Breeding Management
Breeding Systems in the Lab

- Permanently-mated polygamous system
- Harem system
- Monogamous system
- Hand-mating/Forced-mating system

- With any system, take the female to the male’s cage or put both in a neutral cage.
# Comparison of Systems

<table>
<thead>
<tr>
<th></th>
<th>Polygamous</th>
<th>Harem</th>
<th>Monogamous</th>
<th>Hand-mating</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cost</strong></td>
<td>Low</td>
<td>Low</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>--few males--few males</td>
<td>--few males--few males</td>
<td>--more males--more males</td>
<td>--few males--few cages</td>
</tr>
<tr>
<td><strong>Record Keeping (Pedigree)</strong></td>
<td>Poor</td>
<td>Good</td>
<td>Excellent</td>
<td>Excellent</td>
</tr>
<tr>
<td></td>
<td>--can’t tell parents of offspring</td>
<td>--if dam is removed prior to parturition</td>
<td>--dam and sire together</td>
<td>--sire is recorded</td>
</tr>
<tr>
<td><strong>Post Partum Estrus (Production Efficiency Index)</strong></td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>--male present at birth--higher production efficiency index</td>
<td>--male not present at birth--longer reproductive life</td>
<td>--male present at birth--higher production efficiency index</td>
<td>--male not present at birth--longer reproductive life</td>
</tr>
</tbody>
</table>
### Comparison of Species

<table>
<thead>
<tr>
<th>Species</th>
<th>System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mouse</td>
<td>Any system will work. Females are tolerant of males and other females. Males are good dads.</td>
</tr>
<tr>
<td>Rat</td>
<td>Will tolerate any system but monogamous or hand mating are common in lab primarily due to cage size.</td>
</tr>
<tr>
<td>Hamster</td>
<td>Hand mate--females are territorial. Best is female is introduced to male during PE, but many will tolerate males for a short period of time (1 week or less). Monogamous if pre-pubertal.</td>
</tr>
<tr>
<td>Gerbil</td>
<td>Monogamous. Generally breed prepubertally (5 to 7 weeks of age). Will abort a litter if male is removed and often will not accept another mate.</td>
</tr>
<tr>
<td>Guinea pig</td>
<td>Any system will work, but large harems (10 ♀ to 1 ♂) are most common.</td>
</tr>
<tr>
<td>Rabbit</td>
<td>Hand mate. Female is usually receptive and mating occurs within about 15 minutes. Lab cages usually won't accommodate multiple rabbits and females are territorial.</td>
</tr>
<tr>
<td></td>
<td>MOUSE</td>
</tr>
<tr>
<td>------------------------</td>
<td>-------------</td>
</tr>
<tr>
<td><strong>PHYSIOLOGY</strong></td>
<td></td>
</tr>
<tr>
<td>Life span</td>
<td>1 - 2 yrs</td>
</tr>
<tr>
<td>Breeding life</td>
<td>1 yr</td>
</tr>
<tr>
<td>Birth weight</td>
<td>1 - 1.5 g</td>
</tr>
<tr>
<td>Adult wt F/M</td>
<td>30/35 g</td>
</tr>
<tr>
<td><strong>BREEDING DATA</strong></td>
<td></td>
</tr>
<tr>
<td>Breeding onset-F</td>
<td>6 - 7 wks</td>
</tr>
<tr>
<td>Breeding onset-M</td>
<td>6 - 8 wks</td>
</tr>
<tr>
<td>Cycle length</td>
<td>4 - 5 d</td>
</tr>
<tr>
<td>Gestation</td>
<td>19 - 21 d</td>
</tr>
<tr>
<td>Weaning age</td>
<td>21 d</td>
</tr>
<tr>
<td>Litter size</td>
<td>10 - 12</td>
</tr>
</tbody>
</table>
Practical Applications

• You are asked to produce 30 adult female mice. Mice should be between 6 and 7 weeks of age by January 1\textsuperscript{st}.
  – What mating scheme do you use?
  – How many litters do you need?
  – When do you need to mate the females?
Practical Applications

• Breeding system
  – Which system do mice tolerate?
    • Any, but record keeping is poor in a polygamous system and not common in the lab.
  – Do we need more than 1 litter per female?
    • No, we want all offspring born around the same time so post-partum estrus matings are not desired.
  – Do we need to time mate?
    • No, we have a one-week window for mice to be born.
  – Harem mating is most common for this situation.
Practical Applications

• How many litters do you need?
  – We need 30 females
    • Assume a 50:50 ratio of sexes
    • Assume 10 mice per litter
  – We should get 5 females per litter
  – $30/5 = 6$ litters
  – What might affect this number?
    • Some females might not get pregnant.
    • Some litters might not be a 50:50 ratio.
    • Knowing how well your line breeds will help you make this determination but I would always add a couple of extra females if possible.
Practical Application

• When do you breed?
  – You need mice to reach 6 to 7 weeks of age by January 1\textsuperscript{st}.
  – Mice need to be born between November 13\textsuperscript{th} and November 20\textsuperscript{th}.
Practical Application

- What is the gestation for a mouse?
  - 19 to 21 days

- Mating should occur in what window?
  - 19 day gestation: 10/25 – 11/1
  - 21 day gestation: 10/23 – 10/30
  - Mate between 10/25 and 10/30 to be sure and fall within the necessary time frame.
Timed Mating and Pregnancy Confirmation

• Mouse
  – Group house 2 weeks (Van der Lee/Boot)
  – Expose to male (or pheromone) 3 days before desired plug date (Whitten Effect)
  – Check plugs for confirmation
    • Plug remains in vagina for several hours before disintegrating.
  – Can also use saline lavage to determine PE or look for sperm.
Timed Mating and Pregnancy Confirmation

- **Rat**
  - Synchronize cycle by group housing
  - Plugs fall out intact before lights come on
    - Can house in wire-bottom cages over black paper to find plugs
  - Use saline lavage to determine PE and/or copulation. A post-copulatory smear contains spermatozoa and more leukocytes than cornified cells.
Timed Mating and Pregnancy Confirmation

• Hamster
  – Very territorial female—will fight with male except during behavioral estrus.
  – Very regular 4-day estrous cycle
  – Determine estrus by looking for post-ovulatory discharge.
    • Creamy white
    • Viscous (stretches 5-6”)
  – Count 3 days to PE
  – Introduce to male
Timed Mating and Pregnancy Confirmation

• Hamster
  – Mating can be confirmed by the presence of a copulatory plug or presence of sperm in the vagina.
Timed Mating and Pregnancy Confirmation

• Gerbil
  – Monogamous pairs make timed matings difficult
    • Generally bred at 7 or 8 weeks of age, prior to sexual maturity.
    • Male may be removed for up to 2 weeks post-partum to prevent PPE mating, but no longer or may fight when reunited.
  – Plugs are small and deep so not useful in determining mating.
  – Saline lavage for presence of sperm in the vagina.
Comparative Physiology Review

<table>
<thead>
<tr>
<th>PHYSIOLOGY</th>
<th>GUINEA PIG</th>
<th>RABBIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Life span</td>
<td>4 - 5 yrs</td>
<td>5 - 6 yrs</td>
</tr>
<tr>
<td>Breeding life</td>
<td>2 - 3 yrs</td>
<td>1 - 3 yrs</td>
</tr>
<tr>
<td>Birth weight</td>
<td>100 g</td>
<td>100 g</td>
</tr>
<tr>
<td>Adult wt F/M</td>
<td>900/1200 g</td>
<td>6/5 kg</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>BREEDING DATA</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Breeding onset-F</td>
<td>8 - 11 wks</td>
<td>5 mo</td>
</tr>
<tr>
<td>Breeding onset-M</td>
<td>9 - 12 wks</td>
<td>6 mo</td>
</tr>
<tr>
<td>Cycle length</td>
<td>15 - 17 d</td>
<td>induced (15 - 16 d)</td>
</tr>
<tr>
<td>Gestation</td>
<td>65 - 72 d</td>
<td>31 - 32 d</td>
</tr>
<tr>
<td>Weaning age</td>
<td>14 - 21 d</td>
<td>4 - 8 wks</td>
</tr>
<tr>
<td>Litter size</td>
<td>2 - 3</td>
<td>7 - 9</td>
</tr>
</tbody>
</table>
Timed Mating and Pregnancy Confirmation

• Guinea Pig
  – The best method for determining behavioral estrus is the presence of lordosis.
  – Saline lavage to determine cycle stage is also helpful. Cell type varies during the time the vaginal membrane is open. It may also be used to look for sperm.
  – Rupture of the vaginal membrane is not a good indicator as it is open ~ 2 days prior to estrus and timing is unreliable.
  – Like the rat, plugs fall out intact before lights on and so are not a practical method for confirming mating.
Timed Mating and Pregnancy Confirmation

• Rabbit
  – Induced Ovulator
    • Female is receptive 15 out of 17 days.
    • Vulva is dark pink to purple when receptive
  – Hand mated—Immediate copulatory behavior
Timed Mating and Pregnancy Confirmation

• Rabbit
  – Rabbits don’t “show” and gain very little, if any, weight during pregnancy
  – To confirm a rabbit is pregnant during the cycle, you can palpate for fetuses between 9 and 15 days of gestation.
Placentophagy

• Dams & does eat placenta and amniotic sac
  – Retains nutritional and hormonal components
  – Removes it from nest
  – Sometimes dams don’t know when to stop.
Nest Building

• Mouse: Large
• Rat: Small
• Hamsters: Large, don’t disturb
Nest Building

- Gerbils: Nest box
- Guinea pig: No nest built
- Rabbit: Nest box—no retrieval instinct
Fostering

• Mouse, rat, gerbil, and rabbit: Usually successful if done within the first few days of birth and to a litter about the same age.
  – Mice and rats group rear young, sharing nursing duties
  – Some mice will tolerate fostered pups at any age
• Hamster: Rarely successful
• Guinea pig: Successful, but also easier to hand rear.
• To Foster:
  – Remove dam
  – Place young in nest and rub bedding on them to transfer scent or restrain dam and have her urinate on young.
Cannibalism

• Causes:
  – primiparous females
  – low milk production
  – drop in body temperature of pups
  – abnormal or unhealthy pups
  – disturbed or exposed nests
  – sometimes with excessively large or small litters, or overcrowding
  – biting (hamsters—born with incisors)
• Uncommon in rats, gerbils, guinea pigs, & rabbits
• Common in mice
• Very common in hamsters
# Breeding Management for Rabbits

<table>
<thead>
<tr>
<th>Day 0</th>
<th>Hand mate doe</th>
</tr>
</thead>
<tbody>
<tr>
<td>9 - 14 day pc</td>
<td>Able to palpate fetuses</td>
</tr>
<tr>
<td>27 day pc</td>
<td>Change floor to wire mesh, put in nest box</td>
</tr>
<tr>
<td>29 - 30 day pc</td>
<td>Doe becomes restless, begins pulling fur from neck and nipple line.</td>
</tr>
<tr>
<td>Parturition</td>
<td>Begin ad lib feed for doe, wear gloves to handle kits, remove any dead kits, retrieve to nest if necessary</td>
</tr>
<tr>
<td>3 week pp</td>
<td>Remove nest box, give double-wide cage, provide ad lib food for kits</td>
</tr>
<tr>
<td>6 - 8 weeks pp</td>
<td>Wean, largest kit first. Decrease doe's feed over next week or 2.</td>
</tr>
<tr>
<td>2 - 4 months</td>
<td>Kits on ad lib feed. Can have hay but no veggies</td>
</tr>
<tr>
<td>5 - 6 months</td>
<td>Reaching maturity, slowly decrease to maintenance level feed. Watch for fighting if group housed.</td>
</tr>
</tbody>
</table>

pc = post-coitus; pp = post partum
Rabbit Lactation

• Rabbits must pull fur from their nipple line
  – Stimulate lactation
  – Keep kits warm
• Note also the floor and nest box
First 1 week—hairless, blind, stay in fur-lined nest box. Doe protective but not in nest. By 2 to 3 weeks, begin to explore outside of nest box.

- ~1 week
- ~1 ½ weeks
- ~2 weeks
By 3 weeks, open cages to 10 ft\(^2\) (double wide). Two *ad lib* feeders.  
4-6 weeks—out of nest box  
6-8 weeks—wean a few at a time.
Sexing Kits at Weaning

Female

Male
Breeding Problems

• Dystocia
  – Difficulty in giving birth
    • Weak contractions (low oxytocin)
    • Size discrepancy
    • Vaginal prolapse
    • Split vagina
  – Guinea pig
    • First birth must be before 6 months of age
    • Fusing of pubic symphysis
Ketosis--Rabbits

- Pregnancy toxemia—a metabolic energy imbalance resulting in low blood sugar and high ketone body levels.
- Sign: Doe goes off feed
  - Weakness, anorexia, abortion
  - Agalactia
- Associated with first litter, obesity, or old age
- Breed early and often
Weaning stress

- Naïve gut--loss of passive immunity, low acidity
- Stress caused by separation lowers immunity
- Proliferation of Clostridium ssp.
- Bacterial toxins
- Diarrhea/Death