-nigrosin)
  - Warm stain in tuberculin syringe and add to one drop of fresh semen
  - Mix by drawing a second slide over the two drops on the first slide
  - Live sperm= light in color
  - Dead sperm= dark in color

- **Sperm Morphology**
  - Use same live dead slide
  - Common findings in alpacas (southern Peru and northeastern US)
    - Decapitated heads (1%)
    - Cytoplasmic droplets
      - Proximal (5-11%)
      - Distal (1-9%)
    - Headless tail (1-2%)
    - Normal sperm (25-70%)
    - Midpiece abnormalities (low %)
      - Irregular midpiece
      - Thickened midpiece
      - Bent midpiece

- Terminally coiled tail
    - cold shock artifact of staining
    - not common
- Severely coiled tail- abnormal
- Head abnormailities
    - Double heads (< 1%)
    - Microcephaly (<1%)
    - Tailless heads (<5%)
    - Misshapen head (<1%)


RBC
Detached Head
Dead Sperm
RBC
Normal Head
Bent Midpiece

Under investigation

- Variation among sequential ejaculates from the same male- proven
- Much variation among males- proven
- Seasonal variation in semen characteristics- in progress
- Relationship between semen parameters and fertility- in progress