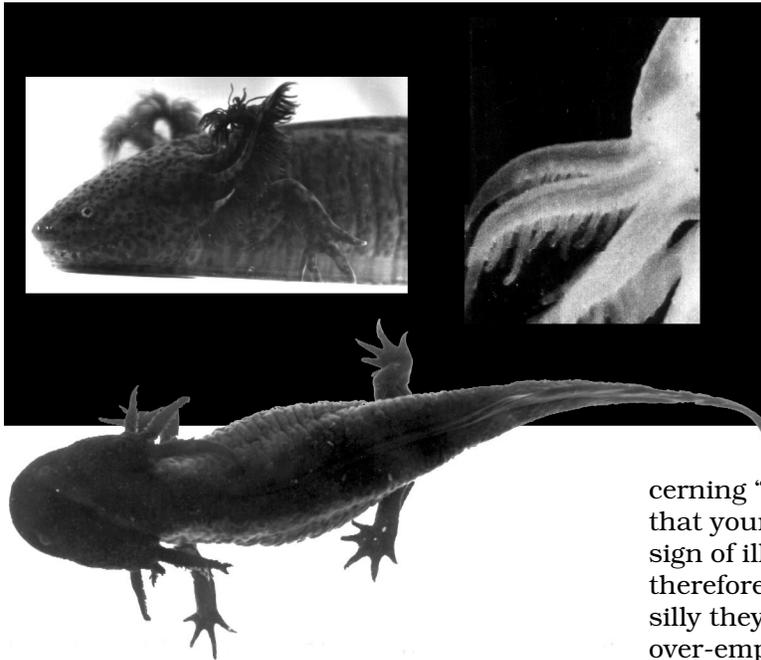


Practical Axolotl

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I have received hundreds of calls and emails over the years from researchers, teachers, and pet owners who want to know "Is my axolotl sick?" or "What should I do?" or "Can I give it something?" Sometimes their animals are not eating, sometimes their axolotls are floating, sometimes the axolotls just don't seem quite right. When this happens, people want to *do* something that helps. And it is very tough for people to go out and find someone or some book that has much to say about salamander medicine, let alone axolotl medicine! I am afraid that even I haven't always been much help over the years, since my experience with what can be done for a colony of 600 adults has very little to do with what the average axolotl owner with only a few animals in the lab or at home can do. I catch myself saying, "Well, in that situation, with those symptoms, we usually give antibiotics." "How?" "Well, we inject . . ."



The top pictures are of healthy gills and healthy gill posture. The lower picture shows raggedy gills with many missing filaments and twisted branches.

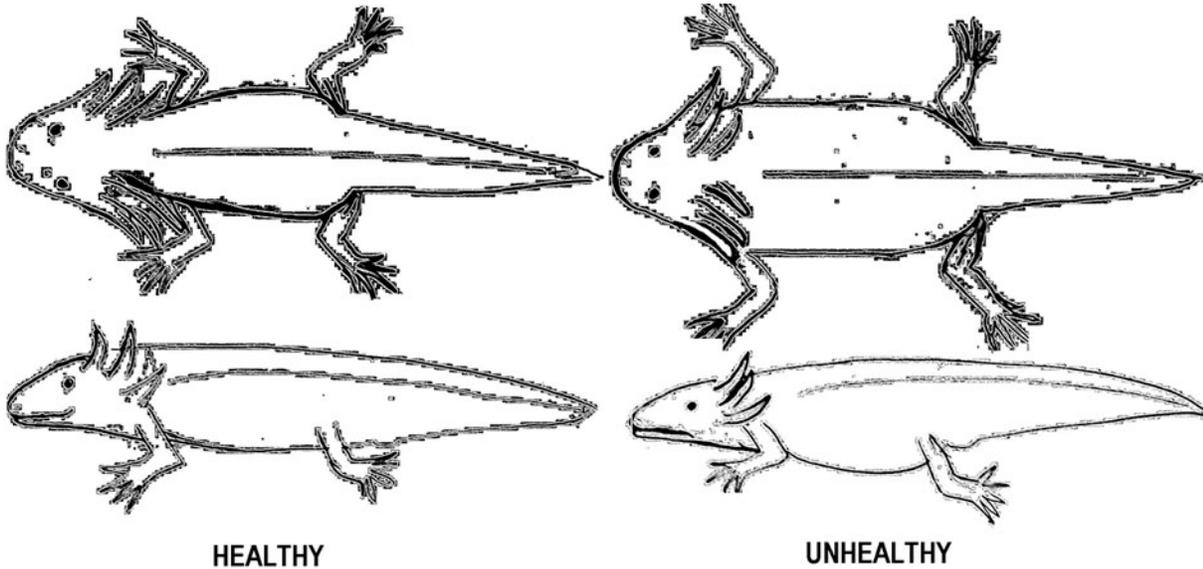
Alerted to the need for more practical advice by an increasing volume of email and calls, I decided to write this article. I will describe signs of illness in axolotls, tell what to do immediately and how to go about selecting a treatment, and mention a few treatments from a local pet store that I have tried and know are safe.

Signs of Illness

The easiest way to tell if an axolotl is sick is by noting changes in its eating habits. If the animal is stressed because of infection or water quality, it will probably stop eating or reduce the quantity it consumes before other symptoms become obvious. On the other hand, if you think your animal is ill, yet it is still eating, then you can probably safely assume that it must not be too sick and that you have caught the problem early.

Floating or "tilting" in the water can be a sign of systemic problems. This behavior is different than the axolotls' "hangout" posture, in which they appear to be suspended mid-tank. *Hangout* is normal axolotl behavior. When floating is a symptom of illness, the axolotl looks a bit hunched, sometimes with its back or tail out of the water at the surface. It seems sprawled out. Often it looks like it is leaning on one side. These signs can be an indication that there is some infection either effecting the animal's equilibrium or producing extra gas.

Poor gill condition is an early sign of poor water quality, but it can also be an early sign of stress on the inside. Continuously pale gills (more obvious on white and albino axolotls), overgrown gills, and limp gill posture can all be signs of infection. There may be times when your animal's gills are pale, but a few hours later you note that they are nice and pink or red again. This is normal. Concerning "overgrown gills": please don't think that your animal's beautiful healthy gills are a sign of illness! Gills that are overgrown (and therefore a sign of possible trouble) look sort of silly they are so large, like a caricature that over-emphasizes key features. We think animals with overgrown gills are compensating for other internal problems. Overgrown gills don't happen overnight, but if you don't look at your animal very often it may seem that way!



Poor skin condition is usually a sign of more advanced illness, unless you are talking about damage from dirty water or chemicals. Skin that has a grayish cast (on dark animals), blisters or open sores, or pale white patches, or skin that is too red (in the case of whites or albinos) or too yellow or white (again, in the case of whites and albinos), can simply mean that you have a parasite you need to get rid of, or it can mean that you are seeing signs of advanced systemic infection.

If the shape of your axolotl's body is your first clue that something is wrong, then there is a good chance that it is too late. Bloating of the abdomen or tissues is a sign of fairly advanced illness. Please don't confuse a well-rounded female filled with eggs with a bloated, sick animal. Bloating makes the animal look sort of like a balloon with legs. The skin feels tight when touched, and the balloon-effect is apparent on the underside as well as side to side. Swelling is most obvious in the limbs and neck area, where the tissue will look puffy.

If you find blood in your axolotl's water, don't panic. It could just be a simple injury. If the axolotl is housed with other axolotls and a gill gets nipped, the gills will sometimes bleed and bleed, but ultimately be OK. However, some parasites can cause localized bleeding. And there are some internal infections that make the skin more fragile and susceptible to injury and to parasites and

bacteria in the environment.

You will notice most of these symptoms only if you have a very good idea what your axolotl looks like when it is healthy. For example, you can't tell if an albino is too yellow unless you know how yellow it was in the first place; you can't tell if it is eating well if you don't watch it eat every once in a while when it is healthy.

Practical Refrigeration

Now, what to do with the diagnosis of a problem? As soon as you decide that there is definitely a problem, or even if you suspect one, put the animal in the refrigerator and get it cooled down. Cooling the animal slows the animal's metabolism and the progress of the infection. Cooling the animal helps the animal get better, but we aren't sure why. We know from experience that refrigeration has saved animals that would have otherwise died. It could just be because it lowers the level of stress that the animal is experiencing. It could be because there is more oxygen dissolved in the water. It could be because it creates conditions unfavorable to the bacteria in the axolotl's environment. Whatever the reason may be, cooling the animal is the best and easiest way to give your axolotl a chance.

Here at the Axolotl Colony, refrigeration for every axolotl illness and injury is a very practical solution because we have a refrigerator

dedicated to axolotls and their embryos. However, since this article is dealing with practical solutions for the reader, I want to talk about practical ways of refrigerating your axolotls so that those of you who are squeamish about putting your animal in the fridge may give it a try. Find a plastic bowl or bucket with a lid. For adult axolotls, one-gallon (about 4 L) ice cream buckets work very well, as do large margarine containers. Remember that the cooling will slow down the animal's metabolism, so having lots of space isn't all that necessary.

Fill the bowl with 1.5-2 L of water (approximately 0.5 gallon), put the sick animal in and put the lid on. When we were kids, we were all told not to put the lid on tightly or to punch holes in the lids of containers holding the various poor critters we caught and stuck in jars. But it will be OK for your axolotl to not have holes. You wouldn't want to stick your animal in the fridge, then totally forget about it, of course, but remember that (1) when cooled, the axolotl needs less oxygen because its metabolism is slowed, and (2) when it is cold, more oxygen is dissolved in the water. So if you take the axolotl out every few days to change the water and feed it, there should be plenty of oxygen for the animal. In this way, if you are squeamish about salamanders in the fridge you don't have to worry about amphibian water being splashed on your food. If you really feel a need to put holes in the lid, just cut some slits or a small hole with a knife in the center of the lid to minimize escaping splashes.

After refrigerating the axolotl, you may want to watch it for a few days to see how it does before proceeding to other treatments. You may suddenly find rocks in its bowl, for example, and voila! There's your problem. If you are sure it is something more serious, then pack up and head to the pet store to browse through the available treatments.

Practical Pet Store

Your choice of a treatment will depend on your diagnosis of the illness: systemic infection or localized infection or injury. Shopping for medications for aquatic animals can be quite a trial—I discovered this when doing the research for this article! Here are some tips on buying safe treatments for your axolotl.

First, never buy something that doesn't list the ingredients very clearly. I was shocked at how many products don't have ingredients

listed. I also found this problem when doing searches for medications on the Internet. The same medicines were there, but I could not read the package in the picture, and the vendors most often didn't volunteer this information on their sites. If you know exactly what you are looking for, the Internet can be a convenient source, but it is definitely not good for browsing and choosing the right treatment. The most helpful site I found is Noah's Pets (<http://www.noahspets.com>), where they list what chemicals are used for what bacteria/fungi/parasites and then what medicines contain those chemicals.

A second tip when shopping for treatments for axolotls is to avoid treatments containing any of the following:

- copper
- other heavy metals in long-term treatments
- acriflavin, if you are treating white animals
- tetracycline or related antibiotics
(for instance, doxycycline or oxytetracycline).

Effective treatments for axolotl disease might contain

- nitrofurans derivatives
(Nitrofurazone, Furazolidone)
- naladixic acid
- formalin
- sulfa drugs
(sulfamethazine, sulfathiazole, sulfacetamide)
- sodium chloride or other salts

I tested lines of medications from Aquarium Pharmaceuticals and Jungle because they seemed the most basic of all that was available at the stores where I shopped. Nalagam, E.M. Tablets, Triple Sulfa, Furan-2, and Fungus Eliminator tested safe at one, two, and sometimes three times the dose listed on the package. I tested double and triple doses because the doses listed on the packages were often well below the recommended dose for amphibians for these medications (See Table 2 for comparison). These medicines are all designed to go right into your aquarium, so multiplying the dosage might disturb the balance in your aquarium. Or, if you have fish in your tank, it might not be good for them. It is a better idea, when treating an axolotl, to remove it from the aquarium into a bowl by itself. The catch here is that the available medications are all premeasured for 5- or 10-gallon volumes (about 19 or 38 L, respectively), and you only

Table 1. Recommended Doses

Drug	Dose	Regimen
Naladixic acid	10 mg/L ¹ 24mg/L ²	Bath Dip for 24 hours every other day
Nitrofurazone (in Furan-2)	10-20 mg/L	bath, change daily
Sodium Chloride	2 g/L 4-6 g/L 35 g/L(1)	Housing water Bath for 1 week dip 10 min
Artificial sea water	35.8 g/L ³	Dip 10 minutes, every other day for 3 doses
Formalin 10%	1.5 ml/L(1)	dip 10 min every 48 hrs
Sulfamethazine (in Triple-Sulfa)	1 g/L	bath, change daily
Gentamicin (or Amikacin)	10 mg/L*	dip, 1 hr/day
Enrofloxacin	10 mg/L*	dip, 1 hr/day

1. Modified from *Kirk's Current Therapy XI Small Animal Practice* (1) R.W. Kirk and J.D. Banagura, Eds. W.B. Saunders Co. ,1992

2. Dr. Heather Eisthen, Michigan State University, Web page on the treatment of "red leg" (*Aeromonas* infection) in axolotls (<http://www.msu.edu/user/eisthen/lab/methods/animalcare/redleg>)

3. Dr. Heather Eisthen, Michigan State University, Web page on the treatment of *Columnaris* infection in axolotls (<http://www.msu.edu/user/eisthen/lab/methods/animalcare/columnaris>)

* Gentamicin and enrofloxacin (Baytril) are effective against *Pseudomonas*, a common pathogen. They are not available except through a veterinarian. I know that the doses listed are safe from our experience with them in the Axolotl Colony.

need about 1/2 gallon (about 2 L) of water in the bowl. There are a few ways to handle this:

1. Find a large container in which to make the medicated water in the volume specified on the package, then fill the bowl from this larger container each day until the treatment is finished.

2) Make a concentrated stock solution by adding the dose to 1 quart (this makes a 20X solution) or 1 liter of water. For example, if the medicine is packaged for a 5-gallon volume, add 3 fluid ounces of stock solution to the 2 quarts of water in the bowl (don't forget to treat the water for ammonia and chloramine also!). If the medicine is packaged for a 10-gallon volume, you need to add 1.5 fluid ounces of stock to the bowl. If you are working in liters, add either 100 ml to 1.9 L or 50 ml to 1.95 L water in the bowl. Keep in mind that these calculations are designed to achieve the recommended dose for fish, which is safe for axolotls, but not necessarily therapeutic.

3) If you decide to increase the dose, you can modify the above by adding more tablets or capsules to your treatment water or by using more of the stock and less fresh water.

For those of you who want to do the math, Table 1 shows some doses that have been recommended for axolotls.

All of these products contain antibiotics or antimicrobials. They may be effective for local-

ized skin infections at the dose on the package, so if you are worried about skin infections as a result of irritation or injury, try that dose as a safety precaution to prevent infection. Say you walk up to your tank one day and you notice suddenly that your animal has dropped all of its gill filaments, the gills are limp, and the animal looks stressed. This probably means there is a water problem. The problem could be chemical contamination, the proliferation of bacteria or parasites, or too warm a temperature. Correcting the water problem is a must, of course, but you should protect your animal from opportunistic bacteria that might attack its damaged skin. Refrigerate the axolotl, select one of the treatments listed above, or another with similar content, and use it for a week, maybe in conjunction with a water conditioner such as Novaqua or StressCoat, which are designed to reinforce the natural slime coats of aquatic animals. Then give the axolotl nice clean water until you have determined the cause of the initial problem and corrected it. I would follow this same procedure for an injured animal.

Adding salt to the water is an excellent thing to do for animals with skin problems. You can use any of the commercial aquarium-salt products, sea salt, or even just non-iodized table salt. One to two teaspoons (5 to 10 cc) of salt in a gallon (about 4 L) of water will help to keep bacterial levels low, and

axolotls can live in this slightly salty water indefinitely. For serious skin problems, a strong salt-water dip is one of the best and safest things you can do (see Table 1).

To treat for systemic infection, you will need to increase the listed dose for most of the pet-store medications (see Table 2). If you notice that your animal has stopped eating, is floating or tilted in the water, has limp gills with no apparent damage, or other symptoms of illness, separate the animal from other axolotls, refrigerate it, and treat it with an antibiotic. Salt can also be added to reduce the titer of bacteria in the sick animal's water. This way its body can concentrate on healing inside. If you need help coming up with the right dose, please email me (sjborlan@indiana.edu), and I can help you figure it out.

Another chemical that I haven't mentioned yet is Mercurochrome. We use Mercurochrome routinely at the Axolotl Colony for skin problems or injuries. If an animal develops skin sores, or it has been injured by a tank mate, I isolate the animal and give it a few drops of Mercurochrome tincture. It is hard to recommend this to people, because it isn't readily available, and people often confuse "methiolate" with Mercurochrome. You do NOT want to give your axolotl methiolate!

Mercurochrome can be purchased from Sigma online. A small quantity will go a long way. Add a few crystals to a small bottle and fill it with water. Use an eyedropper to add some of this tincture to your axolotl's water, stirring between drops. The water should turn a peach color. You can make the solution stronger, but you should then limit the length

of time in the solution to 2 or 3 days.

Mercurochrome can be used in combination with salt. For serious infections, follow with an antibiotic treatment or, for parasites, a chemical such as formalin, which is also available at pet stores.

Practically the End

I think that it is important to recognize that there are all kinds of disease-causing bacteria and parasites in the axolotl's environment at all times. As long as the axolotl is healthy, it can fight off these bacteria and not be overwhelmed by the parasites. However, even minor stress can eventually bring down the animal's immune system. If your tank is a little too warm, for instance, or it has low levels of chlorine, or ammonia occasionally builds up to dangerous levels, the axolotl(s) may not be killed right away, but opportunistic bacteria may take hold. The axolotl may not be able to fight off the disease while still under stress. Please remember that preventing disease in axolotls is easier than curing it.

It is also important to realize that one illness may cause a different illness. If you are treating an axolotl for systemic infection, you still need to give it clean water and watch for skin problems. Or, if the axolotl has had parasite problems, they may have led to a systemic infection.

And, remember, it all takes time! Your axolotl won't be frolicking around the tank in a day. It may take weeks to get back to normal. The resumption of normal eating will be your sign. Good luck. Write to me if you have any questions.

Table 2. Package-Recommended Doses

Brand Name	Drug	Dose on Package	Recommended Dose
Triple-Sulfa	Sulfa Drugs: sulfamethazine	4.3 mg/L	1 g/L
Nala-Gram	Naladixic Acid	5.3 mg/L	10 mg/L(1)
Fungus Eliminator	Nitrofurazone Furazolidone Sodium chloride	Specific mg not listed	
Furan - 2	Nitrofurazone	1.6 mg/L	10-20 mg/L
Dr. Wellfish's Aquarium Salt	Sea salt	Tonic Dose 1.3 g/L	4-6 g/L