

## Feline Reproduction

## Puberty

- **Queen**
  - Age of first estrus and fertile ovulation
  - Prepubertal ovarian follicular development
    - 3-4 months of age
  - Pubertal estrus
    - 4-9 months

## Puberty

- **Factors that influence onset of puberty**
  - **Season**
    - Anestrus season (October-December)
    - Northern hemisphere
      - Pubertal estrus in early part of year as daylight hours increase

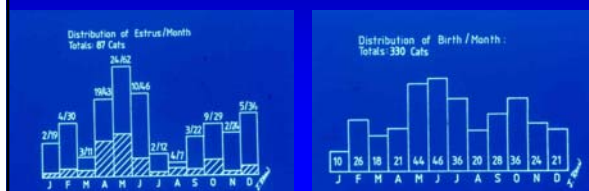
## Puberty

- **Factors that influence onset of puberty**
  - **Confinement**
    - Earlier in free-roaming cats relative to confined
  - **Breed**
    - Later in long haired cats relative to short haired
  - **Nutritional plane**
  - **Exposure to other cats (toms or queens)**



## Breeding Season

- **Seasonally polyestrous**
  - **Timing and duration dependent on photoperiod**
    - **USA: January to October**



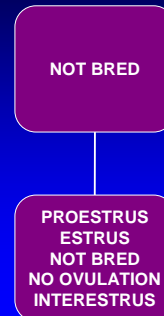
## Breeding Season

- **Induced ovulator**
  - **Neurochemical reflex**
    - Releases LH, ovulation, and CL formation
  - **Ovulation stimuli**
    - Copulation, vaginal stimulation, medical therapy
  - **Spontaneous ovulation**
    - Can occur in response to pheromones or visual cues

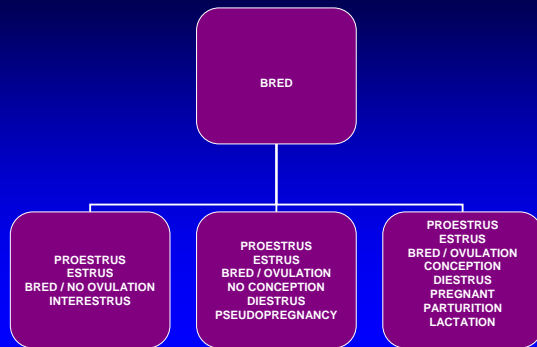
## Estrous Cycle

- Estrus cyclicity
  - Occurs at regular intervals
    - 4-30 day intervals (14 hours of daylight/day)
  - Variations in duration and character
    - Mating
    - Ovulation
    - Conception
    - Interrupted
      - Pregnancy or pseudopregnancy
      - Seasonal anestrus

## Feline Estrous Cycle Paths



## Feline Estrous Cycle Paths



## Ovulatory and Anovulatory Cycles

- Anovulatory cycle
  - No ovulation
  - Follicles regress over 4-7 days
  - Nonreceptive period of 1-2 weeks
- Ovulatory cycle
  - Induced ovulation
  - Breeding behavior persist for 1-2 days

## Proestrus

- Period between episodes of receptive behavior
  - Nonovulatory queen
    - Duration 9-14 days
  - Ovulatory queen
    - Metestrus
      - CL forms and progesterone rises
    - Diestrus
      - Progesterone dominant hormone
      - Duration 30-40 days
      - Cycling resumes 2 weeks after progesterone falls or 2 weeks post weaning
    - Interestrus interval varies from 44-120 days

## Anovulatory Cycle

- Duration 2-3 weeks
- Interestrus interval (9-13 days)
  - Time period between active estrus behavior
  - 1-2 weeks of nonreceptive behavior
- Cycles of receptive-nonreceptive behavior
  - Corresponds to growth and regression of ovarian follicles

## Ovulatory Cycle

- **Proestrus**
  - Duration 0.5 to 2 days
  - **Behavior**
    - Rubbing of head/neck against any object
    - Will not permit mating
    - Usually not observed unless male present
  - **Follicle size and estrogen levels increase**
  - **Vaginal cytology**
    - 20% parabasal cells
    - 60% intermediate cells
    - Nucleated and nonnucleated superficial cells

## Proestrus



## Ovulatory Cycle

- **Estrus: period of maximum sexual receptivity**
  - Duration 2-10 days
    - Influenced by mating and season
  - **Behavior**
    - Vocalization
    - Rubbing, restlessness
    - Lordosis, treading, elevation of tail
  - **Follicular size rapidly increases**
  - **Vaginal cytology**
    - Superficial nucleated and non-nucleated cells

## Estrus behavior



## Follicles during estrus



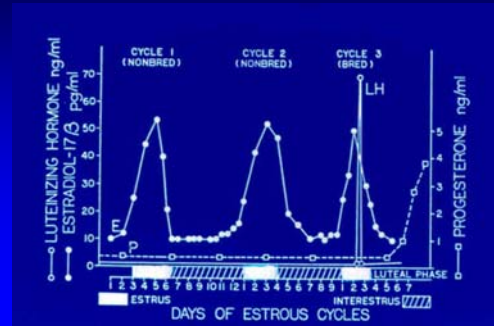
## Ovulation

- **Requires copulation**
  - **Neural reflex**
    - Initiated by stimulation of anterior vagina and cervix
  - **Multiple copulations**
    - Prolonged LH levels and ovulation
    - 50% queens ovulated with one breeding
- **Reflex stimulates hypothalamus**
  - GnRH release → LH release
  - **Ovulation occurs 24-36 hours after LH release**

## Ovulatory Cycle

- **Diestrus**
  - Follows ovulation and formation of CL
- **Conception**
  - Period of progesterone secretion
  - Gestation 63-66 days
- **No conception (pseudopregnancy)**
  - Duration shorter (30-40 days)
  - Progesterone levels lower
  - Cycling reoccurs
    - 2 weeks after drop in progesterone < 1ng/mL

## Hormonal changes in estrus cycle

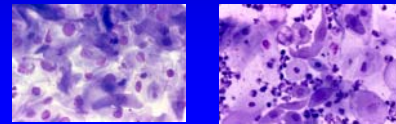


## Anestrus: Sexual Quiescence

- **Seasonal absence of cycling**
  - October-December in northern hemisphere
- **Ovaries**
  - Small with the absence of follicular growth
- **Hormones**
  - Based line progesterone and estradiol levels
  - Low gonadotropin levels
- **Vaginal cytology**
  - Predominantly parabasal and intermediate cells

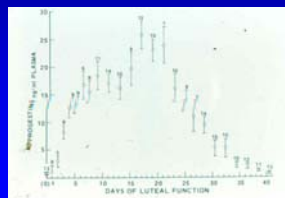
## Vaginal Cytology

- Traditionally not used in queens
  - Not accurate
  - Can induce ovulation
- **Mating**
  - Cornification of 90% vaginal epithelial
    - Occurs 2 days prior to 2 days after onset of estrus



## Hormones

- **Luteinizing hormone (LH)**
  - Mating stimulation necessary for release LH
    - Increases 10 minutes postcoitus and persists for 20 hours
    - Prolonged high levels with successive matings
- **Progesterone (P<sub>4</sub>)**
  - Elevated post ovulation (>2ng/mL)
  - Source
    - CL of the ovaries supports pregnancy
    - Placenta small P<sub>4</sub> contribution



## Hormones

- **Progesterone (P<sub>4</sub>)**
  - **Pregnant queen**
    - Increased 3-4 days post breeding
    - Peaks at 3-4 weeks of gestation
    - Decreases immediately prior to parturition
  - **Pseudopregnant queen**
    - Increased first 2 weeks post ovulation
    - Levels begin declining at day 21
    - Baseline by 40 days post breeding

## Hormones

- Estradiol (E<sub>2</sub>)
  - Elevated during estrus
  - Decrease within 5 days after ovulation
- Pregnant queen
  - Estradiol levels increase 1 week prior to parturition
- Pseudopregnant queen
  - Estradiol levels increase greatly between 50-60 days
  - Follows the return of P<sub>4</sub> levels to baseline

## Hormones

- Prolactin (PRL)
  - Gradual increase ~3-5 weeks of gestation
  - Plateaus at day 50
  - Rapid rise 3 days prior to parturition
  - Remains elevated throughout lactation
  - Returns to basal levels 2 weeks post weaning
- Pseudopregnant queen
  - Levels remain at baseline
- Pregnant queen
  - Luteotrophic effect

## Hormones

- Relaxin
  - Peptide hormone produced by fetal-placental unit
  - Production occurs ~20-25 days of pregnancy
  - Plateaus at 30-35 days of pregnancy
- No present in pseudopregnant queen
- Functions
  - Soften connective tissue around pelvis aiding in delivery
  - Acts with P<sub>4</sub> to keep uterus quiet during pregnancy

## Mating

- Prebreeding examination
  - Signalment
    - Minimum breeding age 12 months
    - Reproductive activity can continue to 14 years
  - History
    - Vaccines
    - Puberty, interestrus interval, mating, pregnancy
    - Reproductive and nonreproductive diseases
  - Physical examination
    - General
    - Genitalia

## Mating

- Laboratory evaluations
  - CBC, chemistry, UA
  - Serology
    - FeLV, FIV, and FIP
  - Blood typing
    - Type A >95%, B <5%, AB <1%
    - Type A or AB kitten born to a type B queen
      - Neonatal isoerythrolysis is possible

## Mating

- Felines reluctant to mate when observed
- Mating
  - Takes 0.5 to 5 minutes
  - May be repeated 30 times in 24 hours
- Coitus
  - Tom
    - Bites firmly on back of queens neck
    - Grasps lateral thorax with fore legs
    - Back legs treads into position
    - Penis introduced with thrusting motion with immediate ejaculation
  - Queen
    - Maintains lordosis position, deviates tail laterally
    - Withdrawal of penis triggers "copulation cry" with attack of male
    - Post copulation
      - Queen resistant to feline or human contact for 20-60 minutes

## Mating behavior



## Post mating behavior



## Breeding Practices

- Maximize fertility
  - Photoperiod >14 hours daylight
  - Queen taken to tom's territory for 24-48 hours
    - 1 tom for each 4-5 queens
    - Overuse of tom
      - Decreases vigor, semen quality, and conception
  - Pair confined to undisturbed area
  - Multiple matings
  - Vaginal swabs to document mating
  - Free roaming queens
    - Superfecundation possible

## Mating

- Normal mating behavior dependent
  - Sexual experience
  - Hormonal status
- Pheromones
  - Valeric acid in vaginal secretions during estrus
  - Smell attracts tomcat
- Behavior
  - Estrus queen
    - Will call to tom and tom may mimic
    - When tom present
      - Queen rubs against objects, rolls, lordosis
  - Proestrus queen
    - Aggressive to tom and will not allow mating

## Pregnancy

- Gestation length
  - Between 63-65 days (from day of ovulation)
    - Shorter with large litters
    - Longer is queen stressed, diseased, or single fetus
    - Parturition prior to 59 days considered premature
- Fetal development
  - Ovulation follows coitus by 24-36 hours
  - Fertilized ova
    - Remain in the oviduct for 4 days
    - Enter uterus as morulae 4-5 postcoitus

## Fetal Development

- Implantation
  - Between 12-13 days after ovulation
- Placentation
  - Endothelial chorial
  - Zonary in shape
  - Placental transfer of maternal antibodies to fetus
- Superfetation possible
  - Estrus activity during gestation
    - Days 21-24 or during 6<sup>th</sup> week of pregnancy

## Fetal Development

- Litter sizes vary
  - 2-7 kittens
- Teratogens
  - Griseofulvin
  - Glucocorticoids
  - Modified live virus, feline panleukopenia vaccine

## Pregnancy Diagnosis

- Behavioral/Physical signs
  - Cessation of estrus
  - Poor appetite during first trimester
  - Quiet, docile, and more interested in humans
  - Mammary development
    - Nipples more prominent and pink (after 2<sup>nd</sup> week)
    - Increases in last 2 weeks of gestation
  - Significant weight gain (4-6 weeks)
  - Fetal activity (last 2 weeks of gestation)

## Pregnancy Diagnosis

- Abdominal palpation
  - Earliest between 14-21 days
    - Small, firm, and round AV--
    - "string of pearls"
  - Between 21-28 days
    - Uterine enlargement (2-2.5 cm)
  - After 28 days palpation more difficult
    - Generalized uterine enlargement
    - Abdominal distention



## Pregnant uteri



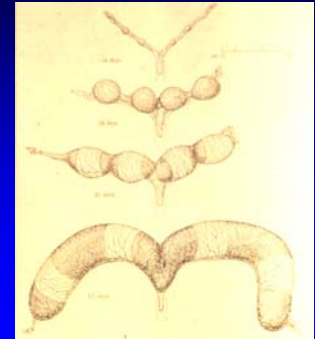
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35



49



## Pregnancy Diagnosis

- Abdominal ultrasound
  - Fetal heartbeats (day 16-26)
  - Fetal morphology (after day 26)

## Pregnancy Diagnosis

- Radiographs
  - Uterine swelling (> 16 days of gestation)
  - Most useful after day 35
    - Day 45 fetal skeletal calcification
- Hematology
  - PCV and hemoglobin decrease during last third of pregnancy

## Care of Pregnant Queen

- **Feeding**
  - Free choice food and water
  - Daily intake increases linearly throughout gestation
    - Increases by 25% + in last half of gestation
- **Pregnancy diagnosis**
  - 3-4 weeks
- **Weigh weekly**
- **Provide dry and warm queening area**

## Parturition Stage I (duration ~24-48 hours)

- Queen's activity will decrease with seclusion
- Vulvar enlargement with mucoid discharge
- Abdominal wall drops
- Episodes of straining
  - Increased uterine muscle activity
  - Progressive cervical relaxation
- Last 24 hours
  - Perineal tissues become very flaccid
  - Nipples contain colostrum
- End of stage I
  - Entrance of first kitten in birth canal
  - Uterine contractions may result in queen being restless and pant

## Parturition Stage II (duration ~2-6 hours)

- Increased respiratory rate and panting
- Abdominal contraction obvious
  - Intense abdominal push observed when kitten enter pelvic canal
- First kitten
  - Fluid expelled from vulva prior to delivery
  - Kitten delivered quickly but may take as long as 60 minutes
  - Posterior presentation common
- Subsequent kittens
  - Delivered randomly from both horns
  - Variable periods of rest between birth of kittens
  - Entire litter may be born within 2 hours
- Stage II longer than 6 hours without delivery is considered prolonged
  - Possible to let queen go for 6-12 hours if
    - Not actively straining
    - Eating, drinking, nursing kittens, and otherwise content

## Parturition: Stage III

- Placental delivery
  - Usually delivered after each kitten
  - Two kitten born close together may have both placentae follow the second kitten
- Uterine involution
  - Occurs rapidly within a few days to 1 week
- Estrus resumes in 7-10 days following parturition
  - Postpartum estrus
    - Shorter and have low ovulatory rates
  - Lactation and suckling of kittens
    - Lactational anestrus (persists until 2-3 weeks after weaning)

## Dystocia

- Rare in cats
  - Reported incidence 3.3-5.8%
  - Higher incidence
    - Pedigreed litters relative to mixed breeds
    - Dolicocephalic and brachiocephalic breeds
- Signs
  - Strong nonproductive contractions that last for 1 hour
    - Straining longer than 1 hour between kittens
  - Rupture of fetal membranes or blood with no kitten produced in 15-30 minutes
  - Longer than 3 hours between kittens
  - Contractions decreased in strength and frequency

## Dystocia

- Obstruction of fetal egress
  - Fetal dystocia
    - Deviation or large head
    - Oversized fetus or monsters
    - Diagnosis
      - Vaginal exam
      - Radiographs
  - Maternal dystocia
    - Narrow pelvic inlet, uterine torsion
    - Ectopic pregnancy, inguinal hernia
    - Uterine inertia

## Uterine Inertia

- Failure to start uterine contractions
- Primary inertia
  - Gestation length exceeding 71 days from first breeding
  - Serum progesterone of < 2 ng/mL
  - More common
    - Primiparous queens over 5 years
    - Multiparous queens over 8 years
- Secondary inertia
  - Difficult, prolonged parturition
  - Excitement

## Dystocia

- Indications
  - Failure to start labor at term
  - Failure to progress normally through labor
  - Intrapartum maternal shock or depression
- Diagnosis
  - History
    - Previous pregnancies
    - Breeding date
    - Time of onset of labor
    - Time of delivery of previous kittens

## Dystocia

- Diagnosis
  - Physical examination
    - General physical examination
    - Abdominal palpation
    - Vaginal examination
  - Imaging
    - Radiographs
    - Ultrasound
  - Laboratory evaluation
    - CBC, chemistry (including calcium and glucose)

## Dystocia

- Oxytocin
  - Cervix open and no obstructions
- Digital manipulation
  - Rarely beneficial
  - Fetus lodged in the posterior pelvic canal
- Caesarean
  - Oxytocin fails
  - Large fetus or obstruction

## Postparturient Problems

- Hysterical mothers
  - Quiet environment and tranquilize
- Postpartum hemorrhage
  - Follow dystocia tx with oxytocin
  - OHE
  - Rule out coagulopathy or DIC
- Retained placenta
  - Oxytocin (total 3 treatments)
  - OHE
- Uterine prolapse
  - Rare
    - During parturition or within 48 hours
  - Manual reduction vs surgical removal

## Other Postparturient Problems

- Acute metritis
  - Within 12-96 hours of parturition
  - Queen very sick with fever, PU/PD, V/D
  - Odoriferous vaginal discharge
  - Supportive treatment and antibiotics
  - Oxytocin first 24 hours after parturition
  - OHE
    - If no response to medical therapy

## Metritic uteri



## Other Postparturient Problems

- **Mastitis**
  - Associated with parturition
  - Posterior glands most often affected (inflamed)
  - **Signs**
    - Fever, depression, anorexia
    - Noisy and thin kittens
  - **Bacterial**
    - Staphylococcus, Streptococcus
  - **Treatment**
    - Antibiotics
    - Hot packing
    - Bottle feed kittens

## Infertility in the Queen

- **Functional failures**
  - Reproductive organs failure
- **Behavioral**
  - Inadequate socialization or inability to copulate
- **Male infertility**
  - Semen: absent or poor quality
- **Uterine/endometrium**
  - Uterus unable to support embryonic life
- **Early embryonic death**
  - Including abortion and fading kitten syndrome
  - Noninfectious and infectious

## Functional Failures

- **Intersex**
- **Delayed puberty**
- **Ovarian dysfunction**
  - Prolonged anestrus
  - Prolonged proestrus and estrus
- **Ovarian dependent syndromes**
  - Progesterone dependent diabetes mellitus
  - Pseudocyesis

## Functional Failures

- **Intersex**
  - Hermaphrodites or male pseudohermaphrodites
  - **Chromosomal**
    - Nonfunctional XXY
    - Chimeras XX/YY
- **Delayed puberty**
  - Poor nutrition
  - Parasitism
  - Chronic disease
  - Stress
  - Insufficient lighting

## Ovarian Dysfunction

- **Prolonged anestrus**
  - **Physiological**
    - Seasonal (absence of light)
    - Pregnancy
    - Pseudopregnancy
  - **Psychological**
    - Absence of behavioral signs
  - **Previously spayed**
  - **Pathological**
    - Infectious
    - Malnutrition
    - Male pseudohermaphrodite
    - Turner syndrome "XO"
    - Adrenal disease

## Ovarian Dysfunction

- Prolonged proestrus or estrus
  - Longer than 3 weeks
  - Hormonal treatment (estrogens, DES)
  - Vulvovaginitis
  - Cystic ovarian disease
  - Ovarian tumors
    - Granulosa cell tumors
    - Dysgerminoma

## Cystic ovaries



## Ovarian Dependent Syndromes

- Progesterone dependent DM
  - Secondary to prolonged progesterone therapy
    - Skin disorders
    - Estrus suppression
    - Pregnancy
- Pseudocyesis (false pregnancy)
  - Does not cause infertility
  - Secondary to rapid fall in P4 after weeks of P4 influence

## Behavioral

- Abnormal/suppressed estrus
  - Stress
  - Estrus displayed only when tom present
  - Inexperienced tom
  - Overuse of tom
- Physical barrier to mating
  - Inexperienced tom
  - Matted hair
  - Penile hair ring
  - Vulvovaginal abnormalities
  - Feline urological syndrome
  - Urethral irritation
  - Physical incompatibility



Loss of penile barbs

## Uterine Diseases

- Cystic endometrial hyperplasia
  - Can progress to pyometra
  - Middle-aged to older queens
  - Infertility, early abortions, decreased litter size
  - Causes
    - Progesterone influence on endometrial glands
    - Cystic glands produce mucus and blood resulting in endometritis or pyometra

## Uterine Diseases

- Pyometra
  - Occurs within 1-3 months of last estrus
  - Signs
    - Anorexia, depression, +/- vaginal discharge
    - Febrile, PU/PD, dehydration
    - Leukocytosis, anemia
  - Treatment
    - Prostaglandins
    - OHE

## Uterine Diseases

- Uterine rupture
  - During pregnancy
  - Treatment: exploratory laparotomy
- Ectopic pregnancy
  - Fetus within abdominal cavity
- Uterine torsion
  - During pregnancy

## Pyometra



## Early embryonic loss

- Noninfectious causes
  - Defective zygote
    - Genetic
    - Teratogens
      - Antibiotics (penicillin safest antibiotics during pregnancy)
      - Corticosteroids
      - Griseofulvin
  - Structural changes of the genital tract
    - Endometrium unable to support embryos
  - Nutritional deficiency
    - Deficiency: Vitamin A, iodine, calcium
    - Primary uterine inertia (familial)
  - Stress
  - Abnormal CL function (low progesterone)

## Early embryonic loss

- Infectious causes
  - Viral infections
    - Feline viral rhinotracheitis (FVR) due to herpes virus
      - 40% of losses
    - FIP
    - Panleukopenia
    - FeLV
      - 40% of losses
  - Parasitic
    - Toxoplasmosis (mid-late gestation abortions)
  - Bacterial
    - Streptococcus, Staphylococcus, E. Coli, Salmonella sp
    - Sources: vaginal, systemic, endometrial
  - Chlamydia
    - 20% of losses

## Macerated fetus



## Population Control Contraception

- Surgical
  - OHE
- Physical
  - Sham mating (vasectomized male)
  - Stimulation of vagina



## Population Control Contraception

- **Chemical**
  - **Prevention or suppression of estrus**
    - Progestin therapy
      - Megestrol acetate (Ovaban)
      - Medroxyprogesterone acetate (Depo-Provera)
      - Increased risk of development of CEH-pyometra
  - **Prevention of implantation**
    - Estrogens (retards transit through oviducts)
    - Progestins (prevents implantation)



## Population Control Pregnancy Termination

- **Surgical**
  - OHE
- **Chemical**
  - PGF<sub>2</sub>
    - After 40 days of gestation
  - Cabergoline
    - Inhibits prolactin release (PRL luteotropic properties)
    - Experimental

## Male Infertility

- **Immaturity**
  - Most males produce fertile sperm by 7-10 months
  - Some may take up to 1 year
- **Testicular abnormalities**
  - Cryptorchidism
  - Testicular hypoplasia or aplasia
- **Overuse of male**
  - Decreased in sperm cell numbers and libido
  - Breeding 4 times/week can decrease sperm output by 50%
- **Testicular damage**
  - Heat, trauma, infection
    - Damages seminiferous tubules



## Male calico



Questions???