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Your hands on
guide exploring
rat breeding from
the ground up.

RATBREEDING 101



Written by Bleuming Tails Rattery

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INTRODUCTION



Many rat owners are enthusiastic advocates for their favorite - but often highly stigmatized - pets. The idea of beginning to breed to produce high-quality pets to help spread the good word of their loved pet begins to take seed, but where should they begin? Breeding rats can be an extremely rewarding experience, or it may result in frustration and failure. Preparation is key.

The intention of this guide is to provide you with information valuable to:

- Aspiring rat breeders
- Beginner rat breeders
- Curious pet parents.

While this guide is available to experienced rat breeders, it's my hope that the information held within this guide would be redundant by that point in their hobby. This guide is not meant nor designed to be an all-inclusive guide, but instead a jumping off point from the most common questions poised by aspiring or novice breeders, either located or following ethics popular in the U.S. pet rat fancy.

Poor breeding practices have tremendously damaging effects on rats, and on the well-being of owners. The results of poor breeding practices may lead to a lifetime of distress, through poor health and poor overall temperament as pets, resulting in an untimely death, abandonment or relinquishment. Breeders have an ethical responsibility to ensure rats they've produced have the opportunity to live a healthy and fulfilling life.

Rats deserve to have a good quality of life regardless of use, feeder or pet, and any breeder should do everything in their power to act sensibly and with compassion to care for the lives they've produced. It is ultimately the duty of the aspiring breeder to ensure they are well-educated and prepared to care for rats and their litters prior to making their first pairing.

*Abby
 Bleuming Tails Rattery*

D1 ABOUT THE NORWAY RAT

THE BEGINNING

Norway rats (*Rattus norvegicus*), also known as brown rats, were originally native to northern China, but due to their adaptable nature, quickly found their way into Europe by the 18th Century. By 1770, brown rats found their way to North America as stowaways on ships (Armitage, 2004). Rat domestication can date all the way back to Japan in the 1600 to 1700s, where they were kept as ornamental pets. Domestication began in Europe, and is subsequently a portion of the start of the U.S. fancy, as blood sports to eliminate the rising rat populations. The main drive for domestication in the U.S. stemmed from laboratory use (Hulme-Beaman et al., 2021).

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THE FANCY'S ORIGINS TO TODAY

The National Mouse Club in the U.K. was founded in 1895, and due to an increasing interest in rats, was changed to the National Mouse and Rat Club in 1912. However, after the death of Miss Mary Douglas (the “mother of the rat fancy”), interest waned and the rat was dropped from the name in 1929.

By 1976, the interest in the rat fancy had grown to be large enough to found the National Fancy Rat Society. While the origins of the fancy in the U.S. remains foggy, it is fairly certain most spawned from individuals interested in rats from laboratory use. In 1978, the American Fancy Rat and Mouse Association was founded. Over the last 45



years, varieties have been imported to North America, and several new varieties have even been founded here (Royer, 2015).

OUR RATS

While our domesticated rats are not distant enough from their wild counterparts to warrant a unique subspecies like dogs vs wolves, they have earned their own nomenclature: fancy rats. Due to this lack of distinction, wild rats and domesticated rats can easily interbreed, making it vital that your pets are kept in secure housing in an area free of wild rats.

DID YOU KNOW?

Black rats (*Rattus rattus*) were the long-suspected carriers of the fleas that caused the bubonic plague, but new studies are suggested that the black rats are innocent, and are now pointing fingers at humans and human lice (Gill, 2018).

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FAST FACTS

- The average life span for a domesticated rat is 2 to 3 years.
- Fancy rats are terrestrial/fossorial, and prefer floor space vs vertical climbing space. Their arboreal cousins are the black rat.
- The average size for a standard rat is anywhere between 150-500g, but it's not uncommon for bucks to be even larger.
- Dwarf rats result from a recessive gene; they're not just a small standard rat.
- A rat's front teeth continually grow throughout their lives, but are ground down through eating, chewing, and bruxing behaviors. Rats do not need special chews to grind down their teeth, since they can handle it themselves by bruxing or teeth grinding.

- Rats are social animals, and should always be kept in a minimum of two same-sex cage mates unless neutered.
- All rats are the same species/breed. The different colors, coat types, or other popular variations are known as varieties.
- Rats are crepuscular, which means they are the most active during dawn and dusk times, with varied activity during the night. Most of the time, rats sleep during the day.
- Tumor growth in rats is caused both by genetics and environmental causes. Two such causes are high sugar consumption, and light during dark periods of the circadian cycle (Roberts et al., 2022).



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GENERAL HUSBANDRY

HOUSING

Rats, like hamsters, require a large amount of living space. However, the minimum is far less than the arbitrary 2 sq ft commonly found among pet forums. Studies have shown that rats receive no negative effects when housed in spaces that allot for .5-1 sq ft of space per rat. Of course, if you have the ability to provide more space, do so, but remember that rats are a burrowing animal and large, open spaces can cause behavioral and fear problems.

Rats are fossorial by nature and prefer floor space over vertical space. In other words, rats prefer to burrow rather than climb. A fall from a tall cage can result in serious injury, as they are not particularly graceful. Rats have extremely sensitive respiratory systems and react poorly to any amount of ammonia or other scents in the room. Even a change in the type of bedding can trigger the sniffles. However, many lines of well-bred rats are robust enough to easily tolerate basic household scents without issue.

CAGE SIZING MINIMUMS

Body weight (g) of rats	Floor area/ animal (cm2)	Floor area/ animal (ft2)	Min. enclosure size (cm2)	Min. enclosure size (ft2)
Up to 200	200	.22	800	.86
Over 200 to 300	250	.26	800	.86
Over 300 to 400	350	.38	800	.86
Over 400 to 406	450	.48	800	.86
Over 600	600	.65	1500	1.61

Chart from Animalab, 2019, EU Based

01 BARRED CAGES

Traditionally, barred cages are top-of-mind when it comes to enclosures. Barred cages should have gaps no larger than one-half inch wide. If a rat can fit its head through a hole, it can fit its entire body. When cleaning a barred cage, you must be sure to wipe down each bar to prevent the buildup of urine and dangerous ammonia. For cages such as the Double Critter Nation, the entire cage needs to be broken down and thoroughly rinsed as urine and grime filters into the joints of the cage.

02 TANKS

Tanks, due to lack of ventilation, build up ammonia in a dangerously short amount of time. Even with commercially sold tank toppers, the ammonia settles into the bottom of the tank, as it is heavier than air. Tanks are heavy and difficult to clean and do not offer the correct amount of space or enrichment opportunities for happy pet rats. Due to these compelling reasons, tanks are not generally suggested as ethical housing.

03 BIN CAGES

A popular caging option is a bin cage. A bin cage is typically crafted from a 110 quart

Sterilite bin and has multiple windows cut out and replaced with half-inch wire mesh on the interior of the bin, not the exterior. However, many sizes of bins can be used, and you are only limited by your ingenuity. Because rats are fossorial, these bins offer a great amount of floor space, and they can be decorated similarly to a barred cage. A 110 quart can hold, on average, 4 adult males and 5 adult females respectively and costs roughly \$40. These cages can be customized and can be as large as you want by connecting bins with PVC piping.

04 HOMEMADE CAGES

While some homemade cages can work, cages crafted primarily from wood are generally unacceptable. Unless thoroughly sealed, the wood will soak up urine and will smell very quickly without any way to properly clean and remove the smell. Other types of homemade cages, such as ones built with PVC frames, often offer ample escape routes and require a lot of editing and maintenance.

BEDDING TYPES

KILN-DRIED PINE / ASPEN

For years, pine has been touted as being dangerous due to the level of phenols found in the wood. However, the kiln-drying process destroys these phenols and renders the product safe. Nearly all commercially sold pet bedding in the US is kiln-dried, as it's also the most cost-effective way to dry large amounts of pine. KDP has natural odor and ammonia control, and is very cheap to purchase. It has been shown that rodents actually prefer wood chip bedding over artificial bedding. It was found that hamsters preferred pine shavings over aspen shavings, corncob, and wood pellets (Becker et al., 2010).

Similar to KDP, aspen is another type of acceptable wood bedding that offers natural ammonia and odor control. Aspen primarily comes in flake form, and does tend to be more expensive than KDP.

CORNCOB

A type of bedding that is rarely discussed is corncob bedding. From all the studies, it shows that rats frequently prefer it over wood bedding, and it has a high absorbency and relatively decent ammonia control. So why isn't it used as much? Simply put, once wet, corncob bedding has a nasty habit of molding rather quickly, and it isn't very cost-effective. Additionally, multiple studies have shown that rats tend to prefer other bedding over corncob (Ras et al., 2002).

CAREFRESH / TEK FRESH / PAPER BEDDING

While paper bedding tend to be highly absorbent, they offer subpar ammonia control, let alone odor control. Rats and



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other rodents have also been known to ingest the paper bedding. They also tend to be very dusty compared to other bedding options. In a study comparing various beddings, Carefresh had to be discontinued early because the ammonia level in the cage reached dangerous levels (Smith et al., 2004).

HEMP

Hemp is a newcomer to the bedding scene. It touts great odor and ammonia control and is an alternative to wood shavings. Unfortunately, it is fairly pricey and is difficult to find reliably.

FLEECE

Fleece has zero natural odor or ammonia control. Unless treated beforehand, liquids also tend to pill on top of the fleece or get wicked underneath, leaving a puddle of urine to sit and ferment. Fleece, in order to be used properly, must be swapped out every two days and a secondary absorbent layer must be beneath it to allow for the urine to dry. Ammonia levels quickly become dangerous when fleece is used incorrectly.

CEDAR

Cedar is never acceptable as the kiln-drying process does not reduce the phenols to safe levels as it does with pine.

NUTRITION

	Protein	Fat*	Fiber
Recommended % for general maintenance	5-8%	5%	As low as possible
Recommended % for growth/weanlings	12-17%	5%	As low as possible
Recommended % for reproduction	18-25%	5%	As low as possible

*The minimum requirement for all life stages is 5%, but a range of 5-10% has been found acceptable.

COMMERCIALLY AVAILABLE FOOD BLOCKS

Lab-formulated food blocks, such as Mazuri, Oxbow, Harlan-Teklad, and Kalmbach, are specially formulated to be nutritionally complete for your rats. However, just like with all marketed foods, not all blocks are created equally. Blocks found at Walmart or other big box stores rarely use quality ingredients, or are properly balanced.

Regarding Oxbow, Oxbow Adult Essentials is the preferred option, as Oxbow Young Rat & Mouse and Oxbow Garden Select are not as nutritionally compatible. Both options include subpar ingredients and fillers that aren't compatible with rats' systems, such as whole grasses.

DOG FOODS

Many brands of dog foods are nutritionally quite similar to rat blocks. Rats are grain-based omnivores, and many of the lower to mid grade dog foods are grain-based as well. Some of the most common options include Doggy Bag from Tractor Supply and Twin Pet and Kal Kan from Walmart. When choosing dog food as your staple diet, you have to make sure of a few things:

- No dyes (Especially red dyes.)
- Protein is between 14-23%.

- Fat is 5-10%.
- Fiber is as low as possible.
- Grain-inclusive

MIXES

Store-bought mixes are only good for the occasional treat. These mixes are rarely balanced and often include dangerous ingredients such as dried whole corn. (This type of corn can produce a type of mold that is dangerous when consumed.) Homemade mixes must be carefully crafted and fed correctly in order to be balanced, similarly to a raw diet for domestic carnivores. There's a lot of math, measuring, and planning that goes into creating a balanced homemade mix.



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CORN AND CITRUS

GOOD TREATS

- Dark Chocolate
- Pastas (cooked or raw)
- Fruits (limit due to high sugar content)
- Common Veggies (No raw potato or gas-producing veggies)
- Lean Meats (Raw or unseasoned cooked)
- Crackers
- Dog treats/Bones
- Non-sugary cereals
- Captive-bred live insects/dried insects
- Yogurt
- Baby food

WHAT'S THE BIG DEAL?

For a long time, it's been preached across the fancy to never allow your male rats to eat citrus fruits or have the juices. Why is that? This is due to a terpene in the skin called d-limonene.

This substance is primarily found in the skin of citrus fruits such as oranges, lemons, limes, mangoes, and other herbs and spices such as dill, cumin, black pepper, and bergamot. This naturally occurring terpene is commonly used in citrus-scented products, goo gone cleaners, and citrus-flavored products.

Some preliminary studies found that high doses of limonene in a male rat's diet causes an increased risk for kidney cancers and a male rat-specific kidney toxicity referred to as hyaline droplet nephropathy. Why is this only an issue for male rats? Well, male rats' livers produce a protein known as alpha 2U-globulin. When administered high doses of limonene, the protein builds up and causes hyaline droplet formations (Hard & Whysner, 1994).

It's been discovered that this binding process is completely reversed after 48 hours, even when limonene is given at high doses (Nielson, 2013). So at what point do we need to be aware of when it's just *too much?*

The TD50 (or the rate at which 50% of the population develops cancer) for limonene in rats is 204 mg/kg of rat (Carcinogenic Potency Project). We also know that 800 mg/kg of pure D-limonene is processed and gone from the kidneys after 48 hours (Nielson, 2013). There is an average of 1300 mg of limonene from the peel of an entire orange (El-Ishaq et al., 2011). A 6 oz serving of orange juice contains 5.49 mg of limonene (Lee, 2001).

In order to hit the TD50, a 1 kg rat would have to eat roughly 16%, or just under 1/5, of an entire orange peel in one sitting. From juice? A 1 kg rat would have to drink 22 oz of orange juice, or 1.375 pints, in one sitting, understanding that even at this amount, it would be completely gone from their system in 48 hours.

BAD TREATS

- Caffeinated drinks
- Alcohol
- Bleu Cheese
- Raw Potatoes
- Raw Beans
- Raw Nuts
- Wild-caught Insects
- Spinach (very limited amounts)
- Soft bread (choking hazard. Stale/toasted is fine.)
- Undiluted Peanut Butter (choking hazard)

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A TD50 is different from an LD50 which is the rate at which 50% of the population dies. An LD50 is immediate. A TD50 takes time.

This ultimately means that if a buck were to be given a slice of mandarin orange or a mango chunk, they're going to be fine. Should citrus be a staple part of their diet? No. But a snack here or there is not going to harm them.

Most of us are familiar with the back and forth about corn being used as a filler in pet foods. But is it? And when is corn safe for rats?

Corn is not nutrient deficient. This is a myth that has been passed around for years. Corn is a highly available source of complex carbohydrates, protein, fiber, essential fatty and amino acids, and antioxidants, which makes it the opposite of a filler. Fillers contain no nutritional benefit. Corn is safely and easily digestible by pets. It is more digestible than rice, wheat, barley, or sorghum, and corn gluten meal touts an impressive 87.5% digestibility. Higher than beef/bone meal, poultry by-product meal, and fresh beef or poultry.

Corn meal and corn gluten meal do have different % between protein, carbs and fat. Given that our pet rats require lower sides of protein, corn meal tends to be a little better as it's more carbohydrate dense than protein dense.

So what makes corn a problem?

Whole corn kernels in mixes and lower-quality commercial foods pose a very dangerous problem. This type of corn is generally only dried at high temperatures, not ground and cooked like we see in our corn meals.

This process invites mold to form, which creates mycotoxins. Mycotoxins are common contaminants of dried corn. Aflatoxin and fumonisin are known carcinogens and are largely found as contaminants of corn. Aflatoxin causes liver, kidney, and colon cancers in rats, and fumonisin causes liver cancer.

Aflatoxin is a common contaminant of dried corn, peanuts, and their products. In these foods, aflatoxin and fumonism most likely occur at levels which are carcinogenic to rats; So feeding a daily diet, which consisted of only these foods, would result in liver, kidney and colon tumors in many of the rats. Feeding a daily diet limited in dried corn, peanuts, and their products reduces aflatoxin and fumonism levels and reduces associated tumors risks.



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DO YOU WHY DO YOU WANT TO BREED?

There's a lot more that goes into breeding than just throwing a buck and doe together. So, how do you know when you're ready to breed?

1. Setting clear breeding goals is crucial for responsible practices. Breeding without objectives can worsen issues like poor temperament and health in rats. While prioritizing better temperament and health is essential, breeding for specific colors or traits is acceptable, as long as it's balanced with improving temperament and health. Without goals, breeding might not be the right choice.



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2. Getting a good handle on local genetics and color names is crucial for successful breeding. Without this knowledge, there are risks to both the rats' well-being and achieving your breeding goals, like aiming for the perfect Russian Beige Harley Dumbo. Plus, knowing your genetics earns you respect from other breeders. Not being aware of common issues with different rat varieties can spell trouble for your rats.

3. Knowing how to care for sick rats is a must, even if you're not into playing vet. You need to know how to deal with things like abscesses and when a mama rat isn't interested in her babies.

4. Having enough space, money, and gear is super important when you're dealing with a bunch of new baby rats. You need a good setup for mom and babies, and enough cash on hand for emergencies.

5. Breeding isn't always smooth sailing. You have to be ready to make tough calls, like culling when it's necessary.

6. Being part of the breeding community is like going to school for breeding. You learn a ton from watching and talking to other breeders. Just remember, not every breeder knows everything, so take advice with a grain of salt.

7. Before diving into breeding, make sure there's actually a demand for rats in your area. Check out local pet groups and see if people are interested. If not, you might end up with more rats than you can handle!

ETHICS

eth·ics
noun

1. moral principles that govern a person's behavior or the conducting of an activity.

synonyms: moral code, morals, morality, values, rights and wrongs, principles, ideals, standards (of behavior), value system, virtues, dictates of conscience

2. the branch of knowledge that deals with moral principles.

Ethics and emotion should never coexist.

Emotions are an innately selfish response to a stimulus and cloud proper decision-making when it comes to the care of animals, especially animals to which the breeder has an attachment.

Ethics and science SHOULD coexist.

If you are a breeder, you are dabbling in the scientific world. Breeders mold entire lines by selecting for desirable traits and discarding traits that are not desirable. Selective breeding, also known as artificial selection, has been used by humans for centuries in an effort to create better crops and animals for our use and preferences.

In the world of science, debates are frequently settled or assisted with the use of scientific studies.

OPINION

o·pin·ion
noun

1. a view or judgment formed about something, not necessarily based on fact or knowledge.

synonyms: belief, judgment, thought(s), (way of) thinking, mind, (point of) view, viewpoint, outlook, attitude, stance, position, perspective, persuasion, standpoint; More the beliefs or views of a large number or majority of people about a particular thing.

FACT

fact
noun

1. a thing that is indisputably the case.

synonyms: reality, actuality, certainty; More used in discussing the significance of something that is the case.

In the world of rat breeding and pet keeping, ethics is often a hotly discussed topic. What is ethical when it comes to the care of your rats? Is humane euthanasia in a rat with a mammary tumor large enough to impede movement ethical? Is it ethical to let this rat live out the rest of its life because it is still eating, drinking, and active within its limitations? Is it ethical to cull a litter of 18 down to 8 in order to allow the remaining kittens to thrive? Is it ethical to leave all 18 kittens alive, even if it means that a few won't make it to adulthood due to the high amount of competition?

The generally accepted form of ethics among rat breeders (US) is to follow a Quality of Life scale. If an animal drops into a danger zone or fails altogether, hard culling is frequently the most merciful and ethically sound solution.

It's a hard pill to swallow, but not every animal can be saved.

WHAT IS THE DIFFERENCE BETWEEN OPINION AND FACT?

Facts are backed by peer-reviewed, current scientific articles from reputable sources. Opinions are a person's judgement without the use of scientific backing.

In the rat breeding world, fact vs opinion comes up frequently. Especially in cases concerning US breeders vs UK breeders. Many breeders, falsely, believe that experience trumps science, and we've already discussed that if you're breeding, you're a part of the scientific world. Experience definitely has its place, and is not something that should be disregarded completely, but in the ever-changing world of husbandry, medicine, and genetics, science reigns supreme.

Rats are fairly new to domestication, and the lineages vary region to region. In the UK, the fancy dates back centuries, and many lines are extremely established and no longer require major artificial selection. In the US, lines tend to be fairly new and do need a firmer hand and more severe artificial selection.

Does this make one region more correct than the other? No. Different environments will have different standards and practices to which they adhere.

Does this mean that because regional differences exist that you can blanket that entire region with the same assumption? No. Does this mean that because you are a UK breeder and do not hard cull that all US breeders are monsters? No. Does this

mean that if you are a US breeder that UK breeders are irresponsible? No. Is it possible to discuss regional differences without resorting to arguments? Yes. Does this require an open mind, and a strong scientific base? Yes.

If you choose to breed any animal, a line must be carved in the sand as to where you stand. If you choose to breed any animal, you must be prepared to put that animal's well-being above selfish emotions.

Experience leads to confident decision-making. Educated experience leads to confident, correct decision-making.

TYPES OF RAT BREEDERS



All rat breeders fall into three categories: pet, feeder, or dual.

PET RAT BREEDER

These breeders tend to be smaller scale on average, though not always. Their demand does not include a high demand for feeders, so their supply comes from carefully chosen pairings to produce the best possible outcome for pet-quality animals. Such traits include a solid temperament, good health, and a well-documented lineage proving health and temperament. Not all pet breeders breed for the public.

Pet breeders tend to have strict adoption policies, utilize contracts, and have adopter applications. Often, these breeders will use a separate application for other breeders wishing to purchase stock. While pet breeders may feed their culls to various species of animals, breeding to produce feeders is not their main or even secondary goal. Many pet breeders choose to provide greater amounts of space, but large amounts of

space doesn't make them any more ethical than pet breeders who choose to utilize space closer to the lab minimum.

Due to such care with choosing pairings, record keeping, and strict policies, an ethical pet breeder may charge more for their animals than a feeder breeder. Pet breeders should understand the genetics of the varieties they choose to breed at a minimum, as it's necessary for making solid decisions when pairing. When pairing, pet breeders may pair by checking for an active heat, placing a pair together for 10 days or until the doe is visibly pregnant, or even utilizing a colony setup (leaving the buck with multiple does permanently) if they're equipped to handle a higher volume.

Not all pet breeders are ethical simply because they only breed for pets, and should always be examined closely if you're wanting to purchase from them.

FEEDER BREEDER

As stated in chapter one, all domesticated rats are the same species. This means that animals produced by pet breeders and animals produced by feeder breeders are all fancy rats. However, feeder breeders usually breed at higher volumes, and breed for the purpose of feeding these animals to other carnivores such as snakes, dogs, cats, birds of prey, or other carnivorous pets.

Feeder breeders do face some stigma among the pet community, but basic ethics should still be followed. Basic levels of care, such as husbandry, and utilizing humane euthanasia methods are key components for breeding rats ethically as food. Feeder breeders should still be selecting for solid temperaments for their breeding animals, and many utilize colony breeding vs single pairings.

Colony breeding tends to produce higher volume, and provides rats at different sizes which is necessary for providing a feeder clientele, or even just for feeder breeding for personal use.

Feeder breeders tend to have a bad rap because there are a portion of very unethical feeder breeders who breed only for volume and do not provide appropriate husbandry, or choose for good health and stable temperaments. Not all feeder breeders are



unethical just because of their purpose for breeding, and, just like with pet breeders, they should be examined closely if you're wanting to purchase from them.

DUAL-PURPOSE BREEDER

A dual-purpose breeder is someone who has a focus on both pet breeding AND breeding as feeders. These breeders tend to be pickier when selecting pairings or holdback stock, but may produce higher volumes than a pet only breeder. The purpose of the hard culls from a dual-purpose breeder is to provide food for other animals. Just like with the other two categories, a base of proper ethics should be present.

METHODS OF EUTHANASIA

When choosing to cull or remove an animal from a breeding program, a breeder will decide if the animal can be soft culled or retired vs hard culled, which is humane euthanasia. In a breeding program, all rats who are being pet homed are being soft-culled, as well as retired breeders who stay at the rattery. If opting to hard cull, a pet breeder should follow AVMA standards for at-home euthanasia if they do not utilize a vet. These include freezing neonates under 10 days of age, cervical dislocation on animals under 200g in weight, and regulated CO₂.

FREEZING

Rat pups are born neurologically underdeveloped, and their pain receptors are not well-developed until after 5 to 7 days old (AVMA, 2020). The AVMA guidelines for euthanasia has changed over the years on the age when freezing becomes unacceptable, but the current version states freezing is acceptable until 10 days of age. When choosing to freeze, babies should be placed in a towel lined container to prevent touching cold surfaces.

CERVICAL DISLOCATION

By far the most hands on method, cervical dislocation is often used in laboratory settings as a way of humane euthanasia without the introduction of sedation, or other chemicals used in euthanasia. Unlike in rabbits, a rat's neck muscles grow quite large, thus rendering this already-difficult method

far more difficult as the animals ages, limiting the use of this method to rats under 200g in size.

1. Restrain the animal in a normal standing position on a solid, flat surface, and grasp the base of the tail firmly.
2. Place a robust pen, rod like a screwdriver, or closed scissors/hemostats against the back of the neck at the base of the skull.
3. Quickly push forward and down the tool against the head, while pulling backward with the hand holding the tail base simultaneously. The action should be fast, and sharp.
4. Success can be verified by feeling for a separation of cervical tissues. When the spinal cord is severed, a 2-4 mm space will be palpable between the occipital condyles and the first cervical vertebra. Occasionally, however, the dislocation occurs between thoracic vertebrae.
5. Watch closely to confirm respiratory arrest, and verify that there is no heartbeat (Office of Research Support and Compliance, 2008).

REGULATED CO₂

The only form of CO₂ that is approved is compressed gas from a tank, as it can be regulated. Other forms, such as dry ice or baking soda and vinegar, are never acceptable. In order to be humane, the air displacement rate needs to be 30-70%. Using this displacement method, CO₂ flow should be continued for at least 1 minute after respiratory failure (University of Kentucky, 2020). This method is best for rats over 2 weeks of age, over 200g in size, or for large groups.

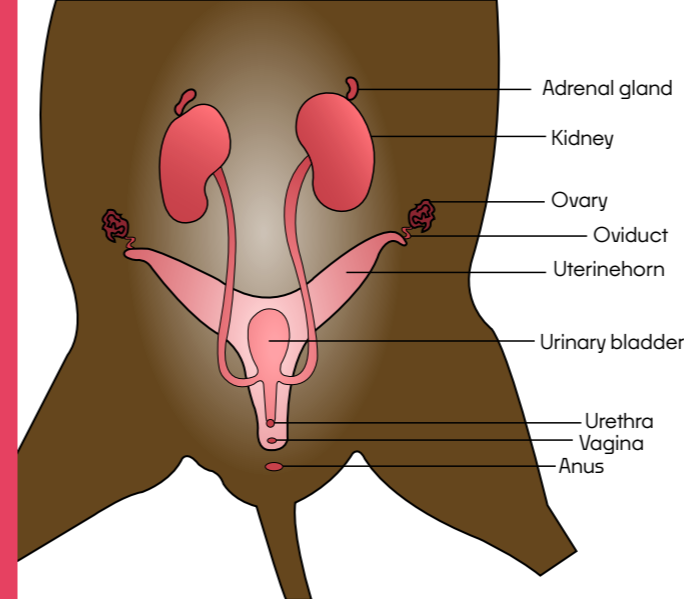
This method requires connecting co₂ tanks through a flow meter to a non-airtight container. It is not humane without the flow regulator and correct displacement rate.

Elena M. Tarasova / Shutterstock.com

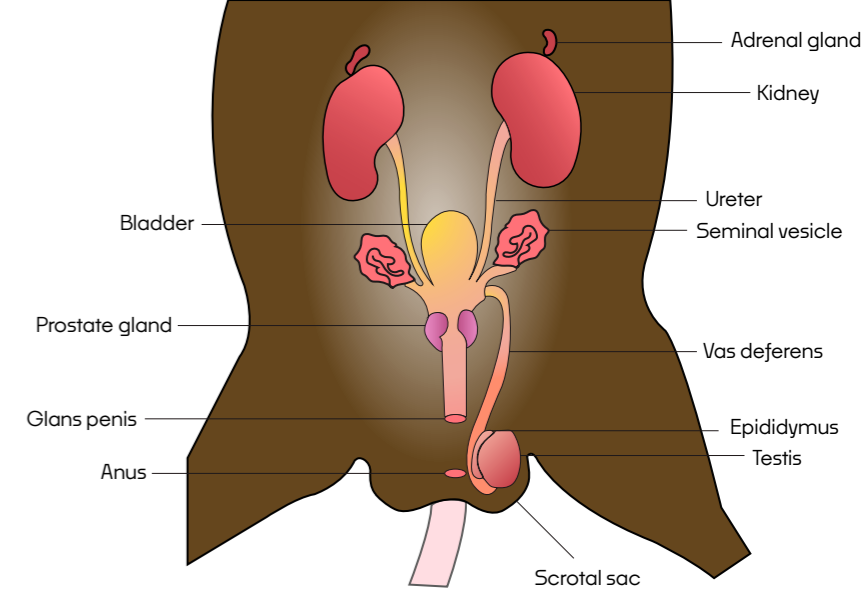
03 BREEDING

THE UROGENITAL SYSTEM

The urinary or excretory and reproductive systems of rats are closely interconnected and are collectively known as the urogenital system.



DOE ANATOMY



BUCK ANATOMY

The urinary system removes wastes and the reproductive system produces gametes or sperm and eggs and creates a safe environment for the growing embryos.

The excretory organs include the kidneys, adrenal glands, bladder, ureters, and urethra. The major reproductive organs of the male rat are the testes, which are located in the scrotal sac. Surrounding the testis is a coiled tube called the epididymus which stores sperm that has been produced by the testes. The vas deferens moves sperm from the epididymus to the urethra

The glands located to the left and right of the bladder are the seminal vesicles. These glands produce the fluids that will become semen. The gland below the bladder is the prostate gland.

Rats are known for having large testes, and is one of the main factors that turn adopters away from keeping bucks. The ultimate size will vary between individuals. In premature bucks, the testes descend between 4–6 weeks of age. A rat with either one or both testicles that remain undescended is

known as cryptorchidism. Cryptorchidism is a condition where one or both of the testes fail to descend into the scrotum. Rats with cryptorchidism have an increased risk of developing testicular tumors, as well as potential testicular torsion and inguinal hernias. For these reasons, neutering is recommended for cryptorchid rats.

The testes are able to retreat into the rat's abdominal cavity and can seem to disappear, especially during times of distress, as a way to protect the delicate organs.

Another role of the testes involves the secretion of hormones such as testosterone, estrone, and progesterone. Overproduction of testosterone is often the main culprit behind hormonal aggression, as the testes produce more than 95% of a bucks' testosterone.

The prostate gland is a gland located behind and slightly below the urinary bladder and is partially wrapped around the penis.

The male rat has 5 pairs of accessory sex glands, including the prostate glands. The fluids produced from these glands are designed to cultivate and activate the sperm, to clear the

urethral tract, provide transport to the sperm in the vaginal canal, and to create a plug to help ensure fertilization and reduce competition.

Despite not having nipples, male rats do have mammary tissue, and can still develop mammary tumors.

The main reproductive organs of female rats are the vagina, ovaries, uterus, and mammary glands.

The vulva/vaginal canal is what leads from the uterus to the outside of the body. The vaginal opening or vulva is found below the urethra. Does have a membrane covering the vaginal opening that typically ruptures on its own by 33–42 days of age (Grant, 2023).

Rats have a uterus consisting of the two horns, referred to as a bicornuate uterus. The horns of the uterus come together to form the vagina. The ovaries are located at the end of the uterine horns and connected via the oviducts near the kidneys. The ovaries produce the eggs, and certain hormones such as estrogen, progesterone, and up to 25% of the testosterone found in a doe's body.

The nipples and mammary glands, which produce milk and colostrum for offspring, can occur anywhere along two parallel lines running along the belly. Does have 10 to 12 nipples along these abdominal lines.

Some varieties, such as Hairless and Harley, can cause milk production to be limited or nonexistent (Grant, 2023).

BASICS OF BREEDING

Ethics and breeding basics vary greatly by region, so familiarizing yourself with your region's norms is your first step.

Fast Facts (Grant, 2023)

- Sexually mature: 5–6 weeks of age
- Frequency of estrus: Every 4-5 days year round
- Length of estrus: Usually 12 hours (most often at night)
- Postpartum estrus: 12–24 hours after birth
- Pelvic fusing in does: No
- Gestation: 21–23 days
- Fur development: 7–10 days
- Eyes open: 12–15 days
- Ear canal open: 12–14 days
- Separation age: 5 weeks on average

CHOOSING YOUR BREEDERS

Selecting breeders is an important step in establishing your lines. There are two main ways to procure stock: purchasing already established lines from a reputable pet breeder or purchasing feeder bred stock from a reputable feeder/dual breeder. Both options are valid, and present with their own pros and cons. No matter which option you choose, it's suggested to not adopt out to the public prior to 3 or more generations produced in your rattery. This is to ensure solid temperament/health, and to familiarize yourself with the line.

Once you have your stock, the next step is choosing the best pairing for your goals. This requires you consider the genetics, temperament, and health of your animals to determine how they will meet your goals. The general rule of thumb for pairing rats in the U.S. pet fancy is that does are both a minimum of 4 months old, and 250g in weight. Bucks should be a minimum of 6 months of age to help ensure hormonal aggression is not present. Most breeders only breed does 2 to 3 times total, and retire at 1 year of age.

Bucks are safely capable of breeding until death, but advanced ages does decrease sperm quality. This can result in a larger amount of preimplantation loss, decreased fetal weight, and increased neonatal deaths (Serre & Robaire, 1999). Does do not experience a true menopause, or full cessation of fertility, and instead have what is known as an estropause. Estropause refers to an irregular, reduction or cessation of estrus cycles. This can begin as early as 9 months of age, but is more typically seen between 15–18 months of age. This means does can breed until death, but risks increase with age.

Established lines can operate differently depending on the capabilities of your lines, and can safely breed earlier than the suggested age, as well as later in life.

PET STOCK

Pros:

- Temperament issues should be mostly bred out of the line
- Health should be stable
- Known lineage / trackable pedigrees
- Likely less hard culling required

Cons:

- More expensive
- Potential restrictions from original breeder
- Potential travel

FEEDER STOCK

Pros:

- Often cheaper
- Little to no restraints imposed by original breeder
- Likely little travel

Cons:

- Often have to deal with temperament issues
- Health issues may be present
- Little to no known lineage
- Likely needs heavy-handed hard culling early

FERTILITY ISSUES

Rats can experience fertility issues as a result of numerous factors including nutrition, environmental causes, and illnesses.

In bucks, low sperm count may occur with a pre-existing genetic condition, a hormone disorder, infection, and age. Infertility may also result from cryptorchidism or other testicular abnormalities. In does, common causes of infertility include: tubal blockage, hormone imbalance, tumors and cysts in the reproductive system, thyroid conditions, and disease.

Other factors that impact fertility and litter loss in female rats pertain to age, weight, and stress factors such as poor husbandry and nutrition. Older females can either stop producing eggs or have eggs that are less viable. Obesity and being underweight can result in infertility, larger pup birth weight or low birth weight, cause fetal and neonatal death, entire litter resorption, contribute to birth defects, and complicate the birth process.



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MATERNITY HOUSING

Pregnant does should be moved into a single level, barless cage prior to birth. This includes properly made bin cages, and rat racks. Tanks are not suitable for maternity housing for the same reason they are not suitable for regular housing. Neonates can be injured by a climbing doe or can be pushed between bars, even in a cage with 1/2 inch spacing. Housing should include deep, appropriate bedding such as hemp, aspen flakes, or kiln-dried pine flakes, as well as a shelter. The shelter can be anything from a commercially sold igloo house to a soda box. Being that rats are fossorial, rats in the wild will create burrows and place their nests underground. In captivity, they will often build deep nests with high walls of bedding. Many does will even block off the entrance to their house with bedding. However, some does nest very little, and as long as neonatal care is good, it's not a concern.

Some breeders will include additional nesting materials such as straw, but paper products like paper towel, toilet paper, and tissue paper should be avoided until after birth. Paper can stick to damp, delicate new-



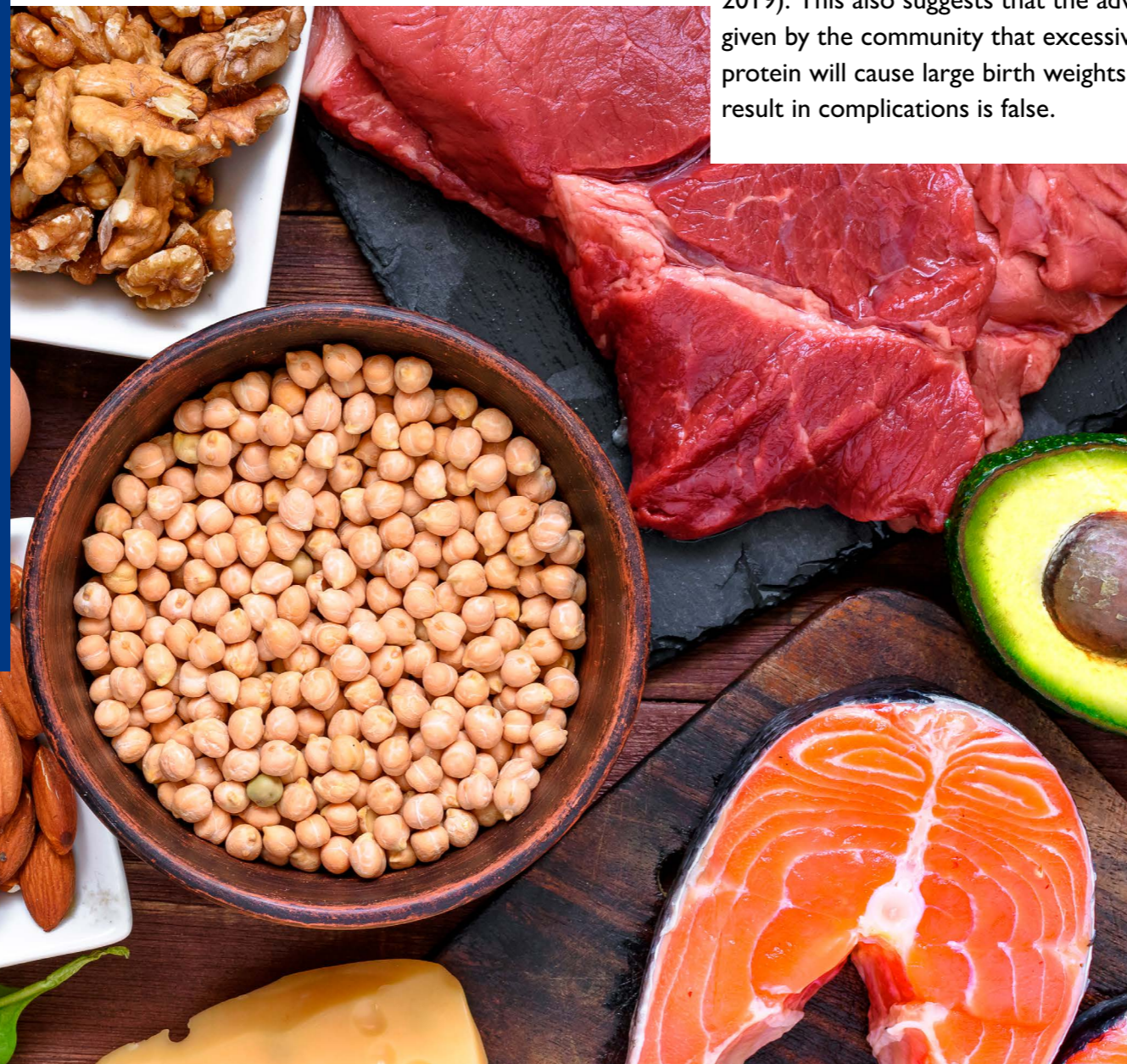
born skin and cause tearing when removed. Until about 2 to 3 weeks of age, maternity housing should be fairly bare bones, as the doe will be spending most of her time on the nest. Once pups begin to explore, they can be moved to a barred cage with appropriate wire spacing, or have their current caging decked out with exploratory items.

While it can be safe to allow does to co-raise litters, and is often the case in colony settings, careful considerations must be made. Issues from one doe hoarding all the babies can arise, resulting in excess strain on the doe, and babies may not receive proper nutrients. Pups can also be injured by cohabitating does fighting over the babies. If you experience these situations, it's best to separate the does and their litters into separate housing.

THE PROTEIN PROBLEM

It's long been stated among the breeding community to avoid supplementing pregnant does with extra protein as it will cause the fetuses to grow too large, and cause labor complications. The high-quality lab block is sufficient. If you need to supplement, which you should be aiming to use does who handle pregnancy and nursing without major intervention, it's been suggested to do it postpartum.

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However, it's been suggested in studies to avoid a high protein diet during gestation - and even lactation - for an entirely different reason. The results indicate that low-protein diets significantly reduced litter birth weight and pregnancy weight gain, but did not influence litter size or pregnancy feed intake. In comparison, high-protein diets were found to reduce pregnancy feed intake, but did not change litter size, litter weight, or pregnancy weight gain. The results suggest that low but not high-protein gestational diets alter reproductive outcomes at birth in rats (Ajuogu et al., 2019). This also suggests that the advice given by the community that excessive protein will cause large birth weights and result in complications is false.

However, pups receiving a high protein diet during gestation or lactation did experience a lower body-weight post-weaning. Regardless of does' diets, pups receiving high protein diets after weaning had 7% lower body weight, 16% lower total energy intake, and 31% lower adiposity (body fat). Pups eating high protein after weaning experienced increased blood glucose, insulin, and glucagon when food deprived (Desclée de Maredsous et al., 2016).

However, potentially far more concerning, is a study performed on mice regarding a high protein diet during lactation. Female mice received a control food of 21% protein or were fed a high protein diet of 42% protein during mating, gestation, and nursing.

An impact of high-protein diet during pregnancy impacted does' body weight gain, body weight of newborns, number of offspring, and also survival in later life. Most concerning is the finding that the high-protein diet during lactation caused a more than eight-fold increase in offspring mortality. Although pups nursing on does fed high protein diets might have the advantage of lower abdominal fat within the second half of life, this benefit does not outweigh the risks (Walther et al., 2011)

Ultimately, choosing healthy, well-bred does and feeding a high-quality, balanced lab block is the most you should have to do between mating and weaning. If you find your does cannot keep condition, or the condition of their pups is suffering, it's an issue with your stock as long as your nutrition and husbandry is correct.



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BREEDING METHODS

Various methods of breeding exist, but they all involve placing the buck and doe into the same space. In order to successfully breed, does must be able to reach a position called lordosis, which is the arching of the back. This reflex is triggered by pressure from the male at the base of the tail. This means that rats are not capable of breeding through bars.

COLONY BREEDING

The method that is most popular with high volume breeders is known as colony breeding. This method refers to keeping groups of rats together at all times. These groups generally contain 1 buck to 2 or 3 does at a time. This method can produce back-to-back

litters, which is safe for does as long as they retain condition. If you find that your does are unable to keep weight during pregnancy or nursing, they are not a good candidate for breeding, no matter the method. Your goals should be to produce does who can successfully and easily bear the strain of whelping litters, even back-to-back.

Norway rats experience postpartum estrus, where is where a doe will go into heat roughly 12 to 24 hours after birth, in which she can be bred again. A common result of colony breeding prevents back-to-back births and is known as delayed implantation. Rats do not retain sperm, but, instead, delay implantation. Conception does not begin at

fertilization, and instead actually begins when the egg implants itself into the uterine lining. In mice, dormant blastocytes have been shown to remain viable longer than 3 weeks (Lee et al., 2011). This ensures the doe is able to nurse her current litter without the strain of pregnancy, and give birth after the first litter is weaned.

ESTRUS TRACKING

Does go into heat every 4 to 5 days, primarily in the evening, as this is when they're most active naturally. Estrus tracking is when a breeder manually checks by examining a doe's vaginal opening. When in heat, the vulva is slightly gaped with a light dusky, purple hue. A breeder will place the doe

with the chosen buck, and if the doe is receptive, the pair will likely mate multiple times in the span of a few minutes. Once mating is successful, the pair are separated and go back into the same-sex colony where the doe will remain until close to birth when she should be moved to maternity caging. This method gives a more precise due date, as the breeder witnessed copulation.

COHABITATION

This method occurs when a doe and buck are placed together for 10 days (2 heat cycles) or until the doe is visibly pregnant, then the buck is removed. If the buck is not removed before birth, the doe will likely be bred during postpartum estrus. Depending on when the buck is removed, the doe should either be returned to the female colony, or remain in maternity housing. This method is less reliant on tracking heat cycles, so it's often more convenient. However, you don't have a precise due date and instead will operate on a range from date of pairing.



LABOR AND LABOR COMPLICATIONS

Most rat labor only takes 1 to 2 hours for completion. Birth is very rapid for rats. Once active labor begins, leave mom alone in a quiet, dark area. Only check in once an hour or so (if you manage to catch it) to make sure everything is going smoothly. Rat contractions are easy to see. Prior to labor, you need to have an emergency plan. This means either having access to a vet who will see the rat or means of humane euthanasia at home for the doe should she have continual issues.

A small amount of blood post-birth while mom cleans up the pups and placentas is normal, but continual and prolonged vaginal bleeding post-birth is not normal for rats and is a sign that something is wrong. Should your doe experience dystocia there are a few steps to complete.

WHAT IS NORMAL

- 1 or 2 stillborns
- 1 or 2 deaths during initial 48 hours
- The mom eating the deceased babies. This provides valuable nutrients and protein.

WHAT TO DO

1. Asses the doe's physicality
 - a. Is she warm to the touch?
 - b. Responsive?
 - c. Have contractions stopped?
 - d. Is she displaying pain signs?
 - i. Fluffed fur
 - ii. Sucked sides
 - iii. Squinted eyes
2. If contractions have stopped and pain signs are present, and few pups have been born, the doe may have stopped contractions early.
 - a. Tums antacid can be used in a pinch to restart stopped contractions.
3. Children's Pedialyte is useful to restore sugars and electrolytes to a laboring doe.
4. Heat pads set on low and covered with a towel can provide much needed heat to a laboring doe. This allows her body to focus on laboring rather than keeping the internal temperature warm.
5. Contact the vet! In extreme situations, oxytocin can be administered to help aid with contractions. At worst, some vets are capable of performing an emergency spay.

SIGNS OF LABOR COMPLICATIONS

- Excessive vaginal bleeding
- Signs of shock
- Protrusion of stuck pup visible from the vaginal opening
- Severely convulsive labor
- Prolonged pain vocalizations from the mother
- Prolonged labor (labor longer than 3 or 4 hours)
- Unproductive contractions
- Multiple stillborns
- Deformed, under-formed, or macerated pups
- Mother ignoring live pups already delivered

SIGNS OF SHOCK

- Labored breathing
- Slowed or shallow breathing
- Lethargy/exhaustion
- Pale lips, ears, extremities
- Lack of thermoregulation (cool rather than warm to the touch)

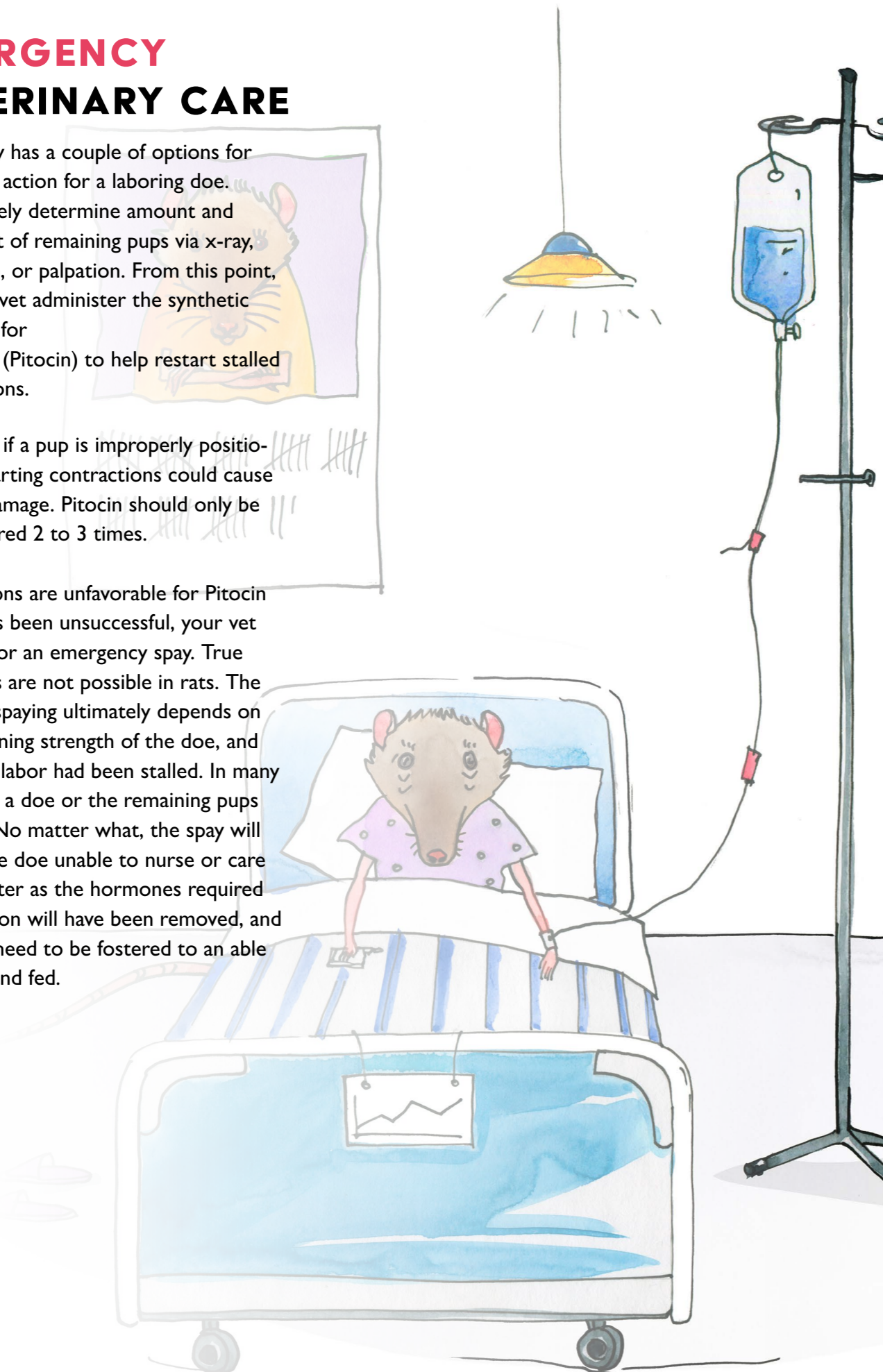


EMERGENCY VETERINARY CARE

A vet only has a couple of options for course of action for a laboring doe. They'll likely determine amount and placement of remaining pups via x-ray, sonogram, or palpation. From this point, they may vet administer the synthetic hormone for Oxytocin (Pitocin) to help restart stalled contractions.

However, if a pup is improperly positioned, restarting contractions could cause further damage. Pitocin should only be administered 2 to 3 times.

If conditions are unfavorable for Pitocin or if it has been unsuccessful, your vet may opt for an emergency spay. True c-sections are not possible in rats. The result of spaying ultimately depends on the remaining strength of the doe, and how long labor had been stalled. In many instances, a doe or the remaining pups may die. No matter what, the spay will render the doe unable to nurse or care for the litter as the hormones required for lactation will have been removed, and they will need to be fostered to an able doe or hand fed.



NURSING/NURSING COMPLICATIONS

Most rats will have litters that range in size anywhere from 10 to 16 pups on average. Natural litters ranging in size above and below these numbers do happen and are normal. Healthy pups should be grouped together in the nest, warm to the touch, and visible milk bands, a white band around their belly, should be apparent. If a pup or two are separated from the nest, you can try to place them back. It's often that the doe will move them away once more. When a doe decides to separate one or two and neglect them, she's often saying there's something wrong. In these cases, humane euthanasia is a merciful option.

LARGE LITTERS

Rats have 10–12 nipples, and when litters are larger than that number, strain is placed on both mom and pups. In extremely large litters (16+), it's likely to find pups who are underweight due to the high levels of competition. Does who are under major strain during nursing can lose a lot of weight and physical condition if they are not bred to be able to handle larger litters. Too much strain unchecked can kill a doe.

So, there are a few options when it comes to handling large litters.

HEAVY SUPPLEMENTATION FOR MOM

Feeding the doe daily treats higher in fat and protein can help combat large litter nursing strain. This can include boiled eggs, lean meats, and the flesh of an avocado (avoid skin and pit). The normal quality lab block should remain the main food, and be available at all times.



SUPPLEMENTATION AND ROUND-ROBIN FEEDING PUPS

This means using kitten formula, human infant soy formula, Esbilac puppy formula or Esbilac goat formula and hand-feeding half of the litter on a rotation while the other half is left with mom. When hand feeding, a syringe should never be used as the risk of aspiration is great. Instead, micro nipples or a small paintbrush should be used.

HUMANE EUTHANASIA

The litter has the numbers humanely reduced to accommodate better doe health per AVMA approved methods.

Rats are capable parents, and can sense far more than we can about the health of the pups at birth.

But that doesn't mean every doe is going to be successful at raising a litter.



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ILL-CARED FOR LITTERS AND OTHER COMPLICATIONS

Not all does are quality mothers, but luckily rats tend to be pretty self-sufficient parents without the need for excessive humane intervention. You'll frequently see maiden does have issues with handling a litter. In this instance, being a neglectful first-time mother is not always indicative of not being safe to breed a second time. While not ideal, maiden does can have problems with maternal behavior kicking in.

Some issues, such as litter scattering, are only problematic when combined with does who are not feeding, or keeping pups warm.

If the pups are scattered, but are warm and fed, they'll likely be fine and don't need human assistance. If you have a doe who is litter scattering as well as not feeding pups, a sometimes quick-fix involves placing the doe and litter in miniscule housing where she's unable to go anywhere but sit on the nest. This can sometimes jumpstart maternal behavior. Once she's began nursing (as evidenced by milk bands), she and the litter can be moved back to normal housing under close supervision.

Other issues include agalactia (not lactating), overzealous grooming, or excessive canni-

balism. It's common for a doe to consume pups who were stillborn or who died shortly after birth, but it is not normal behavior for a doe to cannibalize living pups or a significant portion of the litter. Excessive behaviors are often a red flag for the doe's temperament.

Other concerning issues include over-grooming to the point of injury, and cannibalism. Grooming is a natural practice for rats and does spend a lot of time grooming their pups. However, some does become a little overzealous and can cause wounds that vary from minor abrasions to severe injuries such as amputations. Does who over-groom are generally considered ill-fit to be mothers, especially does who severely injure pups. Does who cannibalize entire litters are considered ill-fit to be mothers, and should not be rebred. Unlike in mice, litter cannibalization due to stress is extremely rare, and it's a trait that is not normal in rats.

If a doe continues to neglect the litter, you have, essentially, three feasible options.

- The first option is to find a foster doe in your area that may take on the pups.
- The second option is to humanely euthanize the litter. If younger than 10 days, the method discussed above is suitable.
- Full-time hand raising. This method is not always successful, and is quite difficult.



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Third from the left is an example of an FTT compared to healthy, standard siblings.

FTT AND RUNTS

In the rat breeding community, a hotly debated topic revolves around distinguishing between a pup experiencing Failure to Thrive (FTT) and one that's simply a runt.

FTT pups exhibit clear signs of struggling health. They lag behind in crucial developmental milestones, often appearing frail and underdeveloped. Their diminutive size, scant fur, inadequate fat reserves, and delayed progress in milestones like opening their eyes or transitioning to solid food mark them distinctly. Their bodies lack the ability to efficiently absorb vital nutrients, leading to a state of malnourishment akin to starvation. Left untreated, FTT rats face short, illness-ridden lives plagued by complications.

In contrast, runts are smaller in size compared to their littermates but maintain healthy development. Unlike dwarf rats, which stem from a genetic anomaly, runts are simply undersized without inherent genetic mutations. Notably, runts maintain pace with their siblings in developmental milestones and typically possess robust fur and fat stores.

It's imperative to recognize that FTT individuals face a grim prognosis. With no chance of recovery or improvement, euthanasia is often the most humane option.



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MATERNAL AGGRESSION

Maternal aggression in does can sometimes manifest even before they give birth. Signs such as being overly dominant in the cage, exhibiting bossy behavior, or displaying unusually vocal or aggressive heat cycles can serve as early indicators of potential maternal aggression.

IT'S NOT NORMAL.

Maternal aggression (MA) presents a challenge when a previously docile doe undergoes varying levels of aggression between conception and weaning. Unlike the testosterone-driven aggression often seen in bucks, MA stems from excess oxytocin. Typically, MA subsides after weaning, but in rare instances, it can persist as the doe's permanent temperament, potentially directed towards other rats, humans, or both.

Early signs of MA can range from mild restlessness when the nest is disturbed to vocalizations or agitation when touched after

birth. Moderate cases may involve aggressive behaviors like phantom lunges or shoving, while severe instances manifest as hyper-aggression, with the doe aggressively charging and attempting to latch onto anything entering her cage.

As a pet owner or breeder faced with a litter from a doe displaying MA, the options are limited. Rehoming rats with unknown backgrounds is generally discouraged, and rehoming a litter from a parent with hormonal aggression is deemed irresponsible.

Options include:

- **Keeping the entire litter:** This option requires careful consideration and thorough handling to mitigate potential aggression. However, it's essential to inform potential owners of the increased risk of aggression in the litter's future.
- **Heavily handling and informing potential owners:** While handling and socialization can help temper aggression to some extent, it's not a foolproof solution. Warning potential owners about the risk of aggression is necessary but may not be sufficient to prevent future issues.
- **Humane euthanasia of the litter:** While a difficult decision, this option prioritizes the welfare of both the rats and potential owners. Additionally, it's crucial not to breed the aggressive doe or buck to prevent passing on the trait.

Ultimately, navigating maternal aggression requires careful consideration of the welfare of the rats involved and responsible breeding practices to prevent perpetuating aggressive tendencies in future generations.



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One-day old female | Bleuming Tails Rattery

For most, does are extremely self-sufficient when it comes to caring for their litters. Access to deep bedding, a house, water bottle (not a bowl), and a constant supply of food is all most moms need to allow their litters to thrive.

EARLY HANDLING AND SEXING

Rat pups can be handled immediately after birth without any ill-effects. Additionally, rat pups can be sexed at birth.

breeders keep detailed notes on each pup's temperament.

For breeders, the goal is to select pups with the most desirable temperament traits, such as curiosity, bravery, and resilience to stressors like loud noises. While in the process of refining breeding lines, it may not always be possible to pick the ideal pup, but breeders aim to choose the best available option to advance their lines. This selective process is integral to improving breeding lines over time.



One-day old male | Bleuming Tails Rattery

SOCIALIZATION

Many breeders follow a limited socialization schedule to allow a rat's innate genetic temperament to manifest. This approach helps breeders identify the most naturally stable animals. However, limited socialization doesn't mean complete isolation. Responsible breeders conduct daily checks and observations to monitor the pups' behaviors. Short periods of 10-20 minute observations help

In contrast, for pet owners and those dealing with accidental litters, a different approach is advisable. Utilizing epigenetics, the study of changes in organisms caused by modifications in gene expression, offers a potential avenue to enhance the temperament of pet rats from unknown lineage.

Heavy socialization starting from around 2 weeks of age can lead to significant changes in the temperament of the rats, impacting them on a deeper level than just surface behavior. This intensive socialization involves regular handling for extended periods, which can positively influence the rats' behavior and disposition, making them more suitable as pets.

GENERAL CARE

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WEANING AND BEYOND

Rats will begin to experiment with hard foods once their eyes open at 2 weeks of age. They don't need any special food and can eat the same thing that mom is eating.

Rats wean and become sexually mature at 5 weeks of age. This means that they need to be separated by sex by 5–6 weeks of age. If able, house female pups with other adults does and male pups with other adult bucks. However, only do this if the adults can be trusted and come from lines with good temperament.

5 weeks of age is the earliest that babies can be rehomed as they are officially weaned by this age, but many breeders prefer to keep babies back until they're 8 weeks old or older for health and maturity reasons. This helps the babies mature, and are given opportunities to interact with older rats and develop proper manners and mirror positive behaviors.

RAT MATERNAL AND NEONATAL CARE WEEK-BY-WEEK

PREGNANCY AND LABOR

Does are pregnant on average for 21 days, and handle pregnancy and labor quite well on their own. You should complete a few steps prior to birth (if you can) to ensure as comfortable and safe delivery as you can.

- Move the doe to a single-level cage, ideally a properly made bin cage. Ensure she has some kind of hide that is easy to move to check on pups and mom.
- Multi-level cages pose drop risks to newborns, and barred cages give does the opportunity to accidentally push neonates through the bars. Bin cages are safe, cheap, and easy to make.
- Prepare for birth by having some emergency supplies on hand, and potentially a vet if things go really south. Normal labor doesn't last longer than a few hours.
- Supplies like Pedialyte, a heating pad, a small 1ml syringe, and tums are helpful items in case things go awry. In instances where contractions have stopped, a quarter of a tums tablet can help restart them without the use of oxytocin. Pedialyte can be used to raise blood sugar and electrolyte levels in cases of long and hard labors. A covered heating pad can help the doe conserve energy as she doesn't have to work to keep her body temp up. Most importantly, a vet on standby can be helpful in severe cases. Be aware that c-sections for rats do not exist. It is usually a spay to save the mother, and the babies pass. In some cases, the doe maybe euthanized.

WEEK 1

Shortly after birth, you can go and check on the pups. Discard any stillborns or those who passed shortly after birth. (If you see mom eating one, don't freak out. This is totally natural, and is a great source of protein and energy for mom.) If you know what to look for, you can even sex them at this step. Some things to look for during check-up:

- Mom should be alert, and should be cleaning herself and the pups. If the pups aren't cleaned or mom isn't cleaned, this is a cause for concern. Be on the lookout for pain signs. A pup can be stuck in the birthing canal, which will be fatal for mom.

- Over the next few days, watch mom's behavior for maternal aggression.
- At this point, extra protein may be supplemented, but if you are already using a balanced and quality lab block, it is not necessary. Some popular supplements include boiled eggs, a small amount of boiled chicken, the flesh of an avocado, or some high-quality dog food.
- Check and ensure babies are warm and have milk bands. A milk band is a white stripe through their abdomen. This is literally their stomach full of milk, and we can see it because their skin is so thin. Within a couple of days, their skin thickens, and we can no longer see this band.

One-day old litter | Bleuming Tails Rattery



- If babies are warm, and fed, but are scattered, it's not a concern. Some does just aren't great nest makers. If the babies are cold, or unfed and are scattered, the doe may need to be temporarily moved to a much smaller cage. (A cage with barely any moving room that forces her to sit on the nest. Some does just need a little nudge for those maternal instincts to kick in.)
- You may find some passed babies over the next few days. One or two is common and isn't a concern, but more than that can indicate either the doe isn't doing her job, or there's an issue with the litter.

Week 1 is largely up to mom, and other than daily health checks, there's not much for you to do. For a water source: a water bottle is safer and should be used over a water bowl.

WEEK 2

Week 2 is when we see some more movement, fur growth, and sexing toward the end of the week can become easier. Nipples are easy to spot at this age, and only does have nipples. This week is largely identical to week 1 in terms of daily health checks.

This week does include a milestone at day 14 where eyes and ears open. Most babies should be opening these as close to day 14 as possible. Eyes open too early can be

indicative of eye problems, and too late can be a sign of FTT.

WEEK 3-4

Week 3 is where we really start to see movement and exploration. They'll begin to follow mom out of the nest, try to nibble on her foods, and drink out of the water bottle. Fur comes in more heavily, and sexing can get easier with the appearance of small testicles on males.

Two-week old litter | Bleuming Tails Rattery



For pet owners who are dealing with oops litters, this is when it's ideal to begin handling and exposing them to new sights, sounds, and environments. While this is the opposite of what most breeders follow, pups from an unknown lineage stand a better chance for better temperament by utilizing excess handling.

WEEK 5+

Week 5 is when babies should be separated by sex and housed, ideally, with a well-tempered adult of the same sex. Sexing at this age is easy, as testicles should be easily viewed. This is the youngest age that babies can be rehomed, but it's generally better for mental development to stay until 8 weeks at minimum with their littermates, and with same sex well-tempered adults if available.

Spaying and

NEUTERING

Given that rats retain fertility for their entire lives, the only way to cohabitate males and females without producing offspring is by spaying or neutering. In general, spaying refers to the removal of female reproductive organs, and neutering is referencing the removal of the male reproductive organs. Alternatives include neutering being used as a gender-neutral term referencing the removal of general reproductive organs. You may also hear the term “speutering” as a gender-neutral term that simply combines the words spay and neuter.

Risks are always inherent during medical procedures, but the most common complications with speutering are internal bleeding, anesthetic reaction, post-op infection, and suture reaction. In some cases, rats will chew their sutures, in which case it is an emergency, and the animal should be taken back to the vet. Healthy rats tolerate anesthesia fairly well, and while age is a factor to consider, advanced age is not always an immediate concern. The most common inhaled anesthetic is isoflurane, and the most common combination for injectable anesthetic is ketamine + xylazine (brand name Rompun®) (Animal Resources Center, 2019).

OVARIECTOMY

Pro:

- Least invasive of the two options
- Prevents reproduction
- Prevents ovarian cysts and masses
- Reduces/prevents hormone related mammary tumors and pituitary tumor if done early in life (4 to 6 months of age)
- Potentially increases lifespan

Con:

- Will not prevent uterine tumors, infection or prolapse.
- Often expensive
- Not often performed by vets, even ones familiar with rats

OVARIO-HYSTERECTOMY

Pro:

- Prevents reproduction
- Prevents ovarian cysts and masses
- Reduces/prevents hormone related mammary tumors and pituitary tumor if done early in life (4 to 6 months of age)
- Prevents uterine disorders, tumors, infection and prolapse.
- Potentially increases lifespan

Con:

- More invasive procedure
- Often Expensive
- Difficult to find vets familiar with rats who can perform the procedure

SPAYING

In does, spaying is done either via ovariectomy or ovari hysterectomy. An ovariectomy is the removal of the ovaries, without removal of the uterus or cervix, whereas an ovari hysterectomy is the removal of the ovaries and uterus. A tubal ligation is when the fallopian tubes are cut, and tied. A salpingectomy is the removal of the fallopian tubes. Be sure to follow the post-op instructions given by your vet.

TUBAL LIGATION / SALPINGECTOMY

While arguably the least invasive option for sterilization, these procedures are rarely performed on rats. These options lack the benefits that the other two sterilization options offers, and some research suggests these options have negative effects on ovarian function (Akar et al., 2003, Deniz et al., 2019).

NEUTERING

Bucks have significantly fewer options. Most vets will offer an orchietomy which is the full removal of the testes. The other option is a vasectomy, which is similar to a tubal ligation. The vas deferens are cut, cauterized and sutured. A vasectomy is rarely offered, as the only benefit is preventing reproduction. Post procedure, behavior may take up to 2 weeks to show change. Waiting 2 to 4 weeks post-op to introduce to an intact colony of does has shown to be enough time to prevent pregnancy, but viable sperm have been shown in the remaining epididymis for up to 6 to 8 weeks. Be sure to follow the post-op instructions given by your vet.

SUPRELORIN

This is a surgical method of sterilization that is temporary in nature. A grain-of-rice sized implant is placed between the rat's shoulder blade while under anesthesia. This method has been primarily studied in females, and has been shown to be effective in preventing reproduction for 10–12 months. In males, the studies have only gone to 6 months, so that is the current length of time of effectiveness in bucks. Full effectiveness is reached 2 weeks after implantation. It's arguably the least invasive option across the board, but unlike surgical sterilization, this method has to be renewed every 10 - 12 months to retain effectiveness. Studies have also shown that this method is not likely to reduce tumor production (Vergneau-Grosset et al., 2019).



ORCHIECTOMY

Pro:

- Prevents reproduction
- Prevents testicular cancer
- Corrects cryptorchidism
- May reduce or eliminate hormonal behavior (hormonal aggression, marking, mounting, reduction of buck grease)
- May increase lifespan
- May reduce likelihood of mammary tumors

Con:

- Prone to obesity
- Not guaranteed to fix hormonal behavior
- Often expensive



Bleuming Tails Rattery

OOPS LITTERS

Accidental litters, while common among pet owners and backyard breeders (BYBs), are less frequent with reputable breeders. However, they can pose unique challenges for pet owners who may not be as prepared as experienced breeders.

In the U.S. fancy rat community, rehoming a litter with an unknown background is generally frowned upon. This lack of knowledge about the lineage, including temperament, genetics, and health beyond the immediate parents, complicates the situation. Reputable breeders, on the other hand, typically have a known history for accidental litters.

Several options exist for dealing with accidental litters:

- **Administering cabergoline:** Effective in terminating pregnancies up to day 16 of gestation, cabergoline can be a solution if the mating time or gestation stage is known. However, efficacy decreases as gestation progresses (Negishi & Koide, 1997).
- **Emergency spay:** While true c-sections aren't feasible in rats, emergency spaying renders the doe sterile. However, risks increase during pregnancy, including difficulty in tying off blood vessels and higher bleeding risks.
- **Hard cull via hypothermia:** Approved by the AVMA, this method involves euthanizing the entire litter at birth. While it doesn't prevent birthing complications, it avoids issues during nursing.
- **Keeping the entire litter:** This requires separate housing for males and females and vigilant monitoring for hormonal aggression as they mature.
- **Rehoming with full disclosure:** If rehoming is the only viable option, potential adopters must be fully informed about the rats' unknown backgrounds, which could lead to health and temperament issues.

Additionally, heavy socialization from an early age can help improve temperament via epigenetics, potentially mitigating future issues. Neutering male rats can also reduce the risk of hormonal aggression.

Ultimately, the decision depends on the owner's circumstances and ethical considerations, prioritizing the welfare of both the rats and potential adopters.



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Rehoming rats with unknown lineages from oops litters is frowned upon primarily due to the significant risks it poses to both the rats themselves and their potential adopters.

Unknown lineages open the door to various health and temperament issues. Hormonal aggression, for instance, can escalate to the point where rats maim or even kill their cagemates. Rat bites are notorious for causing nerve damage, infection, and potential illness.

Moreover, genetics play a crucial role in determining a rat's predisposition to certain health conditions, including tumors. Without knowledge of the rat's genetic background, it's challenging to anticipate and address these potential health concerns. A rat's ability to combat common ailments like the mycoplasma bacteria is influenced by genetics.

Managing these health and behavioral issues often necessitates veterinary care, sometimes requiring costly surgeries. Given that rats are considered exotic pets, veterinary services for them can be particularly expensive, making comprehensive care potentially cost-prohibitive for owners.

Rehoming rats with unknown lineages poses significant risks due to potential health and temperament issues, underscoring the importance of responsible breeding practices and thorough consideration before acquiring or placing rats in new homes.

4 STARTING A RATTERY

For many, it's not the research, the set-backs, or the actual breeding that is the most daunting. For many, it's the simple act of starting a new rattery. This portion of the guide is meant to help steer a new breeder in a clearer direction by following a few steps.

STEP 1: IS THERE A NEED FOR A RATTERY IN YOUR AREA?

As much as breeders love their rats and wish to share the joy, an aspiring breeder must evaluate if there's a need for a rat breeder in their area. If there is, what kind? If there's a large need for feeders, but not much need for pets, choosing to become a pet only breeder will likely result in few rehomes, numerous culls, and a very rapid space issue.

While choosing to only breed for yourself is a valid option, it comes with many of the above complications, primarily heavy culling for space reasons. Many breeders also breed to supply their other pets with quality food, but do not opt to sell to the public.

STEP 2: CHECK YOUR AREA FOR LIMITATIONS, RESTRICTIONS, AND LICENSING REQUIREMENTS

The USDA offers a concise questionnaire to help you learn if a license or registration through the USDA is necessary. For the

average pet rat breeder, a license/registration through the USDA is not likely to be needed. However, this doesn't mean your individual state, county, or city doesn't have its own regulations. Be sure to research.

Rats currently are considered "micro-livestock," and have no legal protection. A commercial breeder would need a license, but a small hobby breeder is unlikely to. Additionally, most hobby breeder laws explicitly state cats and dogs. But again, be sure to research.

In the same vein, look up your area's requirements for what constitutes a business. For most breeders, we can easily assess the Nine Factors Test and see that the hobby likely does not constitute a business. While it's not uncommon for breeders to break even, or even make a small to moderate profit compared to expenses, for even the largest hobby breeder, the income is not enough to constitute a business. If you're unsure, discuss the financials with your CPA or financial advisor.



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IRS NINE FACTORS TEST

The IRS has a list of nine factors to be used in determining whether an activity is a business or a hobby:

1. Do you keep good business records, have a business checking account, and generally run your activity like a business?
2. Do you put time and effort into marketing and other activities to bring in customers?
3. Do you depend on the income from this activity for your livelihood?

4. Are your business losses beyond your control or typical startup losses?
5. Have you changed methods of operation to be more profitable?
6. Do you have business expertise and hire competent business advisors?
7. Have you been successful in similar businesses in the past?
8. Do you make a profit and how much?
9. Can you expect to make a profit on assets used in this activity in the future?

STEP 3: THE RATTERY NAME

The rattery's name can be anything you want, but a good rule of thumb is to avoid repeating the initials of another known rattery. Check rattery registries like AFRMA, NFRS, or other area-specific registries, as well as being active in the community. Initials are often used on pedigrees to indicate where a rat originally came from so that lineage can be tracked.

Other than that, the name is entirely a personal decision.

STEP 4: ADOPTION POLICIES / PRICING

Policies are another personal choice. What portion of selling/buying animals do you feel strongly about? What are the ethical norms in your area? For example, it is considered a hallmark of reputable breeders for breeders to take back their animals at any point during

the animals' lives for any reason. Refunds and animal swaps tend to be up to personal discretion. Following a closed rattery protocol is also considered highly ethical for the U.S. region. A closed rattery is when the public are not allowed into the rattery/meet and choose rats in person due to disease transmission concerns.

Other common policies include:

- Adopter age minimum of 18
- Adopting rats in a minimum of same sex pairs
- Age requirements of children in the home
- Husbandry requirements (ex: no fleece)
- Rat adoption age minimum (commonly 8 weeks, but many do older)

What you choose to set as your policies is entirely your own agenda, but certain policies are popular within the fancy for a reason.

Pricing is both a personal and area choice. Older, more established lines proven to have quality health and temperament can be priced higher. Perhaps you have a variety you went to great lengths to procure. These lines are often priced higher. Many breeders price according to line, or they price according to variety. Research your area, see the average prices, and set according to what you believe your animals are worth in your area.

Remember that an ethical breeder should always have health and temperament top of mind when breeding.

STEP 5: ADOPTION APPLICATIONS / CONTRACTS / WAIVERS

Many breeders utilize various types of adoption applications to help build up a client waitlist during downtimes, and to quickly answer common questions. Just like with policies, what you choose to highlight on an application is up to you.

While not generally legally binding, many breeders require adopters to sign adoption contracts either before or at the time of pickup. These contracts generally outline the expected behavior of both the adopter and seller. Research animal contracts, look at other rat breeder's contracts, and decide what you feel is important for your contract if you choose to use one.

Health waivers are becoming increasingly more popular to include with the contracts.

A health waiver is a brief outline alerting rat adopters to the possible adverse health effects that can occur from owning pet rats. Many breeders also use this to state that the animals being sold are clear of any visible illness/have not shown symptoms. Ratteries may also use this space to discuss serology testing.

STEP 6: SOCIAL MEDIA, WEBSITES AND ADVERTISING

Having an online presence is immensely important today. Facebook pages still tend to reign supreme as far as advertising and posting, but other social media outlets like Instagram, Tik Tok, and even Twitter can all help in building a following.

Even if it feels redundant, having the rattery's basic information everywhere allows



potential adopters to easily find information they need. Utilize Facebook and Instagram's automated message response system for a good response time, and placating sometimes very impatient adopters.

The most common questions every rattery will get:

Where are you located?

Do you have rats available?

I found these baby rats in the park.

Can you take them?

What kind of rats do you sell?

While useful for many things, Facebook is becoming increasingly difficult to navigate when it comes to basic information like policies, and general information. This is where a website comes into play. There's many free website builders out there (Wix, Weebly, Square Space, WordPress), and each offers a slightly different user experience. A few key components of a good website are:

- Easy to navigate
- Easy to read
- Mobile-friendly
- Bonus: Ensure your website is ADA-compliant via free ADA website compliance checkers

A common oversight among rat breeders in website design is the failure to optimize for mobile devices. With 45% of web traffic originating from mobile devices, neglecting mobile-friendliness can hinder navigation and comprehension, leading potential adopters to abandon their search.

Photos

When it comes to showcasing rats on websites and social media platforms, high-quality photos play a crucial role. Optimal lighting is key, with indirect sunlight or proper lighting in a photo booth being the best options. Fortunately, modern phone cameras are capable of capturing quality images. Since rats are constantly in motion, using rapid shot modes or recording videos and selecting clear screenshots can help capture the perfect shot. Additionally, positioning oneself at eye level with the subject of the photo ensures a more engaging and appealing visual presentation.



Bleuming Tails Rattery

05 RAT GENETICS

As arguably one of the most daunting facets of breeding for an aspiring breeder, taking the time and putting in the effort to build a basic genetics knowledge is key to becoming the best breeder you can. It's intimidating to know where or how to even start with so many resources available. It's the goal of this guide to give an aspiring breeder, pet owner, or even existing breeder wanting to polish up their skills a solid starting line.

UNDERSTANDING STRUCTURE



For the purposes of this guide, we'll be starting the discussion on genetics structure at the chromosome.

Humans have a total of 23 pairs of chromosomes, but rats have a total of 21 pairs. On these chromosomes are specific, fixed positions where a particular type of gene lives, called a locus (plural: loci). Rats, like humans, are diploids. That means that each locus can host 2 copies of the specific gene that is meant to be at that locus. In order to visualize this, imagine a highway that is full of different coupe-style cars stalled at specific exits along the road. The highway is your chromosome; the cars themselves are acting as your loci. In a coupe, there are only 2 seats meant for passengers. These two seats inside the car are where you'll find the genes.

In the rat fancy, the gene that is responsible for what you'd see without mutation is known as wildtype. An example of wildtype

is agouti fur coloring or black eyes. These genes have produced variants known as alleles. An example of an allele is black fur coloring or ruby eyes due to the red eye dilute gene. In most casual use cases among the fancy, you'll find both the terms genes and alleles being used interchangeably.

When an animal is said to have 2 copies of the same gene/allele at a locus, it is homozygous. When an animal is said to have different copies of the same gene/allele at a locus, it is heterozygous. To better visualize this, let's look at agouti vs black.

Agouti and black both exist on the A (agouti) locus. This is the base color locus for all rats, meaning that every rat will either have an agouti base or a black base. Agouti is considered wildtype and is a dominant gene. Black is the mutated allele found on the A locus and is recessive. A dominant gene only requires 1 copy of the specific gene to express, whereas a recessive gene needs 2 copies to express. The term express is

referring to what we can see, or the animal's phenotype. The genotype explains the animal's actual genes. Refer to the shorthand examples below. A phenotype is generally written like : Russian Blue Agouti

A genotype of that same animal could read like : Aa dd Mm indicating that the Russian Blue Agouti also carries mink.

Aa **AA**
aa

When written down, agouti is referenced with a capital A and black is referenced with a lowercase a. Aa is a heterozygous animal because the A locus has 2 different variants of the gene present, but AA and aa are both homozygous due to the same variant is present in both gene slots.

In all but 2 instances, each locus has 2 options of genes to inherit: wildtype or the mutated allele. However, the C locus and the H locus are both multiallelic loci. This means that these loci contain three or more observed alleles. This includes wildtype plus at least 2 alleles. Keep in mind that each locus is still only able to hold 2 variants of the same gene. More about these loci later.

THE MODES OF INHERITANCE

Rats have a limited number of inheritance types for genes. They are as follows:

Dominant: A type of gene that expresses with 1 copy, suppressing any accompanying recessive gene on the same locus. When an animal has 2 copies of the same dominant gene, the animal visually is unchanged.

Ex: Agouti (Aa or AA)

Homozygous Lethal/Lethal Dominant:

A subtype of a dominant gene where an animal who inherits a dominant copy of a gene from both parents is incompatible with life and is absorbed in utero.

Ex: Pearl (PePe)

Hypostatic Dominant: A subtype of a dominant gene where a dominant gene only expresses if certain terms have been met. When a hypostatic dominant does not have these requirements met, it's said to be unexpressed. It is still not carried.

Ex: Pearl requiring Mink (mm Pepe)

Incomplete Dominant: A subtype of a dominant gene where a 3rd phenotype arises when an animal has 2 copies of the dominant gene.

Ex: Double rex (ReRe) or Mendel's Pea Plant experiment

Recessive: A trait is not expressed when only one copy is present; requires 2 copies of an allele to express.

Ex: Chocolate (bb)

Rats do not currently have any known codominant genes discovered.

Recessives can be carried. Dominants cannot be carried. Hypostatic dominants may be unexpressed, but are still not carried.

UNDERSTANDING THE WRITTEN SHORTHAND

Each gene has a shorthand that can be written and referenced. Generally, a capital letter is referencing a dominant gene, and a lowercase letter is referencing a recessive gene for a specific locus. Unfortunately, learning which types of genes are recessive or dominant comes down to memory.

As was stated above, in the A locus, agouti (A) is dominant and black (a) is recessive. Other examples include the B (brown) locus.

B - wildtype, dominant b - mutated allele, recessive

The B locus controls whether a rat will be chocolate (black base) or Sienna (agouti base). An animal who is aa Bb is black (aa) carrying chocolate (Bb). Since chocolate is recessive, an animal needs 2 copies of the mutated allele (b) in order to express chocolate. However, an animal who is aa bb is called chocolate. Aa bb would be Sienna. Sienna carrying black could be said to include greater information.

PUNNETT SQUARES

Now that we understand the basics of inheritance, and how to write and read the basics of shorthand, we can learn about Punnett squares. For beginning genetics aficionados, a Punnett square can help you visualize how a specific gene may be passed down. A simple Punnett square may look like this:

	A	a
a	Aa	aa
a	Aa	aa

The aa along the left side is denoting the 2 types of genes at the A locus for Parent 1 where the Aa on the top is denoting the 2 types of genes at the A locus for Parent 2. From this, we can see that each pup has a 50% chance of being Agouti carrying black, and 50% of being black.



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	Ab	Ab	ab	ab
AB	AABb	AABb	AaBb	AaBb
Ab	AAbb	AAbb	Aabb	Aabb
aB	AaBb	AaBb	aaBb	aaBb
ab	Aabb	Aabb	aabb	aabb

Punnett squares can become as complicated as you can imagine them. In a dihybrid Punnett square, you're using 2 different traits. For this example, we're pairing Sienna carrying black (Aa bb) to an Agouti carrying black and chocolate (Aa Bb).

From this example, you can see each pup has a:

- 12.5% chance of AA Bb (Homo Agouti carrying chocolate)
- 12.5% chance of AA bb (Sienna)
- 25% chance of Aa Bb (Agouti carrying black and chocolate)
- 25% chance of Aa bb (Sienna carrying black or just Sienna)
- 12.5% chance of aa Bb (black carrying chocolate)
- 12.5% chance of aa bb (chocolate)

Numerous Punnett square calculators exist across the web to help assist in the more complicated squares.

COLOR LOCI

A rat's coat color is determined by the pigment in the hair. The two basic pigments are eumelanin, which causes black/brown color, and pheomelanin, which causes yellow/red color. Genes found at their specific loci determine how these pigments express.

The fancy is constantly expanding, and new colorations are being explored and test bred. This list is not exhaustive of every color locus to exist, but does discuss the most common, and likely most available to aspiring breeders. Color loci can be combined to make almost indefinite combinations, some standardized by clubs and some are not. When a rat has two active color loci other than A locus, they're frequently called double dilutes. For rats with three active color loci other than A locus, they're referred to as triple dilutes. A good rule of thumb is that the more color dilutions that are present, the lighter the rat is likely to be when compared to its single dilution counterpart. For a more in-depth list with accompanying images, please visit the Rat Variety Guide by Igloo Rats.

COLOR LOCI CHART

Locus	Description	Alleles
A (Agouti) locus	The Agouti locus controls the distribution of yellow pigment throughout the coat. AA and Aa animals have a band of yellow near the top of each hair, giving the animal a ticked appearance. aa animals are black based and have hairs which are solid colored. Eyes should be black.	A–Banded hairs (Agouti, dominant) a–Solid hairs (Black, recessive)
B (Brown) Locus	This locus determines whether eumelanin is black or brown. B causes eumelanin pigment in an animal's coat to be black. We see this in the banding in Agouti and Black animals. Eyes should be black.	B–Black b–Chocolate (recessive)
D (Dilute) Locus	This locus causes black and yellow pigment to be lightened. Additionally, the pigment is clumped unevenly along the hair shafts, giving dilute rats a dark, heathering to the coat. dd animals, on a black background, is called Russian Blue. These animals are similar to Blue mice or Russian Blue cats. The D locus is often the only locus in other animals that causes a diluted “blue” coloration, but this is just 1 of 2. Eyes should be black.	D–No dilution d–Diluted color (Russian Blue, Recessive)
G (Gray) LOCUS	Like the D locus, the G locus seems to dilute black fur to a different type of blue, but leaves yellow pigment untouched. This is known as Blue or American Blue. While considered a fault, American blue frequently has light colored bases of the hair shafts, whereas Russian Blue does not. Additionally, American Blue lacks the dark heathering found in Russian Blue. This dilution is known to come in three different shade ranges called (American) Blue, Sky Blue, and Powder Blue. Eyes should be black.	G–Full color (no dilution) g–Diluted color (American Blue, recessive)
Ma (Marble) Locus	While not exactly a color locus, Marble/Spotted Tabby acts as more of a color modifier. The base body color dilutes, and splotches of the original color show throughout the body. Unlike Merle, Marble can be seen on any color. Best spotting is shown on Black, Russian Blue, and Mink. Malocclusion is said to be in some lines of Marble.	Ma–Marble (dominant) ma–Full color

Locus	Description	Alleles
M (Mink) Locus	UK Mink (m) American Mink or Mock Mink (mo) Australian Mink (am) All three mink varieties are recessive, and have their own appearances. Additionally, they do not breed true to each other. Mock Mink is frequently seen to have eyes with a ruby sheen, without the presence of the red eye dilute. Aussie Mink goes through a rather dramatic color change between juvenile fur and adult fur. UK and Aussie Mink should have black eyes.	M, Mo, Am–Full color (no dilution) m, mo, am–Diluted color (UK Mink, American Mink, Australian Mink, recessive)
Me (Merle) Locus	It causes irregular blotches of dark color to appear on a lighter colored background. Merle is a hypostatic dominant that is reliant on the presence of 2 copies of the recessive mink. If an animal does not have 2 copies of the same type of mink, the Merle will not express. Best results are on a Pearl.	Me–Merle (hypostatic dominant) me–Non Merle
P (PED) Locus (Pink eye dilute)	This locus has an extremely strong dilution of eye color and black/brown pigment, creating pink eyes and a pale yellow color. It lightly affects yellow/red pigment. Despite the name, the range in which PED dilutes can vary. Eye color can range from a bright, true red to nearly translucent pink.	P–Black eyed (no dilution) p–Pink eyes (recessive)
Pe (Pearl) Locus	Pearl is a hypostatic homozygous lethal dominant where it causes most of each hair shaft to be white with just the tip being colored. In the fancy, poorer quality pearls are called Dark Phase Pearl. The standard Pearl is a very bright, icy white with that dark tipping. Like Merle, Pearl is reliant on the presence of the 2 copies of the same variant of mink. Homo lethality results in litters that may be 25% smaller than normal. No ethical issues arise from breeding Pearl x Pearl.	Pe–Pearl (hairs white with colored tip, hypostatic homozygous lethal dominant) pe–normal color (hairs have no white)
R (RED) Locus	This locus is very similar to P, but the dilution is not as severe. It dilutes eyes to ruby, lightens black/brown, and slightly affects red. Like PED, RED has a range in how much it dilutes the eyes and fur color. RED eyes can range from so dark ruby they appear black in most lights to dark, bright red.	R–Black eyed (no dilution) r–Ruby eyed (black/brown diluted)

The c locus is hard, but it doesn't have to be.

Bleuming Tails Rattery
Black eye Himalayan Harley Dumbo

C-COLOR LOCUS

You may have noticed we skipped the C locus in the logical place among the color loci listings. This is because this locus requires a more in depth look, as it's one of the multiallelic loci. This section will also include discussion about Burmese and the C locus Black Eye gene. Varieties from the C locus have naturally red to pink eyes without the use of RED or PED. The points found in the C locus are formed by temperature-sensitive tyrosinase. Pigment is darker in the cooler sections of the body such as nose, feet, ears, and the tail. Among the C locus alleles, we have:

- C — no dilution, dominant over all other c-locus alleles
- c — albino (No pigment at all, so fur remains white, and eyes are bright pink.)
- c(h) — Himalayan (Acromelanistic pattern — pigment is color-sensitive, so the cooler parts of the animal are darker colored. These are called points and are found at the face, feet, ears, and tail. Eyes are red to ruby.)
- c(m) — Marten (Yellow pigment is almost entirely removed and becomes silver or very pale yellow. Black pigment is normal in babies, but fades to a dusty charcoal in adults. Eyes are pink to red. A common fault is marbling on the head.)
- c(t) — Tonkinese (Color point shaded variety where the body remains a rich brown that darkens to points. Ruby eyes. Renamed to Siamese Sable by the AFRMA, but the original founder of the variety (Kodachrome Rattery) named it Tonkinese.)

With a total of 5 genes found on the C locus, it can be quite tricky. An important note is that while the locus itself is recessive, meaning that you need 2 alleles that are not C present to express, the alleles themselves have varying levels of dominance that seem the closest to incomplete dominance. All C locus varieties have an underlying color such as Black, Russian Blue, Agouti, etc.

- cc — albino
- c/c(h) — Himalayan
- c(h)/c(h) — Siamese
- c(m)/c — Heterozygous Non-pointed Marten
- c(m)/c(h) — Pointed Marten
- c(m)/c(m) — Homozygous Marten
- c(t)/c, c(t)/c(h) — Tonkinese
- c(t)/c(m) — Marten Tonkinese
- c(t)/c(t) — Sable Tonkinese

In many instances, Siamese can be mistaken for Beige as a young juvenile, but a key sign to tell the difference is that, on an unmarked Siamese, you can see a darkening gradient towards the rump of the pup.

BURMESE

Burmese is a hypostatic incomplete dominant that relies on the C locus to express. Burmese, like Pearl or Merle, exists on its own locus separate from the C locus. The phenotype of the type of Burmese is dependent upon the base genetics found at the C locus. Like other incomplete dominants, 2 copies of Burmese create a 3rd phenotype known as Sable. Wheaten is the term given to Burmese when the animal has an Agouti base. Burmese can have any additional color recessives just like the traditional C locus genes. For example, a Burmese rat with 2 copies of Russian Blue is a "Russian Burmese." Unlike C locus genes, Burmese has naturally black eyes unrelated to the C



Bleuming Tails Rattery
Ivory Dumbo

locus black eye gene. Burmese can have any combination of C locus genes as the base, including Marten and Tonkinese. Below are Burmese combination with the traditional C locus genes.

- Bu — Burmese
- bu — wildtype, no Burmese
-
- c(h)/c(h) BuBu or c(h)/c BuBu — Pointed Sable
- cc BuBu — Sable (no points)
- c(h)/c(h) Bubu or c(h)/c Bubu — Pointed Burmese
- cc Bubu — Burmese (no points)
- A- c(h)/c(h) BuBu — Pointed Wheaten (Agouti) Sable Burmese
- A- cc BuBu — Wheaten (Agouti) Sable Burmese (no points)
- A- c(h)/c(h) Bubu or c(h)/c Bubu — Pointed Wheaten (Agouti) Burmese
- A- cc Bubu — Wheaten (Agouti) Burmese (no points)

C LOCUS BLACK EYE

Unrelated to wildtype, the C locus black eye is a hypostatic dominant that interacts with the C locus. This dominant causes the naturally red eyes of c locus varieties to become black. Like Burmese, this gene exists on its own locus, separate from the C locus.

- Be — C locus Black eye
- be — wildtype

IVORY

One of the options when discussing black-eyed white is Ivory. This variety is created when an albino rat also has the C locus Black Eye allele.

DO I HAVE A SIAMESE OR A HIMALAYAN?

Generally, they cannot be truly told apart post molt. In a well-bred rat, a Himalayan should have a creamy color body with paler points and a Siamese should have a dark creamy body with robust, darker points. However, we often have himis and siams that start out too light in color, and a common rule of thumb in the fancy is that Himalayan and Albino both start out pure white and are indecipherable. As the animals age, the albino stays the same, but the Himalayan's points will darken and develop.

Himalayans darken into their points, and siamese lighten into their points. Markings can mask points.

COATS

Like the color loci, coats exist across a myriad of different loci. Each coat type is unique, and can be combined to create even more unique coat types. Being as this guide is meant as a jumping off point, these combo coat types will not be discussed. For more information on these, please visit the Rat Variety Guide by Igloo Rats. Coat types can come in any color.

bleuming tails rattery
Double rex dumbo





bleuming Tails Tattery
Russian Blue Variegated Dumbos

OFF H-LOCUS MARKINGS

MARKINGS

Markings are a complicated facet of rat genetics. Like the C locus, the H (hooded) locus is a multiallelic locus. In addition to the marking alleles found on the H locus, other types of markings exist on their own loci that interact with the H locus.

Standard markings exist, but these are the ideal representation of the marking. Every kind of marking has over marked (too much white) and under marked (too much color) as non-standard variants, and multiple combos of genes can appear to make the same phenotype. Each allele restricts color from the animal in increasing increments in the following order: h(i)<h<h(n)<h(e)<H(re) (Torigoe et al., 2010). The alleles found on the H locus are as follows (Prinsloo, 2015):

- H — Wildtype, minimum/no white spotting
- h(e) — Extreme hooded, Superficial black eyes that glow dull red in bright light accompanied by extensive white spotting
- h(i) — Irish Hooded, Causes white spotting in the rat, but of a lesser grade than the hooded allele

- h — Hooded, extensive white spotting confined to the rear end of the animal
- H(re) — Restricted Hooded, extensive white spotting, homo lethal
- h(n) — Notched Hooded, Causes white spotting in the rat, but of a higher grade than the hooded allele
- H(ro) — Robert/Essex, homo lethal, slight dilution of color. Color on the back is darkest, evenly fading to lighter color down the sides. White spotting accompanies this color dilution. Pups are already identifiable due to fading.

These alleles all work together in varying combinations to create the phenotypes we know. Another important facet is the hooded modifier locus. This controls the length of the stripe on a hooded rat, as well as potentially effecting white spotting in other varieties.

- H(ml) — long dorsal hooded pattern. Necessary for hooded rats to have a stripe reaching right down to the tail.
- H(ms) — short dorsal hooded pattern. Necessary for barebacks.

Coat	Description	Alleles
Roan/Husky Recessive	Born as a solid color, rats with the recessive ro fade to white as they age.	Ro-standard ro-Roan
Dalmatian Homo Lethal Dominant	Dalmatian acts as both a marking and a color modifier. It causes the base color to be diluted and heavily silvered. In a show quality dalmatian, they have spots of this silvered, diluted color all over their body in equal, even blotches. A dalmatian is NOT a variegated. It does not appear to be within the standard H locus that controls most other markings.	Dal-Dalmatian dal-standard
Downunder Homo Lethal Dominant	Downunder variety with a color on its belly that runs from the neck to the breech and appears to mirror the dorsal hooded marking. Downunder rats also exhibit anophthalmia or microphthalmia with incomplete penetrance. Downunder appears to be a homo lethal (Hieu et al., 2023).	Du-Downunder du-standard
Head spot Recessive	hs has the form of a white sport of variable size in the middle of the forehead just above the eyes, and can range in size from just a handful of white hairs to a full blaze. Recessive blazing cause by hs is not a DWS marking.	Hs-Standard hs-Head spot
Whiteside Recessive	Known for their “pants”, whiteside have a band of white circling their belly.	Ws-Standard ws-Whiteside
Snowflake Recessive	Shows dappled white spots along the stomach area.	Sf-standard sf-snowflake

COAT CHART

Coat	Description	Alleles
Rex Incomplete Dominant	<p>One of the most common rexoid genes in the fancy, it presents as a typical curly furred type. Whiskers can vary between long and wavy, and very short, curly and bent. The hairs of the coat should be short, but dense with as few guard hairs as possible. The fur should be coarser than standard or Velveteen, but not as coarse as Bristle. Bucks have the better rex coats than does, and tend to hold curl better as they age. Rex quality varies heavily and can present with patchy molts, generally thin fur, poor curl pattern, or even an almost non-existent curl pattern. Poor rex is indistinguishable from Velveteen and requires test breeding to see how it doubles.</p> <p>Rex is an incomplete dominant, and rex x rex can create double rex or "drex." A hallmark sign of drex is thin, patchy fur to completely hairless.</p>	Re-Rex re-standard
Velveteen Incomplete Dominant	<p>The other most common rexoid gene, Velveteen, is said to have lighter, softer waves than Rex while retaining its guard hairs. The fur quality should remain full, and the texture tends to be softer than Rex. The whiskers are typically long and curled forward.</p> <p>Velveteen is an incomplete dominant, and Velveteen x Velveteen creates double Velveteen or "dvelv." Unlike drex, dvelv does not molt out patchy in this form. Instead, the fur should remain full, but will be thick and dense similar to a shorn sheep.</p>	Cu-Velveteen cu-standard
Bristle Dominant	<p>Unlike Rex or Velveteen, a Bristle should feel similarly to a wire brush. The coat will be lightly waved as pups, but then straightens with age to a harsh, rough-looking, messy coat. Whiskers will be straight to curled on the ends.</p>	Br-Bristle br-standard
Satin Recessive	<p>Satin has a semi-long, shiny coat with a trademark mussed appearance. As pinkies, satins are easy to identify due to their "blown back" whiskers.</p>	Sa-Standard sa-Satin
Lustrous Recessive	<p>Lustrous will have a shiny (almost greasy), mussed coat. Whiskers on pinkies will be crimped and blown back.</p>	Lt-Standard lt-Lustrous

Coat	Description	Alleles
Silvermane (D'Argente) Suspected Homo Lethal Dominant	<p>A Silvermane is a fancy-favorite with their flashy fur type. To create the look, the hair shafts are hollow, silvering out and lightening the overall tone without the use of dilution genes. The rate at which they silver out depends on the line, but can be apparent as soon as fur begins to come in. Others take months to silver out, and some lose the silvering as they age. Silvermane is not the same as "silvering" as a fault or for "silvered" varieties. A tell-tale sign is the common "Silvermane mask" that appears as darker, non-silvered fur around the nose and eyes.</p>	Sm-Silvermane sm-Standard
Harley Recessive	<p>Harley is a long-haired variety with hallmark long thin wispy fur lacking undercoat. Baby coats can appear greasy. Like Satin and Lustrous, Harley can be noticed from birth by whiskers. Harley whiskers are often short and broken with a wave or curl. Some lines of Harley have been known to have sensitive skin issues, and some may have lactation issues. This is a variety that is ideally handled by experienced breeders. Harley does not have a standardized shorthand.</p>	
Hairless Recessive	<p>Hairless come in several varieties, all recessive, though it's unclear which one(s) is the most prominent in the fancy. The ethics of breeding hairless varies by region, but in the US it's considered ethical as long as the breeder is working toward bettering the variety. Common issues include agalactica, smothering litters, entropion, and delicate skin. Other concerns include temperature regulation.</p> <p>hr which is mostly hairless with a little short curly hair on the nose, feet and small amount on the lower legs and short curly whiskers.</p> <p>fz has a fuzzy body and short curly whiskers.</p> <p>nu lacks all forms of hair. Their body is complete nude and they lack whiskers.</p>	Hr-Standard hr-Hairless Fz-Standard fz-Hairless Nu-Standard nu-Hairless
Patchwork/ Werewolf	<p>The defining feature of werewolf is that the rat continuously molts throughout its life in mostly symmetrical patterns over the body. It is often referred to as 'True' Patchwork in order to reduce confusion to the now incorrect nomenclature given to drex "patchwork."</p>	Pw-Standard pw-Werewolf

SPOTTING

Erroneously known as high white or lethal white, DWS is a dominant marking trait. The traditional DWS markings are capped-stripe, collared, banded, split capped, and dominant blazing. Odd-eye is also a sign of DWS markings, but is not necessarily a DWS marking itself. However, DWS can also present in markings that resemble Berkshire and variegation. Roans are megacolon free. Other odd spine-centric markings with clear-cut edges also can be a sign of DWS.

What causes DWS markings? These interesting markings are caused when cell migration is delayed and the pigment cells, the cells that tell the color where to go, do not reach their final destination. During fetal development, these cells originate in the neural crest along the spine and travel throughout the rest of the embryo. If the cells do not make it to their final destination, it results in patches/patterns of colorless fur. The more the cells are delayed, the higher the white will be along the sides. These delayed cells also affect the head patterning and result in blazes or irregular head spots. Odd-eye can be caused by this delay. However, odd-eye is also suspected to have a genetic component outside DWS.

The neural crest cell delay can also cause problems within the colon where parts or the entirety lacks the ability to contract causing megacolon. Megacolon in rats is always fatal.

Markings such as dalmatian and variegated are not DWS genetics, despite a visual similarity. A defining characteristic is that DWS has very clean edges. DWS is a variety that is best handled by experienced breeders.



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06 MEDICAL

Many new pet owners or aspiring breeders are unprepared for the type of, sometimes emergent, medical concerns that can arise. This portion of the guide is not discouraging the use of educated veterinary staff, but rather encouraging self-education to be as prepared as you can be. This is not exhaustive, but will cover the most common things that you may experience throughout your rat ownership journey.



PHYSICAL CHECKUP

Porphyrin: porphyrin is the red discharge found around the nose, eyes, and ears that is commonly mistaken for blood. Rats' natural bodily fluids are tinged red. Occasional discharge is perfectly fine. It is a major indication of illness or stress (of any kind) when the animal has excess discharge that builds up thickly around the nose, eyes, and ears or continues multiple days in a row. You can see excess buildup on the front paws due to grooming.

BEHAVIOR

A healthy rat will be bright-eyed, inquisitive and curious. Swaying side to side is natural and helps with depth perception, as their eyesight is naturally poor. A female rat in heat may arch her back and rapidly vibrate her ears.

Abnormal: lethargy, sudden aggression, tilting of the head, walking in circles, agitation, jerking, paralysis.

Common physical ailments that affect movement and behavior: Pituitary tumors, hind end degeneration/hind leg paralysis, ear infections, stroke, and sprains/breaks.

EYES

Eyes should be bright, open and free of porphyrin.

Abnormal: Red or yellow discoloration within the eye (can indicate blood pooling behind the eye), cloudiness in young rats (can be normal in older rats), swelling/bulging (can be indicative of SDAV infection or tumor/abscesses/blood behind the eye), excess porphyrin.

EARS

Ears should be clear with a healthy color tone.

Abnormal: excess porphyrin, crusted ears, foul odor, head tilt, loss of balance.

MOUTH

A healthy rat will have aligned, orange/yellow teeth, no difficulty eating. Rats do have special muscles that allow them to separate their bottom incisors horizontally.

Abnormal: pure white teeth, long teeth, swelling, pus, odor, drooling

Common mouth ailments: Malocclusion

(Teeth either are not properly aligned to effectively grind themselves down or they grow too quickly) Malocclusion affects proper eating and can cause abscesses within the mouth/skull and even death. It is a condition that requires either frequent tooth trimming or the complete removal of the front incisors.

NOSE (BREATHING)

Clear, free of discharge.

Abnormal: excess porphyrin, noisy breathing (wheezing, gasping, clicking, rasping, excess sneezing)

These are all signs of URIs. URIs are either bacterial in nature (mycoplasma) or viral.

Rats are obligate nose breathers. Excess drooling and head tucking/ gasping movements can indicate choking. Rats cannot vomit.

BODY

Should be smooth and free of lumps. The tail should be clean and free of tight rings around the tail, and should be held horizontally and straight.

Abnormal: lumps can indicate tumors, abscesses or cysts. Rings on the tail can indicate ringtail. This is usually caused by too low of humidity. A curled tail is an indication of a genetic spinal defect or use of too small of a wheel.

SIGNS OF PAIN

MILD TO MODERATE

- Squinting
- Porphyrin around eyes/nose due to stress
- Fluffed coat
- Increased aggression
- Lethargy
- Abnormal vocalization
- Excess licking/grooming
- Hunched posture
- Bruxing
- Reduce appetite

SEVERE+

- Closed eyes
- Poor skin tone/fur quality
- Dehydration/weight loss
- lethargy
- Side sucking
- Hypothermia
- Self-mutilation
- Poor appetite
- Change in fluid intake
- Hunched posture/head pressing
- Abnormal vocalization
- Abnormal movement
- Poor grooming
- Incontinence
- Labored breathing
- Avoidance of contact with human or cagemates
- Whimper/whine
- Tachycardia (faster than normal heart rate)
- Tachypnea (faster than normal breathing)

ILLNESSES

MYCOPLASMA PULMONIS

A type of bacteria called *Mycoplasma pulmonis* is considered to be endemic in the pet rat population. This strain of mycoplasma is species specific to rats and mice and cannot infect humans.

Upper respiratory symptoms: asymptomatic to early signs of wet sneezing, sniffing, signs of physical discomfort, and porphyrin staining around eyes and nose. Inner ear infections are considered an upper respiratory infection, frequently caused by this bacteria. The rat may be seen with mild to severe head tilt, rolling, and face or ear rubbing.

Lower respiratory symptoms: Advanced stages of disappear exhibit bronchiolitis, bronchiectasis and bronchopneumonia. Rasping, wheezing, gasping, and crackling can also be heard in advanced URIs. Signs of discomfort include: hunched posturing with poor coat quality, weight loss, and changes in behavior due to illness.

Mycoplasma pulmonis may be a cause of pyometra (infection of the uterus), as well as other infections/inflammation of the rest of the female reproductive system. Symptoms: asymptomatic to lopsided abdominal distention or blood-tinged uterine discharge (Grant, 2023).

Pyometra can be “closed” or “open.” During closed presentation, the abdomen will appear distended due to the uterus being filled with pus. An open presentation



Ashton Hollwarth | Improve Veterinary Practice
Porphyrin buildup

creates pus-filled, bloody vaginal discharge. Pyometra requires immediate veterinary action and often requires an emergency spay to resolve the issue, and can be fatal if left untreated.

Not all medications target mycoplasma, but the most common (and effective) treatment for mild to moderate RIs is a combination of Baytril and Doxycycline. Amoxicillin, while commonly prescribed, does not target mycoplasma, but can prevent secondary infections from setting in. Advanced or chronic RIs may require daily nebulization.

The other form of URIs is caused by viral infections and is resistant to antibiotics. URIs fall into one of two categories: acute or chronic. Acute URIs are generally one-off infections in an otherwise healthy animal. Chronic URIs are recurring URIs that are generally progressive and deteriorate the animal's health.

ABSCESSSES

An abscess is a pocket of pus under the skin, usually caused by a bacterial infection from a bite, scratch or other irritant. These lumps often appear “overnight” and grow rapidly. They often feel soft and fluid-filled and can be malodorous. Warm, wet compresses can be applied to the lump multiple times a day in short intervals to help the abscess burst and “come to a head.” Once the abscess has burst, the wound can be kept clean with sterile saline rinses and vet wound rinses. Do not use triple antibiotic ointment or hydrogen peroxide. These products can facilitate outside-in healing, which can trap leftover bacteria. Abscesses should heal inside-out.

Severe abscesses may require surgical intervention, pain management, and a broad spectrum antibiotic to prevent the spread of infection.

EAR INFECTIONS

Ear infections are unfortunately quite common in rats, but are easily treatable. These infections can be caused by *Mycoplasma pulmonis*, *Streptobacillus moniliformis* and other types of viruses and bacteria. The most notable symptom for an ear infection is a head tilt, often toward the infected ear. Other symptoms include ataxia, walking in circles, and other common pain signals such as side sucking, fluffed fur and squinting. Treatment consists of 3–6 weeks of baytril, amoxicillin, doxycycline, chloramphenicol or azithromycin. Ear infections are extremely painful.

Severe or untreated ear infections can cause permanent hearing loss, and head tilt.

Shows proper alignment and coloring of a mature rat's teeth
daniid / Shutterstock.com



MALOCCLUSION

Malocclusion is when the teeth become too long due to a misalignment. Trauma can cause temporary malocclusion, but can be corrected with proper teeth trimming. Genetic malocclusion is a life-long ailment that requires weekly to bi-weekly teeth trims. If left untreated, the animal may become unable to eat properly or the teeth will burrow into the roof of the mouth, abscess and cause the animal to die due to bacteria. Malocclusion can also be caused when the jaw becomes displaced through trauma or due to tumor growth.

Contrary to popular belief, rats do not need to chew toys in order to trim their own teeth. Rat teeth are very soft and can be ground down during activities such as bruxing, chattering, and the day-to-day consumption of their hard rat blocks. Chew items should be considered enrichment and are not necessary.

TUMORS

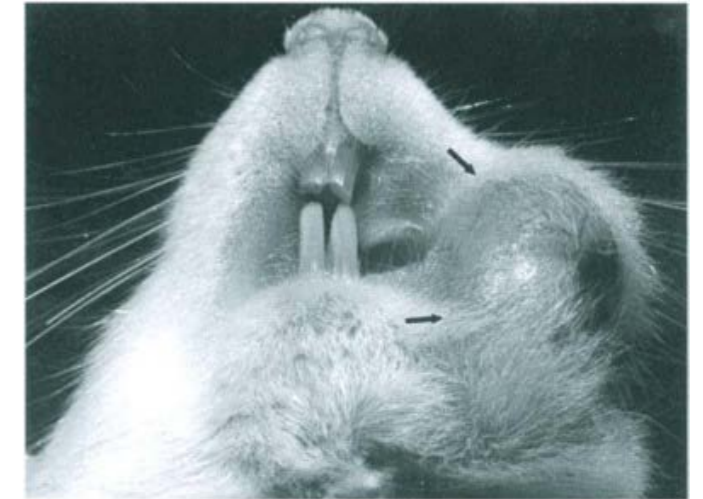
Tumors are an unfortunately common reality of rat ownership. While most tumors are benign, it doesn't mean they aren't harmful. In benign tumors, growth may be slow, and remain localized and noninvasive. They may be encapsulated and be well demarcated, making this type of tumor easier to surgically remove. The sooner a tumor is removed, the easier it is. Leaving a tumor to grow inhibits surgical intervention, potentially eliminating that option entirely.

Despite a slower growth pattern, it will continue to grow larger. They often press on nearby organs and cause difficulty with mobility and decreased general quality of life. If left untreated, these tumors will deplete the rat's nutrients, causing weight loss, may burst due to size, may develop pressure sores and infection, and ultimately death.

In malignant, or cancerous, growths, cells are invasive and show no demarcation, meaning these tumors pose unique issues with surgical removal. If left untreated, the cancerous cells can metastasize, traveling and infecting other regions of the body. Such aggressive growth of these cells can cause ulceration, necrosis, and ultimately steals nutrients causing rapid weight loss, anemia, and ultimately death (Grant, 2023).

ZYMBAL'S GLAND TUMOR

Zymbal's glands are at the base of the external ear canal, and play host to one of the most commonly malignant tumors found in rats. Zymbal's tumors that are aggressive, and local invasion is common. While whole body metastasis is uncommon, metastasis to the lungs is not unheard of. This tumor may appear as a firm mass at the base of the ear. The surrounding skin may show ulceration or hairless. Prognosis is poor.



Zymbal's Gland Tumor
The Laboratory Rat (Second Edition), 2006

Symptoms include, but aren't limited to (Grant, 2023):

- Cyst/abscess at or near mass
- A firm mass seen or felt to the side of the ear
- Ulceration of the skin
- Severe head tilt
- Jaw misalignment
- Malocclusion



Rat with large mammary tumor

PITUITARY TUMOR

A pituitary tumor is a tumor found primarily in females in the pituitary gland, which is a portion of the brain that controls hormones. Being potentially the third most common cause of death in does, there may be as high as a 20% occurrence rate and even upwards of 7% in bucks (Animal House of Chicago, 2020). Spaying massively reduces this risk for does down to just 4%.

As this internal type of tumor grows, it presses on the brain, causing neurological deterioration. Symptoms appear over the course of a couple of weeks with the most noticeable symptom being a loss of coordination. Further loss of limb function may follow. A tell-tale sign is a rat having to eat with the food placed on the ground, requiring all four limbs to be stable in order to balance. Ataxia or changed behavior may become apparent as the tumor progresses. Seizures, head tilt, and stroke may even occur. Prognosis is poor.

MAMMARY TUMOR

The most common tumor in female rats, with a rate of 20-40% occurrence, is the mammary tumor (Russo, 2014). These tumors are often stimulated by estrogen, occurring during estrus. While more common in does, mammary tissue is found on bucks as well, and is present across the entire body. The most common locations for mammary tumors are in the armpits, in the abdomen, groin area, on the chest, and next to the vulva and anus.

Benign mammary tumors are usually lumps just under the skin that you may be able to move separately from the skin and underlying muscle. A tumor that feels tightly attached may be a sign that it is malignant.

Mammary tumor growth can be quite aggressive, growing quite large rapidly. Benign tumors typically have a round shape that protrudes and grows very rapidly. A malignant mammary tumor is usually smaller and slower growing (Animal House of Chicago, 2020).

PARASITES

LICE

Lice are species specific. Their entire life cycle, 14 to 21 days, is spent on the host animal. They obtain nutrition by sucking blood, which can cause anemia in severe cases. Symptoms include itching, hair loss, and skin sores.

MITES

The tropical mite *Ornithonyssus bacotiis* round in shape and appears dark when engorged with blood. They can survive and transfer on fomites, and only stay on an animal when they are feeding. They are not species specific and will also feed from other animals and humans.

The *Radfordia ensifera* is a fur mite that is the most commonly seen in rats. It produces severe pruritus (itching) and leads to scabbing and hair loss, frequently seen on the shoulders, neck, and face of the rat. In severe cases, the edges of the ears will appear bitten and ragged.

Mites under normal conditions are colonized on the skin in small numbers and are unproblematic. During times of stress, illness, decreased immunity, these manageable numbers increase and begin to flourish. The average life cycle requires approximately 23 days to complete, often requiring multiple rounds of treatment, as some treatments only target adults.

Rat with mite infestation
Bloemfontein Courant



FLEAS

Fleas can be determined by the actual presence of fleas or by flea excrement. Excrement will appear as black dots on the skin, but when dissolved on paper or placed in water will appear red. Treatment for fleas should include the home, the rat itself and its environment, and any other animals living in the home.

WORMS

Rats, like any animal, are at risk for intestinal parasites, especially rats who come from poor living situations. Common symptoms can include:

- Diarrhea
- Changes in appetite
- Weight loss
- Excessive licking and chewing of rectal area and base of tail
- Parts of worm or whole worms in feces

Severe infestations can lead to intestinal blockages or perforations. Different types of worms require different treatment, so it's important to identify the type of infestation.

ZOONOTIC DISEASES

SEOUL VIRUS

Seoul Virus is a type of hantavirus where most people who get infected experience mild or even no symptoms. However, in the severe form of the disease, it is associated with hemorrhagic fever with renal syndrome (HFRS), and death occurs in approximately 1-2% of cases. Symptoms appear with one to two weeks and in rare cases up to 8 weeks after initial infection. In certain regions of the world, Seoul is considered endemic.

Symptoms include:

- Intense Headaches
- Back and Abdominal Pain
- Fever
- Chills
- Nausea
- Blurred Vision

Symptoms as the infection progresses may include low blood pressure, acute shock, vascular leakage, and acute renal failure. In rare cases, it can be fatal.

Infection may occur after coming in contact with urine, droppings, or saliva of infected rodents. When fresh rodent urine, droppings, or nesting materials are stirred up, particles containing the virus get into the air, a process known as “aerosolization”. Allowing infected materials directly into broken skin or into your eyes, nose, or mouth may cause infection. Bites from infected animals are another source of transmission (FAQs: Seoul virus 2022).

To prevent infection, wear a mask and gloves when cleaning cages, do not use a vacuum or sweep dust particles into the air, spray down any bedding before moving it, wash your hands before and after handling your rat.

Asymptomatic in rats.



Illustration of RBF - Gram-negative rod-shaped bacteria
Kateryna Kon / Shutterstock.com

STREPTOBACILLUS MONILIFORMIS (RAT BITE FEVER / RBF)

Rat Bite Fever or Streptobacillus moniliformis is an infectious bacteria. Contrary to its name, Rat Bite Fever is found in more than just rats: mice, hamsters, squirrels and gerbils can also carry it. Symptoms usually begin 3 to 10 days after contact, but can be delayed up to 3 weeks.

Symptoms include:

- Fever
- Vomiting
- Headache
- Muscle pain
- Joint pain
- Rash

In some cases, without treatment, rat bite fever can be fatal.

RBF is primarily transmitted through a scratch or bite from a rodent. Other common infection vectors include eating food contaminated by infected urine/feces, or allowing infected material to enter broken skin. To prevent RBF, regularly wash your hands, wear protective gloves when washing cages and avoid putting your hands in your mouth when handling your rats and cleaning their cages.

Education is our best weapon, and following proper and basic health protocols, such as good handwashing practices, when handling rats is key to staying safe until we know more. Purchasing well-tempered rats from an ethical breeder can help prevent bites and further reduce transmission risks.

Asymptomatic in rats.



SALMONELLOSIS

Salmonellosis or salmonella is a common disease which most people associate with undercooked chicken. All common pets can carry salmonella in their digestive tract including dogs, cats, rats, mice, rabbits, lizards and snakes. Salmonella infection can occur in humans and animals, but it is considered very rare in domestic rats.

Symptoms for humans include:

- Diarrhea
- Vomiting
- Fever
- Abdominal Pain

Initial symptoms of diarrhea, fever, and abdominal cramps begin 12 to 72 hours after infection. The illness runs its course over 4 to 7 days, and most recover without treatment. Children younger than 5 years, older adults, and the immune-compromised are more likely to have a severe illness from Salmonella.

Symptoms in rats:

- Depression
- Dehydration and rough body coat
- Distended/swollen abdomen
- Diarrhea and weight loss
- Spontaneous abortion (in pregnant rats)
- Fatal (in most cases)

LEPTOSPIROSIS

Leptospirosis, also known as Weil's disease, is caused by a bacteria called leptospira that is spread via urine from infected rats, mice, cows, pigs and dogs, most commonly in water and on food.

Symptoms include:

- High fever
- Headache
- Chills
- Muscle aches
- Vomiting
- Jaundice (yellow skin and eyes)
- Red eyes
- Abdominal pain
- Diarrhea
- Rash

The incubation period varies from 2 days to 4 weeks. Illness usually begins suddenly with fever and other symptoms. Leptospirosis may occur in two phases:

- After the first phase (with fever, chills, headache, muscle aches, vomiting, or diarrhea) the patient may recover for a time but become ill again.
- If a second phase occurs, it is more severe; may result in kidney or liver failure or meningitis.

The illness lasts from a few days to 3 weeks+. Recovery may take even more time without proper treatment (Signs and symptoms 2017).

Prevention of transmission includes avoiding urine or infected water sources, wash your hands after handling, and do not eat or drink around your pets. Dogs and cats can be vaccinated against leptospirosis as well. To protect your domestic rats, ensure they are safely confined indoors without access to infected rodents.

Asymptomatic in rats.



LYMPHOCYTIC CHORIOMENINGITIS VIRUS (LCMV)

The primary host of lymphocytic choriomeningitis (LCMV) is the common house mouse. Pet rats and hamsters can become infected after coming in contact with infected wild mice. Pregnant individuals are at risk with LCMV. Infections occurring during the first trimester may result in miscarriage, while in the second and third trimesters, serious birth defects can develop.

Symptoms include:

- Fever
- Stiff neck
- Lack of appetite
- Muscle aches
- Headache
- Nausea
- Vomiting

Symptoms usually occurs 8–13 days after exposure and last around a week. A second, more severe, phase of illness may occur. Symptoms may consist of meningitis (fever, headache, stiff neck, etc.), encephalitis (drowsiness, confusion, sensory disturbances, and/or motor abnormalities, such as paralysis), or meningoencephalitis (inflammation of both the brain and meninges). Meningitis is a cause of Acquired Brain Injury, which may lead to life-long mental and physical deficits. LCMV has a 1% fatality rate.

Asymptomatic in rats.

SENDAI VIRUS (SV)

Sendai Virus causes significant respiratory distress in rats, and while it is zoonotic, humans experience only mild illness.

SV poses a far greater threat to immunodeficient domestic rats and mice in the home. It is normally asymptomatic in immunocompetent rats.

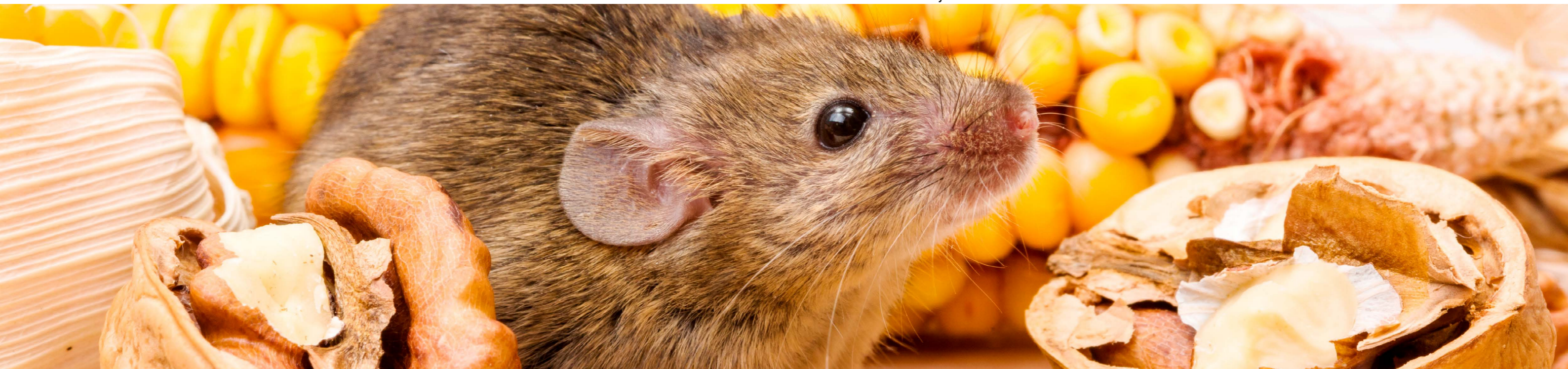
Symptoms in rats include:

- Sneezing
- Hunched posture
- Respiratory distress
- Porphyrin discharge
- Lethargy
- Prolonged pregnancy
- Partial or full litter loss

SV is highly contagious among susceptible populations. Natural infection occurs by way of the respiratory tract. Transmission can be contact and airborne. Airborne transmission can occur over a distance of 5–6 feet as well as through air handling systems. SV is self-limiting and a breeding moratorium can burn it out of the colony.

The suggested moratorium is 12 to 16 weeks after the youngest rats turn 8 weeks of age. SV can shed for 2 weeks.

Szasz-Fabian Jozsef / Shutterstock.com



TRANSMISSIBLE DISEASES

SIALODACRYOADENITIS VIRUS (SDAV)

Species affected: Rats

SDAV is a highly contagious virus from the Coronaviridae family that transmits via aerosol or contact with infected salivary secretions. This means that animals in the same airspace are at risk of catching the virus without physical contact. Diagnosis is completed via serology or PCR testing via Charles River Labs.

Symptoms include:

- Swelling around the neck and cervical nodes
- Bulging of eyes
- May see porphyrin staining, bleeding, or discoloration of tissue around the eyes

Symptoms of secondary respiratory infection:

- Sneezing
- Fluid filled lungs
- Weight loss
- Loss of appetite

In most cases and in immunocompetent animals, SDAV is not fatal, but it does open the pathway for secondary infections to set in. Due to the endemic *Mycoplasma* bacteria, this secondary infection often presents as a severe Upper Respiratory Infection.

After exposure, rats can begin to show symptoms as early as 5 days (porphyrin staining) with respiratory involvement and cervical swelling by 7–8 days. SDAV does not have a carrier state, meaning that the virus will burn through the population in 7 to 10 days per infected rat.

For pet owners experiencing an SDAV outbreak, cease introducing new rats to the home, visiting homes or stores with rats, and interacting with wild rodents for 6 weeks to ensure proper burn out.

PNEUMOCYSTIS CARINII (P. CARINII)

Species affected: Rats

P. Carinii is a fungus found in the family Pneumocystidaceae. Pneumocystis infection causes chronic progressive pneumonia, and immunocompetent rats, *P. Carinii* causes infectious interstitial pneumonia (IIP). It can be transmitted via aerosol, fomites, and direct contact with infected animals. Healthy animals will eliminate the infection and cease shedding after 3–8 weeks, but unhealthy animals may shed spores indefinitely. Diagnosis is completed either during a necropsy or PCR testing.

Symptoms include:

- Hunched posture
- Dry skin/ruffled fur
- Weight loss
- Labored breathing

FILOBACTERIUM RODENTIUM (FORMERLY CAR BACILLUS)

Species affected: Rats, mice, rabbits, and some livestock species

CARB is a type of bacteria and is transmitted via direct contact. There is no evidence for transmission by fomites, vectors, or aerosols. CARB may result in a chronic, progressive respiratory disease. More commonly, it is seen in conjunction with *Mycoplasma pulmonis*. It may increase the severity of disease caused by *M. pulmonis* and other respiratory pathogens, such as *P. Carinii*. Infection in domestic rats is suggested as common.

Symptoms include:

- Rattled breathing
- Labored breathing
- Rapid weight loss
- Hunching posture
- Rough coat
- Wheezing
- Lethargy
- Head tilt
- Porphyrin discharge from eyes and nose
- May be asymptomatic

MEDICATION GUIDE

KEY:

- SID - once daily
- BID - twice daily
- TID - Thrice daily
- PO - Taken orally
- SQ - Subcutaneous (injected beneath the skin)
- IM - Intramuscular (injected into muscle tissue)

URI MEDICATIONS

(These medications attack mycoplasma directly)

Name	LD50/Dose	Use	Notes
Azithromycin (Brand name: Zithromax)	LD50: Oral - 2000 mg/kg Dose: 4-8 mg/lb, BID, PO	Infections by mycobacterium, mycoplasma, chlamydia, and rickettsia	Fairly expensive. Best when used on younger rats/acute URI cases. Less effective on older rats/chronic URI cases. Best when used in conjunction with Doxycycline. Safe for use in pregnant does, and rats under 4 months.
Doxycycline (Brand name: Doxyvet)	LD50: Oral dose \geq 2000 mg/kg, IV - 225 mg/kg Dose: 2.5 mg/lb, BID, PO	Respiratory infection, gram-positive staphylococcus and streptococci, soft tissue infection, UTI	Inexpensive. Related to tetracycline, but works better. Best when used in conjunction with Baytril or Zithromax. Has an anti-inflammatory effect, assisting in chronic URI airway inflammation. Not safe for use in pregnant does, and rats under 4 months. Shelf life of mixed capsule/tablet: 7 days. Dairy impedes absorption by 20% which is not considered clinically relevant.

Name	LD50/Dose	Use	Notes
Enrofloxacin (Brand name: Baytril)	LD50: Oral - \geq 5000 mg/kg Dose: 5 mg/lb, BID, PO	Respiratory infections, urinary tract infections, soft tissue infection and soft tissue injury	Best when used at higher doses (shown). Best when used in conjunction with Doxycycline. Not for use in pregnant/nursing does or babies under 4 months of age. Enrofloxacin 10% contains 100 mg/ml and is so caustic, it must be diluted for use. Reconstituted suspension from powder should be kept refrigerated and has a 14-day shelf life.
Tetracycline (Brand name: Panmycin, Terramycin Soluble Powder)	LD50: Oral - 6443 mg/kg Dose: 5-10 mg/lb, TID, PO When dosed in water: 1 teaspoon per 8 oz water, changed daily; 500 mg tablet/ 1-liter water	Wound and skin infections, effective for mild respiratory infections.	Light sensitive, must be kept covered. Can be refrigerated for 3 days. Treats mild URIs and secondary infections. Dosing in water not recommended.



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SECONDARY INFECTION MEDICATIONS

Name	LD50/Dose
Amoxicillin (Brand name: Fish-mox, Biomox, Amoxi Drops, Robamox)	LD50: Oral - 15,000 mg/kg Dose: 10 mg/lb, BID, PO
Amoxicillin/Clavulanic Acid (Brand name: Clavamox)	LD50: Oral - 15,000 mg/kg Dose: 6.25 mg/lb, BID, PO
Cefadroxil (Brand name: Cefa-drops)	LD50: Oral - 1,000 mg/kg Dose: 10 mg/lb, BID, PO (Most common dose: .2 cc/lb 10 - 30 days)
Erythromycin (Brand name: Ornacyn)	LD50: Oral - 4,600 mg/kg Dose: 5 - 10 mg/lb, TID, PO Dosing in water: ½ - 1 tablet/2oz water
Gentamicin (Brand name: Gentocin 40)	LD50: Oral - 2,000 - 2,200 mg/kg Dose: 1 - 2 mg/lb, BID, SQ/IM
Tylosin (Brand name: Tylan)	LD50: Oral - 6,200 mg/kg Dose: 4.5 mg/lb, BID, PO Dosing in water: 66mg/l liter of water

Use	Notes
Systemic infections, urinary tract infections, skin/skin structure infections	Does not attack mycoplasma directly. Target secondary infections and suppresses URI symptoms, making it easier for the rat to fight the URI off naturally. Is a suspension, not a solution. Requires shaking at every dose, meaning it is not a good drug to dose in water bottles. Give with yogurt/gut flora probiotic. Reconstituted oral suspensions are good for 14 days if refrigerated
Lower Respiratory Tract/Ear Infections – caused by <i>S. pneumoniae</i> and <i>M. catarrhalis</i> . Skin/Skin Structure Infections – caused by strains of <i>S. aureus</i> , <i>E. coli</i> , and <i>Klebsiella</i> spp. Urinary Tract Infections – caused by g strains of <i>E. coli</i> , <i>Klebsiella</i> spp. and <i>Enterobacter</i> spp (Grant, 2023).	Inexpensive. Related to tetracycline, but works better. Best when used in conjunction with Baytril or Zithromax. Has an anti-inflammatory effect, assisting in chronic URI airway inflammation. Not safe for use in pregnant does, and rats under 4 months. Shelf life of mixed capsule/tablet: 7 days. Dairy impedes absorption by 20% which is not considered clinically relevant.
Skin, soft tissue and urinary tract infections. May be used in combination with gentamicin for respiratory illness where secondary infections are involved	Does not attack myco directly. Target secondary infections and suppresses URI symptoms, making it easier for the rat to fight the URI off naturally. Give with yogurt/gut flora probiotic. Reconstituted suspensions kept refrigerated are good for 14 days.
Mild respiratory infections	Causes gastrointestinal upset, give with food. Effective against strep, staph, some strings of mycoplasma and corynebacterium. Safe for use in pregnant does, and rats under 4 months. Refrigerate for 14 days.
Severe respiratory disease and secondary bacterial infections.	Does not attack myco directly. Can cause inner ear or kidney problems. Best used in combination with Cefa-Drops, Clavamox, or Amoxicillin. Not recommended due to SQ/IM requirement. Not safe for pregnant does.
Mild to moderately severe forms of respiratory tract, skin, and soft tissue infections caused by group A beta-hemolytic streptococci and mycoplasma, colitis	Safe for use in pregnant does and rats under 4 months.

OTHER MEDICATIONS

Name	LD50/Dose
Aminophylline	LD50: Oral - 225 mg/kg Dose: 2.5mg/lb, BID/TID
Oxytetracycline (Brand Name: Terramycin)	LD50: Oral - > 2000 mg/kg Dose: Apply 2 to 4 times a day
Oxytocin	Vet prescribed only.
Prednisone	LD50: Oral - 10,000 mg/kg Dose: .25 - 1 mg/lb, SID

PAIN MEDICATIONS

Name	LD50/Dose
Acetaminophen (Brand name: Tylenol)	LD50: Oral - 2,404 mg/kg Dose: 100 - 300 mg/kg, PO, q4hr Use Children's Strength Tylenol in liquid
Aspirin	LD50: Oral - 200 mg/kg Dose: 100 mg/kg, PO, SID

Use	Notes
Pulmonary edema and pulmonary congestion secondary to heart failure. Helpful in rats with chronic respiratory disease and pneumonia.	Contraindications: Erythromycin, enrofloxacin, clindamycin, may increase aminophylline concentrations. Do not give chocolate as this may increase the effect of the drug. Bronchodilator. Can cause panic attacks.
Ointment to help fight eye infections such as conjunctivitis, inflamed cornea, pink eye, corneal ulcer, and inflammation of the eyelids	
Used to stimulate contractions in does during labor.	
Use: Used as an anti-inflammatory and immunosuppressant in the following: <ul style="list-style-type: none"> • Inner ear infections so called wry neck or head tilt • Adjunctive treatment in respiratory disorders such as pneumonia • Supportive/palliative treatment in the presence of tumors • In severe itching (e.g. dermatologic disorders) • Adjunctive treatment for autoimmune disorders • Adjunctive treatment in adrenal disease • In treating shock to improve circulation (Grant, 2023) 	Contraindications: NSAIDS Notes: Anti-inflammatory. Frequently used as temporary treatment for pituitary tumors.

PAIN MEDICATIONS (CON'T)

Name	LD50/Dose
Carprofen (Brand Name: Rimadyl, Novox)	LD50: Oral - 149 mg/kg Dose: 1.5 mg/kg, PO, q12hr 2 mg/kg to 5 mg/kg, PO, SQ, IM, q12hr to q24hr.
Ibuprofen (Brand Name: Motrin, Advil)	LD50: Oral - 1600 mg/kg Dose: 10 mg/kg to 30 mg/kg, PO, q4hr Low dose for analgesia, high dose for anti-inflammatory
Meloxicam (Brand Name: Metacam, Mobic)	LD50: Oral - 83.5 mg/kg Dose: .2 mg/kg, PO/SQ, SID
Tramadol	LD50: Oral - 228 mg/kg, SQ - 286 mg/kg Dose: 1 - 4 mg/kg, PO, SQ, BID

Use	Notes
Treatment of pain - short term or long term use. A lternative to opioid based post-op pain.	Prescription only. Recommended for use in pregnant/nursing does. Avoid use where pre-existing liver or kidney disease is present. NSAID. Use lowest dose required.
Reduce pain and tenderness as well as minor swelling	Discontinue use prior to surgery, NSAID. Give with food to avoid GI reactions.
Relief of inflammation and pain, analgesic following surgery, as a supplement to opioids in major surgery, and during palliative care for inoperable tumors.	Prescription only. Do not use with corticosteroid/anti-inflammatory. Not for use in pregnant/nursing does. NSAID
Moderate to severe post-op or injury-related pain, chronic or terminal illness.	Prescription only. Can be used with anti-inflammatories. Narcotic, Scheduled controlled substance. Not safe for pregnant or nursing does.

PARASITE MEDICATIONS

KEY:

* : Safe for pregnant/nursing does and babies under 5 weeks of age

- : Not safe for pregnant/nursing does and babies under 5 weeks of age

~: Safe for pregnant/nursing does, but not safe to directly treat babies under 5 weeks of age

Name	LD50/Dose
~ Fenbendazole (Brand name: Panacur)	LD50: Oral - >10,000 mg/kg Dose: 20 mg/kg to 50 mg/kg, PO, q24hr for 5 consecutive days. Higher dosing end for giardiasis.
~ Imidacloprid (Brand name: Advocate, Advantage)	LD50: Oral - 450 mg/kg, Dermal - >5,000 mg/kg Dose: 1 drop of cat/kitten formula behind head.

Use	Notes
Treats ascarids, hookworms, Taenia species of tapeworm, pinworms, and roundworms. Also effective against giardia	
Treats lice and fleas. Reapply monthly.	Moderately toxic if ingested Advantage II and Advantage Multi should be avoided as it contains additional active ingredients. However, it is reportedly not recommended for use in pregnant animals, nor should it be used on rats younger than 5 weeks old.

PARASITE MEDICATIONS (CON'T)

KEY:

* : Safe for pregnant/nursing does and babies under 5 weeks of age

- : Not safe for pregnant/nursing does and babies under 5 weeks of age

~: Safe for pregnant/nursing does, but not safe to directly treat babies under 5 weeks of age

Name	LD50/Dose	Use	Notes
- Ivermectin	<p>LD50: Oral - 50 mg/kg, Dermal - >660 mg/kg</p> <p>Dose: Ivomec: 100 mcg/lb to 200 mcg/lb (0.1 mg/lb to 0.2 mg/lb), PO or SQ, May be applied as a topical behind the ear.</p> <p>Horsewormer paste 1.87% : tube of 6.08 grams of paste contains 113.7 mg of ivermectin, PO: dose 0.01 mL for a rat weighing 1 lb or greater. Reduce dose by half for rat weighing less than 1 lb. Risk of overdosing is high with this method.</p> <p>Ivermectin 200 mcg/kg to 400 mcg/kg (0.2 mg/kg to 0.4 mg/kg), PO, SQ, repeat in 7 to 14 days (May be applied as a topical behind the ear.)</p> <p>Cattle Injectable 1%: When having to dilute ivermectin: Dilute with propylene glycol. Take 1 mL ivermectin and mix with 9mL PG; resulting solution is 1 mg/ml, and dose at 200-400 mcg/kg (0.2 mg/kg-0.4 mg/kg) (Grant, 2023).</p>	Treats mites, lice, pinworms, and roundworms.	<p>Easy to overdose via oral route. Not recommended that ivermectin be given to pregnant rats, or a doe nursing baby rats under 2 weeks of age. Should not be given to unhealthy rats, or rats younger than 5 weeks. For rats under 4 months of age, reduce dose by half.</p>
- Moxidectin	<p>LD50: Oral - 106 mg/kg</p> <p>Dose: 1 short-grain of rice sized dose, PO</p>	Retreat weekly for 4 weeks. Used to prevent heartworms, and treat round, hook, and whipworms.	*Potentially toxic, but only based on 1 findable study https://www.ema.europa.eu/en/documents/mrl-report/moxidectin-summary-report-1-committee-veterinary-medicinal-products_en.pdf
*Permethrin (Brand name: Nix)	<p>LD50: Oral - 430- 4,000 mg/kg, Dermal - >4,000 mg/kg</p> <p>Dose: Dilute 1 bottle into 1 gallon of water</p>	Treats mites and lice. Spray down entire cage, toys, houses, etc. plus spray down the rats themselves	
- Praziquantel (Brand Name: Droncit)	<p>LD50: Oral - 2,249 mg/kg</p> <p>Dose: 30 mg/kg, q14 days x 3 treatments, PO</p>	Treats of tapeworms, flukes, schistosomes and trematodes.	
~ Selamectin (Brand name: Revolution)	<p>LD50: Oral - 1,600 mg/kg</p> <p>Dose: 1 drop of cat/kitten formula behind head.</p>	Treats fleas, mites, scabies, certain ticks, hookworms, and roundworms. Prevents heartworms. Reapply monthly.	Use only brands with selamectin only. Revolution Plus should not be used.

EMERGENCY MEDICAL KITS

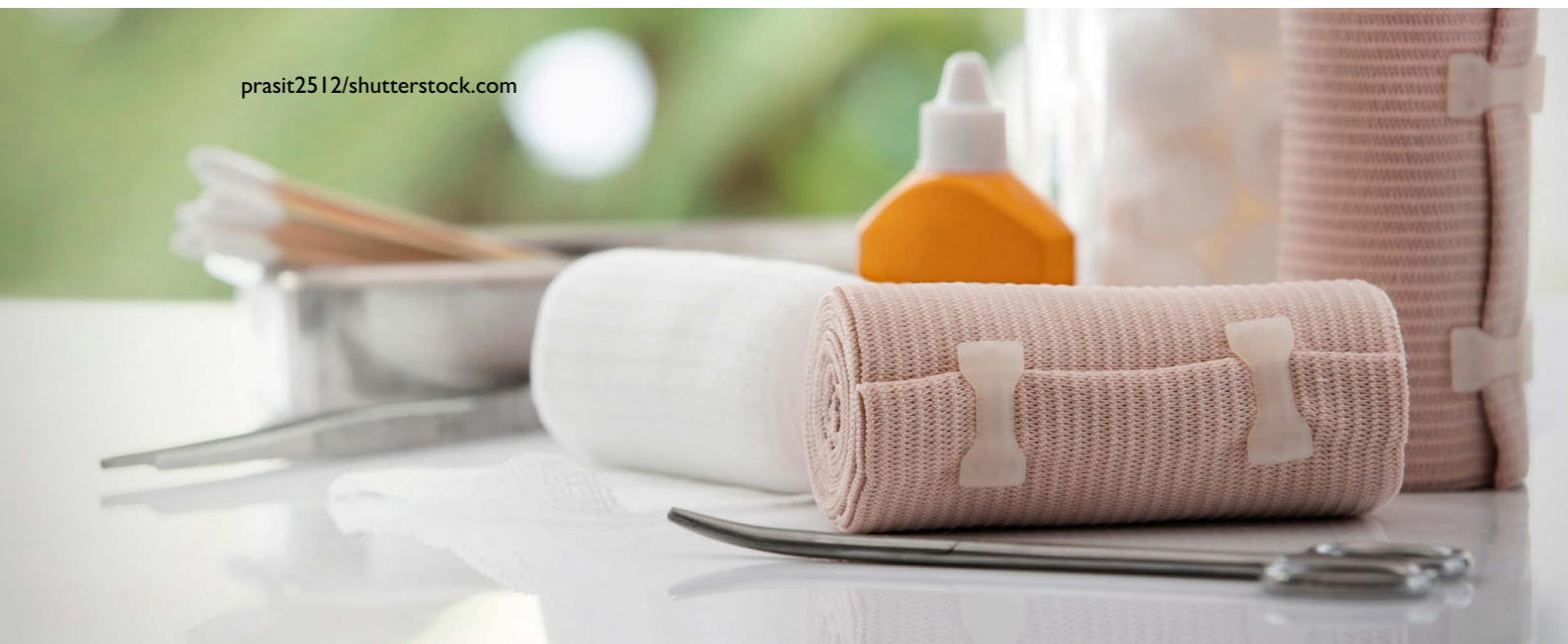
Having emergency supplies on hand is the first step in being prepared, and being prepared can make a hectic situation run just a little smoother. The key to a well stocked kit is having supplies that can cover a range of issues.

BASIC EMERGENCY KIT

Wound Care	<ul style="list-style-type: none"> • 1 ml syringes (with and without needles, sterile) • 10 ml syringes • Vet Wrap • Gauze pads • Sterile saline or other wound rinses
Medications	<ul style="list-style-type: none"> • Baytril • Doxycycline • Amoxicillin • Children's ibuprofen/Tylenol • Terramycin • Panacur • Revolution
Labor/Nursing	<ul style="list-style-type: none"> • Tums • Pedialyte • Heating pad
Other Equipment	<ul style="list-style-type: none"> • Gram scale • Tweezers

ADVANCED EMERGENCY KIT

Wound Care	<ul style="list-style-type: none"> • 1 ml syringes (with and without needles, sterile) • 5 ml syringes • 10 ml syringes • Vet Wrap • Gauze pads • Sterile saline or other wound rinses • Iodine • Styptic Powder • Adhesive Tape • Q tips • Chlorhexidine • Droppers
Medications	<ul style="list-style-type: none"> • Baytril • Doxycycline • Amoxicillin • Children's ibuprofen/Tylenol • Terramycin • Panacur • Revolution • Nebulizing treatments
Labor/Nursing	<ul style="list-style-type: none"> • Tums • Pedialyte • Heating pad • Paintbrush • Milk replacer
Other Equipment	<ul style="list-style-type: none"> • Gram scale • Tweezers • Microscope • Nebulizer • Forceps • Iris Scissors • Stethoscope



SEROLOGY TESTING AND QUARANTINING

Quarantining new rats into a colony is the responsible thing to do to protect your existing rats, and your new rats.

Serology testing is used to ensure your colony is free of concerning diseases that could harm other colonies or humans.

HOW-TO QUARANTINE

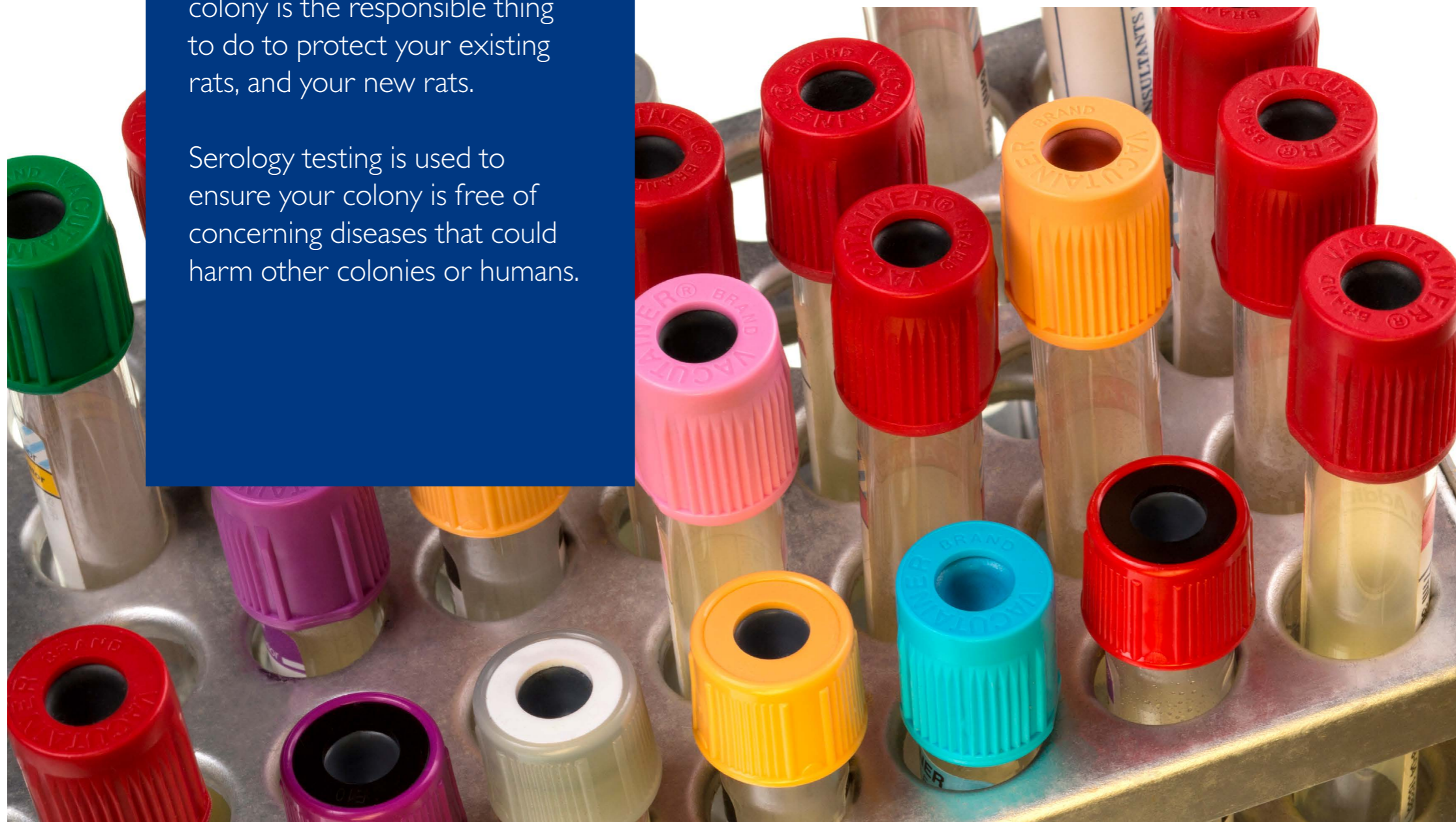
- Be kept in a completely different airspace
 - This means if the main colony is in the house, the new rats are in the garage, a temperature-controlled shed, or a trusted friend's home.
 - If separate air spaces cannot be utilized, do your best to place the cages as far away from each other as possible.
- Lasts a minimum of 2 to 4 weeks
- Be sure to keep from cross-contaminating as much as you can.
 - This means not handling one cage and then immediately going to handle the other rats.
 - Be sure to wash hands and arms, change clothes, and blow your nose between handling sessions at the minimum. A shower is best as certain diseases can even cling to your hair.
- During this QT period, cages **SHOULD NOT** be set up directly next to each other or across the same room.

SEROLOGY TESTING

The risk of infectious disease with pets rats is an inherent risk of owning them. Unlike dogs, cats, and horses, rats do not have the benefits of vaccines to help prevent dangerous illnesses that can decimate a colony, or even make you extremely ill. In 2020, the topic of serology testing for these common diseases became popularized due to an outbreak of SDAV. During this, RBF also came to the forefront.

Health testing in rats is not the same as genetic testing in dogs or other popular species. These tests are also different from a vet examination. Health testing is the inspection of samples, primarily blood, saliva, feces, to provide information on the prevalence of potentially dangerous health issues within your colony. This type of testing is rarely done by your vet, and is instead sent out to institutions such as Charles River Laboratories (CR) and Research Associates Laboratory (RAL).

Testing is something that is fairly unique to the U.S. fancy. Other regions either don't have as many issues with disease, or these diseases are considered endemic and are not a concern.



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GLOSSARY

Agalactia	absence of milk production in an animal that should be producing milk
Allele	one of two or more alternative forms of a gene that arise by mutation and are found at the same place on a chromosome.
Backyard breeder	the irresponsible breeding of animals in inadequate conditions with insufficient care, often by people with little experience or knowledge
Blastocyte	ball of cells that forms early in a pregnancy, about five to six days after a sperm fertilizes an egg
Bruxing	soft, but repetitive, grinding of incisors
Buck	male
Cesarean Section (C-Section)	surgery to deliver a litter
Crepuscular	most active during twilight
Delayed Implantation	paused implantation of a blastocyte into the uterine lining
Diploid	containing two complete sets of chromosomes, one from each parent.
Doe	female
Dominant	a type of gene that requires only 1 copy to visually express
Dystocia	difficult birth
Entropion	Where the eyelid turns in and causes the eyelashes to rub against the cornea
Estropause	irregular, reduction and cessation of estrus cycles due to disruption of hormones in the aged female rat
Estrus	periodic state of sexual excitement that immediately precedes ovulation and during which the female is most receptive to mating

FTT	offspring who have failed to develop and grow normally
Gene	basic unit of heredity passed from parent to offspring
Genotype	the genetic constitution of an individual organism
Hard Culling	to remove from a breeder program via euthanasia
Heterozygous	The presence of two different alleles at a particular gene locus
Homozygous	The presence of the same alleles at a particular gene locus
Hypostatic Dominant	one whose phenotype is altered by the expression of an allele at a separate locus, in an epistasis event
Incomplete Dominant	a cross in which each parental contribution is genetically unique and gives rise to progeny whose phenotype is intermediate
Locus	a particular position, point, or place on a chromosome
Lordosis	an exaggerated inward curve of the spine that typically affects the lower back
Neuter	to sexually sterilize
Phenotype	the set of observable characteristics of an individual resulting from the interaction of its genotype with the environment
Postpartum Estrus	A period of fertility 12 to 24 hours after giving birth
Pyometra	an infection in the uterus
Recessive	a trait that is expressed only when genotype is homozygous
Resorption	The organic process in which the embryo/fetus undergoes lysis and assimilation
Runt	an animal that is smaller than average, especially the smallest in a litter
Soft Culling	The removal from a breeder program by retiring or rehoming
Terrestrial	species that live primarily on the ground
Wildtype	A term used to describe a gene when it is found in its natural, non-mutated (unchanged) form.

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Bleuming Tails

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