KOI HUSBANDRY, HEALTH ASSESSMENT AND HEALTH MAINTENANCE
KOI HEALTH ADVISOR PROGRAM OF THE AKCA
Contributed by Sandra Yosha, DVM, PhD
(last update January, 2004)

INTRODUCTION

One of the goals of The Associated Koi Clubs of America (AKCA) is to enhance the enjoyment of keeping koi by disseminating accurate and up to date information of interest to koi hobby, including koi health articles contributed by knowledgeable veterinarians and other fish health professionals. The AKCA realizes that professional health care for koi is very limited, and koi owners may or may not be willing or able to properly care for their own koi. In order to improve koi husbandry within the hobby, the AKCA has established a Koi Health Advisor (KHA) Program to help upgrade the knowledge base of hobbyists. The concept is simple: various members of affiliated koi clubs will be given the opportunity to receive training from knowledgeable and experienced hobbyists and a licensed veterinarian with significant koi experience. The Koi Health Advisors will be given examinations on the information provided in print and on line, and will be given laboratory, hands-on training, for which they must demonstrate a sufficient level of competence. These KHAs will then volunteer to help others involved in the hobby in their local area. The goal of the program is to increase the enjoyment of the hobby by improving koi husbandry. The emphasis of the program is on the promotion of health and disease prevention**.** Properly cared for koi are known to have fewer problems.

However, even the most conscientious owner knows that fish can still become sick or injured. Therefore, the KHAs will also be trained to recognize and treat many common problems. Early intervention will undoubtedly result in less seriously sick and/or dead fish. Each owner will be advised of the problems that the KHA identifies. The KHA will frequently be able to recommend corrective actions and to advise the owner how to avoid similar problems in the future. When the KHA requires advanced help with pond or fish assessment and/or treatments and/or when prescription medications may be needed, the KHA will recommend the services of a qualified veterinarian. In an ideal world, there would be a qualified veterinarian in each neighborhood for each KHA to contact, and each KHA will be encouraged to find and work with such a local veterinarian**.** However, since local qualified veterinary care is currently rare, the program will attempt to make provisions for the KHA to be able to contact a qualified veterinarian via phone, fax, and e-mail. This veterinary-KHA-owner connection will enable each owner to choose a more comprehensive treatment plan that could include prescription medications, advanced diagnostics (x-rays, ultrasound, blood work), and advanced treatments (hospitalization, surgery) when indicated. The decision to follow the KHA's recommendation is totally at the discretion of the owner, including whether or not to request veterinary involvement. **It should be understood that KHAs are not veterinarians and therefore cannot and will not prescribe restricted medications.** It is hoped that this program will reduce the incidence of husbandry related problems; promote safe, effective and environmentally responsible treatments of koi; improve access to qualified veterinarians and contribute to the knowledge and enjoyment of koi and koi ponds.

Sandra Yosha, DVM, PhD

DISCLAIMER- The Associated Koi Clubs of America (AKCA) or their contributors are responsible for the contents of the information presented. However, any person choosing to act on the information presented herein, including the Koi Health Advisors (KHAs), is solely and individually responsible for the use or misuse of any of the information provided. KHAs are not employees of representatives of the AKCA or any of the other people associated with this program. KHAs are independent volunteers and cannot receive monetary compensation while acting as a KHA. KHAs may make recommendations to koi/pond owners but owners are ultimately responsible and must decide whether or not to follow the advice. It is highly recommended that each KHA work with a local veterinarian or a qualified aquatic animal veterinarian. It is further recommended that each KHA become familiar with their own state and federal laws governing the practice of veterinary medicine, emergency help for animals, and EPA, FDA, and USDA guidelines regarding diagnosis, treatment or administration of chemical and medicines to fish and disposal of treated water. Each KHA is expected to know the laws and local ordinances governing their activities and to stay within those laws. Any violations of the law while functioning as a KHA are grounds for immediate dismissal from the program. Further, any KHA that breaks the law will, by that act, forfeit

their coverage under the liability insurance the AKCA will attempt to obtain for KHAs' activities as member of an AKCA committee.

AKCA KOI HEALTH ADVISOR PROGRAM – PART I --- KOI HEALTH CONCEPTS

The KHA will work with pond owners to improve koi husbandry. To accomplish this, the KHA will become familiar with proper water quality, filtration, nutritional needs of koi, and how to assess koi and koi ponds for common problems. The KHA will be capable of advising the pond owner on how to perform routine pond maintenance, will be able to do some parasite checks and make recommendations that can eliminate some water quality problems and some common koi parasites. The KHA will also be able to accurately determine pond volume and be able to handle koi in a safe manner. When professional treatment is needed, the KHA will be able to help the owner monitor the progress of treatments prescribed by a veterinarian, and can thus extend the reach of veterinary medicine to those areas that do not currently have access to qualified local veterinary care.

Accurate record keeping is essential. The KHA will be encouraged to use a standard fish/pond health assessment form that will provide accurate and complete record keeping. Information from these records will be used to increase our knowledge base to improve health care for koi and to facilitate communication with a veterinarian if needed.

There is no substitute for experience in learning how to evaluate koi health. There must be a good feeling for what is normal or a normal variant before there can a determination of what is abnormal. Make it a point to visit koi ponds, attend koi shows and other displays. The KHA should learn how to view koi, how to observe them without being seen, and how to recognize those that have physical and behavioral abnormalities. Notice the swimming patterns and behaviors that can signal a problem. The following chart can help describe some of the problems that might be encountered. NOTE THAT THIS LIST IS ONLY MEANT TO BE A GUIDELINE. A single behavior or clinical sign can be caused by more than one problem, and a single problem can cause more than one behavior or clinical sign. This section is meant to be used in conjunction with the hands-on laboratory session, the previous sections of this program, and the supplemental textbooks: The AKCA Guide to Koi Health, and Advanced Koi Care by Nicholas Saint-Erne (see References at the end of this section).

ABNORMAL FISH BEHAVIORS AND CLINICAL SIGNS

Decreased Appetite **–**This must be distinguished from a loss of appetite which occurs normally in cold weather when there is a sudden drop in temperature, or due to a change in diet, or in females during the fall when they are using the energy provided by ova resorption sometimes seen during or after spawning season. Normal koi readily come to the surface to feed, so koi that do not come to the surface should be examined.

Top Swimming- This must be distinguished from swimming at the top to interact with the owner or to feed. This is particularly abnormal if the fish is breathing at the top or trying to gulp air (also called *piping*), or are hanging around a water fall or source of oxygen. This can happen to one or several fish, and is particularly significant when the entire school or group of fish are at the top (especially in the early morning hours just prior to dawn), or are staying near an air stone or aerator. Look for oxygen starvation—either in the water, or because of damaged gills.

Bottom Swimming- Fish that linger at or near the bottom, particularly when the fish are not part of the school or group of fish, are not normal.

Swimming on one side, upside down, or unable to go to the bottom or top without a struggle- Koi are normally able to move up and down effortlessly in the water column, so a fish that has difficulty doing this is not behaving normally. Suspect gas bladder problems. While there can be many causes,

correction of swim bladder problems are rarely possible. Even if the cause can be identified and eliminated, the gas bladder can form scars, and scars in the gas bladder will not resolve. The KHA will recommend procedures aimed at eliminating any treatable problems (such as parasites and bacteria) and will recommend proper nutrition, and then hope for the best. Balance, neurological dysfunctions, vitamin deficiency, and injury can also cause abnormal swimming.

Swimming against rock or pond structures, or showing the underside often (also called flashing)- This can be a sign of itching and the fish is attempting to scratch. Look for parasites, which are the most common cause of this behavior, although sudden changes in water conditions or the presence of a toxin can also cause flashing.

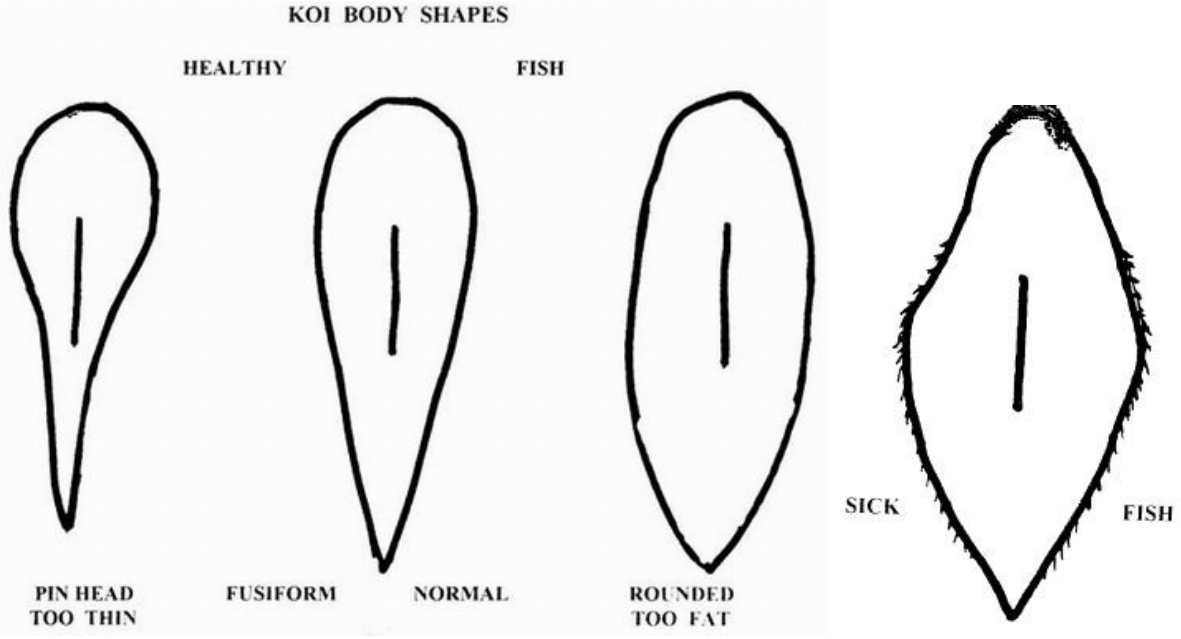
Swimming in a circle or other abnormal pattern- Internal parasites, neurological dysfunction, and damage to the fish's ear or lateral line may all present with this type of swimming behavior. Correct the water, diet, and remove parasites if possible, and then call a veterinarian to help with anything further.

Dropsy, Bloat or Pine Cone disease- Abdominal distention from any cause (fluid, tumor, or gas) is considered to be dropsy or bloat. Dropsy can be caused by an infection, but just as often it can be caused by inflammation, kidney or gill failure, ovarian rupture, or other non-infectious causes. Therefore, the cause must be determined before treatment can be started. KHAs should offer to refer all cases of dropsy or bloat to a veterinarian. A bacterial culture and sensitivity is indicated (laboratory demonstration) and should be offered to the owner. Bacterial infections can cause death rapidly. The following photo is from the AKCA Guide to Koi Health (reprinted with permission).

***Changes in eyes, such as cloudiness, or protruding eyes- (*"pop-eyes")-**These are non-specific signs and can indicate either eye damage or an internal problem from any cause, but usually associated with damage to gills, liver, and/or kidney. Minor problems, such as damage to the cornea, or surface of the eye, can often be treated with an eye ointment, such as triple antibiotic, applied daily for 3-7 days. The challenge is ascertaining the presence of a major internal condition which requires more aggressive therapy. Certainly when "pop-eye" is associated with dropsy, then it is time to call in a consult. "Pop-eye is often associated with dropsy, and may precede it.

Changes in body weight or shape- Chronic changes in feed intake can lead to weight gain or weight loss or a big difference between one individual and the rest of the group. Weight gain must be distinguished

from a normal increase in abdominal size seen during the spawning season. Extreme enlargement of the abdomen, especially when accompanied by protruding scales, can indicate internal distention due to gas, tumors, fluid, or all of the above (dropsy). Extreme weight loss in a fish that has been in the pond for a long time should be considered to be a potential sign of Mycobacteria. **Do not attempt to diagnose Mycobacteria yourself. It is potentially contagious to people. (See bacterial diseases).**

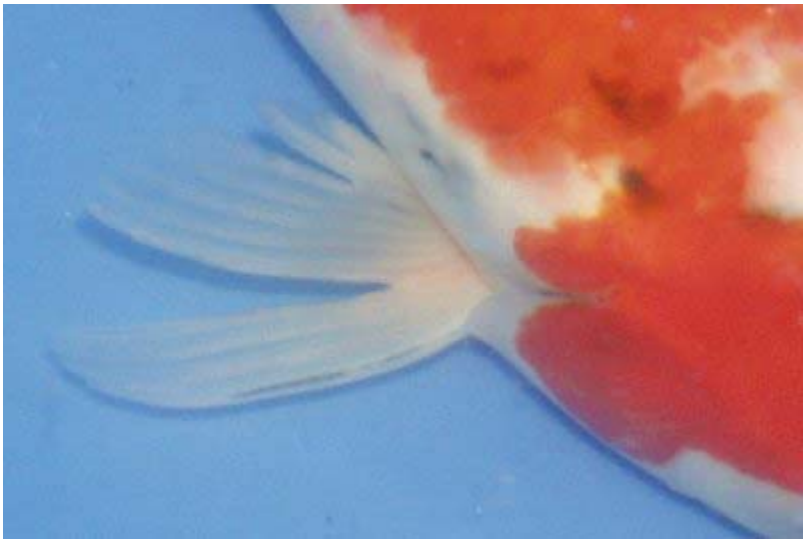


These diagrams represent koi body shapes as they would be seen looking down on the top of the fish as they are seen in the pond.

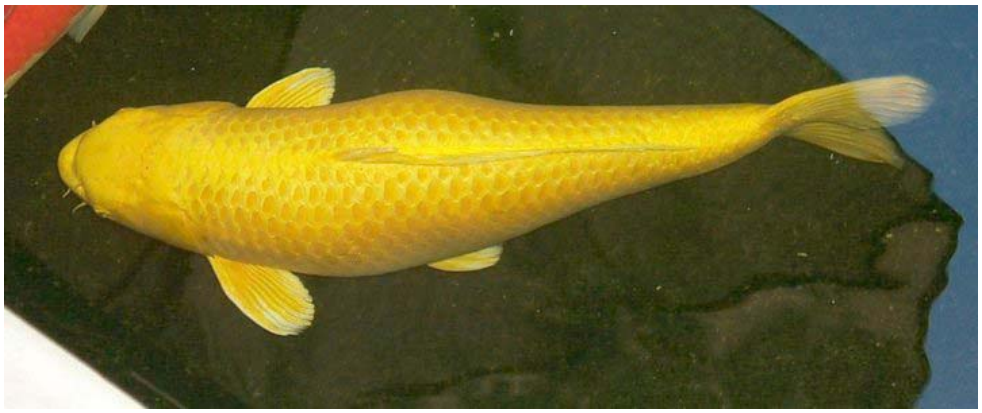
Changes in color pattern- Koi color patterns, which are genetically controlled, change as koi age. Color additions or losses can be normal changes in healthy fish, but are subject to modification by dietary components (see the nutrition section and the supplemental textbook), overall health, endocrine (hormonal) factors and environmental factors. However, red areas of the skin can also be caused by skin irritation or skin damage, parasites, ulcers (areas where the mucus coat and epidermis are damaged) or sunburn. Black or white patches can be normal pigmentation, or due to diseases. Total loss of overall color or faded color can be caused by excess mucus, stress or disease. However, color loss can also occur in an otherwise healthy fish. Dull colors indicate that something is wrong. Spend time studying various color patterns so that normal patterns and colors can be distinguished from diseases.

Clamped fins-Except when they are resting on the bottom in a sleep-like state, Koi generally extend their fins and use them for balance and swimming. Clamped fins, or fins held close to the body, signal an illness, stress, incompatibility or an otherwise unhappy fish. These fish should be examined more closely, and they should be selected for a parasite check.

Fin erosion or damage- Koi fins, except for some of the long fins, are generally regular with smooth edges. Damaged fins should be noted. "Butterfly" or long-finned fish are particularly subject to mechanical fin damage caused by the environment, but this must be distinguished from fin erosion caused by diseases. Split fins can often be repaired with surgical glue, but this should not be tried in an infected fin. Use caution with surgical glue, it can be irritating and cause further damage.



Crooked back- Fish are flexible and can assume many different shapes when swimming, but if the fish has a permanent "S" shape or is crooked, it is a sign that there is a problem. In young rapidly growing fish, a vitamin deficiency might be a possible cause, but this is more commonly seen in association with a broken back (diagnosable on x-ray) thought to be associated with or caused by a lightning strike or electrocution by stray currents. Trauma, especially following spawning has also been associated with this condition, and rarely, a "crooked" fish will be seen after exposure to organophosphates. Make sure that the pond is examined for any stray sources of electricity or toxins, and recommend vitamin C supplementation and diet correction as needed. Obviously, stray electric current is also a potential health hazard. Tumors may also cause a fish to be "crooked." Ogon (yellow fish) below has a tumor.



Missing scales and other signs of skin damage.-Missing scales can alert an owner to a problem. However, some varieties of koi normally have a reduced number of scales or are scaleless.

Protrusions, tumors, or other changes on the body- Koi can have tumors, parasites in the skin, infections or other problems that can be seen as protrusions or bumps. Review the viral section of the AKCA Guide to Koi Health and the course textbook.

Changes in respirations- Breathing rates will increase in response to eating, excitement or exercise. Respirations should be evaluated when the fish are at rest and, if possible, without the fish seeing the observer. Rapid respirations can be a sign of low oxygen in the water, toxins in the water, or diseases that compromise the gills. Rapid respirations can also be a sign of pain. Slow respirations are less

common, but can be seen in a dying fish, a fish that is anesthetized, or during times of inactivity when the fish is in a "sleep-like" state.

Changes or damage to any part of the body-Changes or damage to any part of the body should be noted. Skin, fins, eyes, mouth, gill covers, and vent can all be observed for discolorations, ulcers, abnormal movement, etc. (Review normal anatomy). **Large or deep penetrating ulcers, regardless of cause, generally require injectable antibiotic treatment. If the ulcer is not due to trauma, then bacterial cultures should be recommended.** Antibiotic injections are far more effective than water or feed treatments, and the owners should be advised of that fact**.** (See treatment options section)

Gill examination- Fish gills are the only internal organs that are visible at times while the fish remains in the pond. Fish gills are normally a deep red color, have thin separate filaments, and little or no visible strands of mucus (see the AKCA Guide to Fish Health, and the Anatomy/Physiology section of this course). **Any abnormality of the gill is highly significant.** Gills should be thoroughly examined in any fish that is removed from the pond. Note the color, presence of any spots or mucus, look for thickening, and always recommend a parasite check as part of the recommended health assessment and preventive health care for koi, analogous to flea and tick removal in dogs and cats. This is an important part of the assessment, and also used for prognosis. When parasites are found, it is important to recheck after treatment to be sure that the parasites have been eliminated. Also, severe damage to the gills, no matter what the cause (dead cells, excess mucus, excess thickening, or inflammation) can be permanent. One rule of thumb that has been used in this practice to assess prognosis, is that if the fish's gills are more than 25% damaged, they are at risk, and 50% damage will most likely not survive, regardless of cause, treatment or diagnosis. The prognosis is slightly better if the fish can be kept in cooler temperatures, when their oxygen requirement is lower, but be aware that temperatures lower than 65º F will delay or inhibit healing.

Damaged gills

COMMON FISH DISEASES

Fish diseases can be divided into two general categories*: infectious and non-infectious.* A general description of each disease or problem is presented in this section. This section includes many of the common diseases seen, generally in order from the most common to least common, based on the cases seen in private practice. The exact order will vary from veterinarian to veterinarian, between local populations, according to the time of year, and other factors. This section is neither comprehensive nor complete; new diseases and parasites are continually discovered and reported.

Non-Infectious Diseases

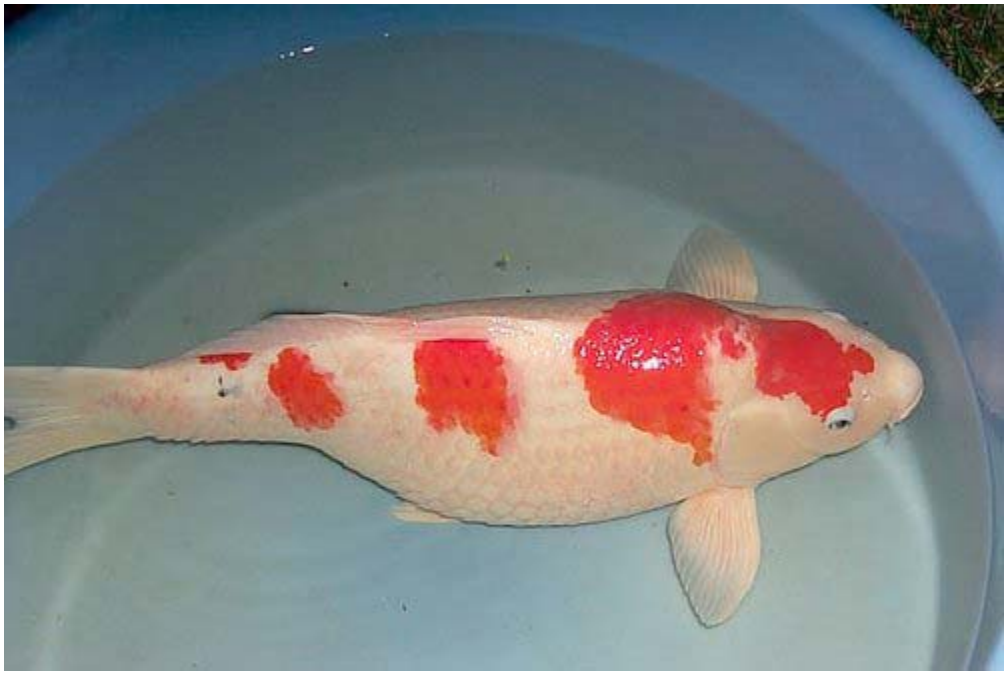
***Poor Water Quality*- Water quality is the single most important factor in maintaining healthy fish** (see previous sections). Ammonia, nitrite, pH, and temperature should be monitored on a regular basis, and during and after any water changes or treatments, fish additions or any changes in the pond. When a closed system is used, alkalinity and, to a lesser extent, nitrate should be checked periodically. Alkalinity is especially important to monitor in water that has a naturally low pH and in ponds that have a fish load. Hardness and salinity (salt content) should be measured as needed. Dissolved oxygen is also important in closed ponds, especially green ponds. Other tests, including heavy metals and hydrogen sulfide should be measured when indicated. Rarely, tests for pesticides should be submitted if there is an index of suspicion. Experience has shown that in the acute situation, water tests will often reveal an unacceptable level of heavy metal contamination even if the fish tissues do not contain traces of a toxin. Each KHA should collect a gallon of water in a clean container from the pond BEFORE any water changes are done so that toxins can be identified if indicated. The owner should be advised to keep the water on the premises for one week, and then, if it is not needed, the water can be discarded. There are many reference laboratories that can do analysis of water samples, and the cost is dependent upon the test or tests requested. When in doubt, seek consultation. Once the sample is obtained, a water change can be recommended. Cases in which the chemical or toxin is suspected to have been introduced from an outside source (i.e. lawn runoff, following a home pest treatment, water from an outside factory or other source), the owner may want a confirmation of the cause.

Injury- Koi can be injured from a variety of causes including birds, pond structures, spawning, being handled, lightening, and many other reasons. Regardless of cause, the nature of the injury determines the treatment. For best results, fish with penetrating wounds (wounds that enter the body cavity) should be treated with an injectible antibiotic. Cleaning the wound may require as little care as swabbing the wound with an antiseptic solution, such as Betadine®, or as much as anesthesia and surgical wound care.(See the treatment section). Refer to proper handling techniques which will be discussed in more detail in the treatment section. The mucous coat and skin are the first line of defense from the environment, and proper handling could mean the difference between saving a fish and losing it. Stress coat® or similar product is beneficial when handling koi.

Prevention is based on anticipating the source of the injury. Bird strikes and other animal predators are usually avoided by providing a cover for the fish. However, some birds, otters and raccoons have been known to get into covered ponds, so the type of structure and cost is determined by the type of predator in the area. (Caution! Some animals are protected by law. Check with your local fish and game commission prior to trapping or harming a predator.) There are many ways to prevent birds from getting to your fish and consuming a very expensive meal of koi. Some of the most popular include an electric type fence wire around the perimeter, surprise attacks from motion detection/sensor activated sprinklers, covering the ponds with a cover and shade cloth or screen, the presence of a fake bird of prey (such as an owl) that has periodic bursts of noise (which may very well disturb the human species living in the vicinity). The method may depend upon many factors such as location, size of pond, budget, and

climate. Regardless of method, none of them are fool proof. One of the favorite methods chosen in Florida is the sprinkler surprise.

Ovarian Rupture, Egg Binding, or Tumors- Female koi are often affected by diseases of the ovaries including ovarian ruptures and ovarian tumors. If the protrusion or lump is on one side, it is more likely to be a tumor, but they are not always distinguishable by external appearance. The most common sign of ovarian tumor or rupture is dropsy, with or without red fins. Death will occur quickly if these koi have a concurrent infection. These koi often stay alone at the bottom and may or may not be eating. These diseases have been seen most often in older, heavy koi. The relationship of fat content of the body to these problems remains to be determined, but these conditions are often, if not always, linked. It has been suggested that ova are normally resorbed during the winter when the fish are not feeding. Perhaps overfeeding, especially in winter, interferes with ova resorption.



The weight/length relationship of normal, healthy koi has been determined for Japanese koi. (Refer to the AKCA Guide to Koi Health for this chart). Most fish examined in this country weigh more than their counterparts in Japan that are the same length. Perhaps, koi in the United States are being overfed, are on an inappropriate diet, or both. (Refer to the nutrition section). Regardless of cause, ovarian ruptures and tumors can be life threatening. Peritonitis (inflammation or infection of the body cavity) is the most common complication. . The few cases that have been treated with an antibiotic alone sometimes seem to recover, only to succumb to dropsy at a later date. Tumors have been successfully removed surgically in a few surgical centers. The KHA who is faced with this problem should seek a veterinary consult so that a decision can be made about whether to treat, how to treat, or when to euthanize. Ovarian tumors and ruptures must be distinguished from other internal problems, including kidney, liver, gas bladder problems, infections, parasites, toxins, trauma, viruses or any problem that can cause dropsy. These conditions must also be distinguished from simple egg binding, which might be treatable with hormones (Human chorionic gonadotropin or Carp pituitary) under a veterinarian's direction. One case was managed with dietary and photoperiod manipulation. Artificially controlled short photoperiod induced one female to begin egg resorption during the summer. However, she developed dropsy the following spring, and was euthanized.

Prevention includes dietary management, appropriate ratios of male and female koi to produce a spawn, and possibly, a grassy or planted area that might be used as a spawning bed. If an affected female koi is not used for breeding, then a surgical ovariectomy (removal of the ovaries, similar to a spay) can

be discussed with a veterinarian as a life saving procedure, similar to spaying a dog or cat that has developed an infected uterus (pyometra). At this point, such a procedure is experimental, but some owners have asked about it as an option.

Cancer or tumors (other than viral tumors which are discussed under viruses)-Koi have been diagnosed with many kinds of tumors. External tumors can be seen as lumps, projections, or changes in pigmentation. Internal tumors can cause dropsy, pale gills (anemia), or many other problems, depending on the organ or organ system involved. Tumors can be benign or cancerous. Some can be removed surgically. The only way to definitively identify the nature of the tumor is from a biopsy submitted to a diagnostic laboratory. Tumors should be distinguished from infections because of the very different treatments required, and because of the potential spread of infection.

Lightening or electrocution-Lightening strikes are not uncommon in the south. Electrocution is also seen occasionally due to stray current from electrical pumps and other items used around the pond. One or several fish might be affected. Sometimes a burn pattern is observed that can indicate a lightening strike. However, the burn pattern is rarely seen on a fish that survives. Koi may end up in an "S" shape or with an abnormal swimming shape. Other causes of crooked back include vitamin C deficiency, trauma, treatment with organophosphates, and there may be others including parasites. If the decision is made to euthanize (humanely kill) the fish, then a post-mortem by a professional can sometimes reveal the cause so that prevention can be initiated in to protect the remainder of the fish. There is no specific treatment for these fish, but non-specific treatment with antibiotics and steroids can be tried. X-rays and have been useful in these cases to identify a broken spine which might be a reason to recommend euthanasia. Fish have survived lightening strikes and have recovered, but others have maintained the crooked shape. The shiro utsuri (black and white fish) below was shocked by a cracked submersible pump. It eventually healed (picture on right).

Sun Burn-Koi kept in shallow, un-shaded ponds can become sunburned. A koi that has reddened, inflamed skin on the top of the fish in the summer should be suspected of being sunburned. White or light colored fish are especially at risk. Prevention includes shading the pond and/or digging it deeper. Deep ponds also protect koi in cold climates from freezing. Treatment usually involves the use of

prescription medicines including an anti-inflammatory and/or antibiotic, depending on the severity. Additional vitamin C in the feed might also aid in wound healing. Treatment with Panalog ® or other equivalent veterinary ointment during the first day or two may alleviate some of the complications of sunburn, but of course this must be balanced against the potential stress of capture, handling, and removing some of the protective mucus. In many other species, chronic exposure to the sun and repeated sunburns are linked to skin cancer. This has not been studied in koi, but it should be considered in older koi with a history of sunburn and suspicious skin lesions. There is a new collagen ointment on the market for use in small animals and it shows promise in treating ulcers of koi. Perhaps, this ointment could be useful in the treatment of sunburn, too, but that remains to be determined. There is a new product called Tricide neo® that is providing wound treatment without injections. It must be used outside of the pond because it will kill the biofilter.

Nutritional Diseases- *(Review the Nutrition section).* Nutritional diseases fall into two categories*: deficiency or toxicity.* The most common deficiency known to date is vitamin C, which can cause crooked backs, bone deformities, bleeding, abnormal wound healing and many other problems. Vitamin C deficiency compromises the immune system so that the koi are more susceptible to other diseases. With the advent of stabilized vitamin C in the food (a synthetic vitamin C that is much more stable than natural vitamin C), vitamin C deficiency is less common. However, much less is known about the other vitamin deficiencies in koi and they might be suspected in cases where the cause of disease is not immediately obvious. The signs of deficiency or toxicity are complex and subtle, and are covered in the supplemental textbook for this course. Also review the AKCA Guide to Koi Nutrition and the nutrition sections of this course.

The KHA is not likely to be dealing with vitamin deficiency if the fish are eating a quality diet, but if they are not, it will be one of the first changes in husbandry that the KHA should suggest. **Catfish and trout chows are not appropriate feed for koi.** Many will debate the quality of koi feeds, but there are many good choices that are commercially available. All feeds are not necessarily appropriate for all life stages or for all seasons. One fact is certain, good quality feed will contain stabilized or synthetic vitamin C. Review the nutrition sections for additional information. In order to maintain nutritional value, check the shelf life of the feed, the date of milling or freshness, buy in small quantity and keep the feed dry and cool. Freezing pelleted feed is not recommended, but short term freezing of pelleted feed containing a medicine can be done since it is a small quantity used only for a specific problem in a defined amount of time. Gelatin coated feed, and gelatin feeds can be frozen, as long as the medicine incorporated within it can be frozen

Nutritional deficiencies are most often seen in production ponds, rather than display ponds. The fry and young, fast growing fish are at greatest risk. Deficiencies should be suspected in fish that are too thin, or undernourished. The thin body shape is termed “pinhead”, because that is what the fish look like from the top—a very large head and a very thin body (see laboratory text). The best treatment is to improve the diet. In extreme cases, vitamin injections can be used on the order of a veterinarian. *However, nutritional deficiency must be distinguished from wasting caused by other diseases, especially Mycobacteria.*

The other nutritional disease that is commonly seen in koi is obesity. Koi are cold-blooded animals that should not be fed when the temperature falls below 50° F. Their need for food is greatly reduced and correspondingly, so is the rate of digestion. At the ideal temperature of 70-75°F, koi can consume approximately 2-3% of their body weight in food/day; or alternatively, the correct amount of feed is about that which is consumed in about 10 minutes. Koi have no stomach. In the wild, koi are omnivores that graze. Small amount of feed containing plant/fiber content will simulate a more natural diet, although in some ponds, there are plants, algae and bugs on which to graze. Crustaceans, such as krill, brine shrimp (*Artemia)*, or water fleas (*Daphnia*) can have a laxative effect in fish. .If a koi is constipated (which is seen as a long fecal trail attached to the anus), then some of these crustaceans added to the feed may alleviate the constipation. In severe cases that are life threatening, medical management (enema or mineral oil) or surgical treatment may be considered by the veterinarian on call.

Koi can overwinter in a pond without food. Many koi breeders advocate a period of fasting each year (virtually always in the winter season) for all koi except first year fish. The effect of this may have several benefits: excess fat built up during summer feeding may be substantially reduced and/or gravid females that did not release their eggs during spawning in the previous season will likely resorb them while fasting. This may be important for the prevention of ovarian rupture during subsequent warmer months.

Koi will require more food as the temperature increases and their ability to digest it more quickly likewise increases. However, at high temperature extremes (85+°F) koi can be stressed and actually consume less food. All bodily functions are compromised at high temperatures, digestive enzymes and proteins can begin to denature (degrade), and the fish may have insufficient oxygen for its needs.

Koi body weight is the best indicator of appropriate feeding rates, but body shape can also be used. Obesity may also be linked to fatty liver syndrome. Fatty liver syndrome of cats is a well documented disease in which the liver has a fatty infiltrate and is associated with lack of appetite, which can be fatal unless the cat is force fed to provide nutrition. There was at least one suspected case of fatty liver syndrome in an obese koi that was not eating. An x-ray of this fish showed massive fat in the body with no room for normal organs. The fish was euthanized due to the poor prognosis for survival, and the post-mortem examination revealed fat infiltrates in the liver and excessive fatty deposits in the body cavity. If suspected, the KHA should advise the owner to contact the veterinarian who can direct treatment including antibiotics and a forced feeding regimen.

Toxicity due to vitamin excess has not been seen in koi to date. Based on the information from nutritional studies of other species, water soluble vitamins (B's and C) do not cause a problem because excesses are eliminated immediately. On the other hand, deficiencies can be common because they are not stored to any great extent. Fat soluble vitamins (A, K, D) can potentially be deficient if the diet is poor in fat, but can be toxic if the diet contains excessive amounts in certain foods. For koi, there is so little known. Signs of toxicity are covered in the supplemental text.

***Toxins*- the most common toxins that affect koi are ammonia, nitrite and chlorine.** Fortunately, these toxins can be easily identified, removed, and prevented.

Ammonia causes the fish to have difficulty breathing, a loss of appetite, rapid breathing, and death. Chronic ammonia in the water leads to hyperplasia (thickening) of the gills, which can lead to decreased growth, hypoxia (low oxygen in the blood), salt imbalance and death. The addition of zeolite or Amquel® may help until the ammonia can be removed by water changes or biological filtration. Review the section on filtration—zeolites can release ammonia in the presence of salt, so exercise caution if there is salt in the pond. (Review the water quality section).

Nitrite poisoning is also called brown blood disease. When nitrite binds to hemoglobin (the red iron containing protein in the blood responsible for carrying oxygen) the hemoglobin-nitrite complex turns brown. The gills, which are full of blood and are easily visualized, appear to be a brownish color. Suspect nitrite poisoning, even if the nitrites are low at the time of examination. Salt will reduce the toxicity of nitrite until water changes or filtration can be done to remove it. The chloride ion (Cl^-) competes with nitrite uptake by the gills. (Review this section in the laboratory section and in the supplemental text).

Chlorine (bleach, hypochlorite, OCl^-) is a strong oxidizing agent (not to be confused with *chloride,* which is a stable ion that is a component of salt, NaCl or Cl^-). Chlorine has a distinct odor, like a swimming pool, but at lower levels is undetectable except by a water test. Even at low concentrations, it is still deadly to fish because it damages the delicate gill filaments. Sodium thiosulfate (ST) can be used to neutralize chlorine, or alternatively, charcoal filtration, aeration, dilution with non-chlorinated water can also be used successfully. Chloramines, which are formed from the reaction of chlorine with ammonia, are almost as toxic as, and much more stable than chlorine. Both of these oxidants burn the gills, skin and eyes, and cause respiratory distress and death. Chronic low levels of chlorine can cause hyperplastic gills which leads to respiratory compromise, slow growth and death.

Other toxins, such as hydrogen sulfide, heavy metals, pesticides and feed contaminants, may need a professional laboratory and a veterinarian to help in the identification. Suspect hydrogen sulfide when there is a detectable "rotten egg" odor, or when there is an excessive amount of black muck or ooze. It is produced by anaerobic bacteria that grow in the muck. The best prevention is to vacuum the bottom of the pond regularly, do not overfeed, and avoid the muck in the first place by having excellent pond maintenance. Once the ooze is present, however, removing it may create a cloud of hydrogen sulfide release, so exercise caution and recommend removal of the fish if necessary to perform the proper clean up. Have adequate aeration and avoid filters and ponds with dead zones (review filtration and pond design). There are also commercial products available that can remove some of these excess organics. Exposure to other toxins, especially those that could potentially be washed into the pond from yard runoff, is usually suspected on the basis of the history. However, there are more subtle cases in which heavy metals, pesticides, feed contaminants, air borne pollutants and less obvious causes are to blame. Identification of a toxin can be difficult and may require a detective-like approach. Sometimes, the behavior or history of the fish points to a toxin. These can be the most expensive and difficult cases to solve. The signs of disease depend upon the toxin and the organ or organ systems that are affected. Sometimes the only sign is one or more dead fish. Often, the skin and/or gills are the first organs affected, so if the fish have pale gills, thickened (hyperplastic) gills, increased respiratory rates, air gulping, etc, a toxin can be on the list of potential problems. Massive sudden mortality in a pond is a strong indication pond that a toxin is present. If a toxin is suspected, save a gallon of water from the pond before any water changes are done, so that an analysis can be done later if indicated. The water can always be discarded if not needed. Review water quality and filtration sections, and the AKCA Guide to Koi Health, to see learn how to correct common water quality problems. **When in doubt, save a water sample and do a massive water change (as long as the source water is not the problem).**

Gas Bubble Disease- This condition is also associated with sudden massive mortalities in a pond. The condition is transient and sometimes difficult to confirm. This condition is suspected on the basis of history. Like a coke bottle that is uncorked, gas bubbles form when dissolved gas under pressure or in high concentration is suddenly released. Conditions that favor the formation of gas bubbles include supersaturation of gas caused by a malfunctioning pump, adding well water (especially a deep well) directly to a pond, from a pump that is sucking air on the inlet side and then pressurizing it on the outlet or big differences in water temperature i.e. well water at 60º F pumped into a pond at 70º F. Cold water holds more dissolved gas than warm water, so fast warming of pond water will cause the gas to bubble out of solution. Like the bends in SCUBA divers, the fine gas bubbles coming out of solution in the blood of fish can get trapped in joints and vital structures such as the heart, gills and brain and cause death rapidly. Since they are gas bubbles, they will disappear and be difficult to find. Look for fine bubbles in the fins or on the walls of the pond. Suspect this condition on the basis of the history. Rapid cooling of affected fish might be attempted, but is probably futile since koi do not handle cold temperature shock very well. Removing the cause will prevent new cases. **Ponds should never be filled from the bottom.** Water should be added via a waterfall or a hose spraying from the top and replacement water should be within 2-3º F of pond water temperature to avoid the possibility of gas bubble disease. Aeration of well water prior to reaching the pond is advisable and preventative.

Frostbite- admittedly, this is not seen in Florida koi (eat your hearts out northerners). But for the record, this veterinarian has lived in Indiana, Ohio, Michigan, Pennsylvania, and Massachusetts before settling in Florida, and was on rotation in January in Connecticut to learn large animal ambulatory medicine (mostly dairy cows). So frostbite is an all too familiar entity. Koi that overwinter in deep ponds should be protected from freezing because the coldest water is densest at 4º F (0ºC), floating to the top as it freezes. However, shallow ponds or ponds present a potential danger to koi. If they do not freeze and die, then a portion of the fish (especially the tail and dorsal fins) could theoretically suffer from frost damage. This damage may not become apparent until the spring thaw. Treatment will probably involve amputation of the affected portion and antibiotics. Fungal growth is likely to occur on damaged or dead

tissue in fish. If the KHA recognizes this growth on the fin tips in the spring with no other signs of disease or parasites, then frostbite might be postulated. After trimming the fin to a level that bleeds, it would be advisable to swab with Betadine®, put an antibacterial ointment on it, and a topical wound healing facilitating ointment, such as a collagen product, could be attempted. More aggressive treatment of large areas other than the tip of a fin should be referred to a veterinarian or recommended for further treatment options. Undamaged fins will, in all probability, eventually re-grow to its original size and shape, but permanent disfigurement cannot be ruled out as a possibility.

Infectious Diseases

Many common diseases of koi are infectious. When dealing with infectious diseases, it is helpful to know the life cycle of the disease causing organism, the point of exposure, and potential treatments that will be effective against the disease organism. While some of this information is known about koi diseases, much remains to be determined. Note! Koi diseases often have multiple causes or secondary problems that require a comprehensive approach in order to treat effectively. For example, external parasites might be associated with a secondary bacterial infection and may require a parasiticide, an antibiotic, and salt therapy to treat effectively. Each situation is different and must be evaluated on an individual basis.

Infectious diseases can be divided into categories based on the causative agent. **Most commonly, the categories include: single celled parasites, multi-cellular parasites, fungi, viruses, and bacteria.** (Also see the AKCA Guide to Koi Health and the course textbook). Parasites are organisms that *must* live in or on the koi, and benefit from the fish while causing damage to the fish. Other organisms that are normally free-living *may* cause disease if the conditions are favorable. Finding a free-living organism on or in a koi does not necessarily mean that they are causing disease. It is a judgment call based on experience and ruling out other primary causes of the problem.

External Parasites

Single Cell Parasites- One of the most common and fatal diseases of koi is *Ichthyopthiurius multifilis, or "Ich"*. It is a ciliated protozoan that has a complex life cycle. It has a growth stage in the pond, and a mature stage in the skin and gills of koi. It is not known if there is more than one variety of Ich, so any species of fish with Ich must be treated as if it is contagious to koi. The organism is an obligate parasite of fish and cannot live long in the absence of a host. This fact can be used to eliminate the parasite from a pond by removing all of the fish from the pond; water, and all other pond contents can remain intact. The length of time necessary for the pond to remain empty of fish to rid the pond of this parasite depends on temperature. In cooler weather, it may not be eliminated completely, although it undoubtedly will not survive freezing. The life cycle is completed in about 4-5 days at 80°F. Lower temperatures require a longer time. Fish that are exposed to Ich might become *asymptomatic carriers* (see vocabulary list). Researchers have been attempting to develop a vaccine to prevent disease caused by this parasite, but for now avoidance and early detection is the best defense. Microscopic examination of skin and gill biopsies is needed to see this parasite. The adults are easy to recognize by the very large size and the horseshoe shaped nucleus, which is commonly seen; the swimming stage is more difficult to identify. Small white spots on the fish (which is the classical presentation of Ich) can be caused by other diseases. Furthermore, Ich can kill fish before the white spots develop, so accurate identification of the immature swimming stage of the parasite is essential for early intervention. This parasite is highly contagious and often fatal (See AKCA Guide to Koi Health for pictures of the parasites as they appear under the microscope). The stage of the parasite that lives on the fish and the stage that lives in the pond are probably resistant to most, if not all, treatments. It is the swimming stage that is most sensitive to treatment.

Other common single cell parasites include Costia (Icthyobodo), Oodinium, Chilodonella, and Trichodina. Except for Ich and Oodinium, which have an encysted stage in the pond, these parasites are transmitted directly from infested fish to clean fish. None require an intermediate host (another animal species). (Review this section of the AKCA Guide to Koi Health and course textbook). In general, the single cell parasites have at least one life stage that is very fragile and susceptible to changes in the environment. Therefore, salt is often effective. Ich cannot live at high temperatures, so raising the water temperature to 85º for 3-4 days will often eliminate this parasite. However, koi can be very stressed at high temperatures when the gills are damaged and oxygen is low. Potassium permanganate or formalin can also be effective (see laboratory manual). Parasites are eliminated from the return water after passing through ozone (caution is advised with ozone since it can be very toxic to fish if it finds its way into the pond) or an ultraviolet light of sufficient strength and contact time, but are not eliminated from the pond or on the fish. The fish's own defense mechanisms, including the slime coat, intact skin and a fully functional immune system, must remove them or control them, but reducing the load in the water by treatment with ultraviolet light, formalin or salt will be beneficial in reducing the parasite load on the fish.

Multi-cellular Parasites- There are many species of multi-cellular parasites. In general, complex parasites require specific treatments and are generally more resistant to environmental changes. These parasites include gill or skin flukes, leeches, fish mites, and crustaceans (anchor worm and fish lice). Skin and gill flukes belong to the Trematode group. They are obligate parasites. All of the species of monogenetic (one host) flukes that attack koi may not be known, but they seem to fall into two general categories: egg layers (oviparous) and live bearers (ovoviviparous). Although the live bearers tend to be found on the skin and the egg layers tend to be found on the gills, both have been found in both places. Some of the common treatments currently available do not seem to affect the eggs of egg layers. Droncit®, which is a veterinary prescription medicine, may kill the eggs, but that is not definitely known. Therefore, the ideal recommended treatment of gill/skin flukes involves two parts: an initial treatment that kills the adults and larvae, but may leave behind live eggs; and a second treatment (or different type of treatment) that kills the newly hatched flukes. Since the life cycle is temperature dependent, the timing of subsequent treatment(s) depends on the environmental temperature. Most often, treatment will be repeated in 1-2 weeks. Weekly skin scrapes and gill biopsies are recommended to assess the effectiveness of treatment, and therefore the interval between treatments. Droncit® is effective when provided in a medicated feed. The medicine, praziquanatel, or Prazi®, is now available. It is specific for flukes, and is much safer for the koi and the environment. Supaverm ® (not technically approved for use in this country) is a combination of anti-fluke and anti-nematode active ingredients has been used by many koi hobbyists. It is labeled as a sheep dewormer, but has been used in ponds to remove gill and skin flukes in goldfish and koi. It is widely accepted that it kills goldfish, and it is now known to cause koi deaths, too. Prazi® is therefore, the recommended first choice at this time for removal of gill and skin flukes. It is, unfortunately, not broad spectrum, so other products are often used because they treat many problems simultaneously. Other effective broad spectrum parasite removal treatments are potassium permanganate (PP), and formalin. *Be sure to observe all safety precautions when using these products.* (See AKCA Guide to Koi Health supplemental textbook and laboratory section for more information).

The same rationale is used to eliminate crustacean parasites. Salt has been used successfully to treat anchor worm, but it is definitely not effective against fish lice. *Organophosphate pesticides (i.e. Dylox®) have been used, but as the name implies, there are human health and environmental implications involved in the use of this treatment.* Furthermore, flukes, anchor worms and fish lice have begun to show resistance to organophosphates (similar to the resistance seen in fleas, especially in Florida) and are not necessarily the best choice for treatment. There are promising new medications that might prove useful for treating these parasites, and they can be administered in the feed, but they are not fully tested yet. Dimilin® and Program® are insect growth regulators. This class of medicine interferes with the ability of some arthropods (crustaceans and insects) to form *new* exoskeleton by interfering

with chitin (an essential component of the exoskeleton) and therefore *will not have an effect on adult parasites which have already formed an exoskeleton.* Eventually, the female will be unable to lays eggs, and will fall off. A combination of an adulticide and a growth regulator would be ideal, and in some ponds, that may be possible. Aquarium Pharmaceuticals has approval for over the counter distribution of Dimilin® for most states. Check with them for current information Program® has not been researched adequately for use in koi ponds. New products are being developed, and some of them may prove to be both safe and effective. (Review this section of the AKCA Guide to Koi Health and the course textbook).

The life cycle is temperature dependent, so colder water will need to be treated for a longer period of time, or repeated more times. Most ponds will need to be treated weekly with organophosphates for 4-6 treatments to kill adults, or once, if followed by a treatment that kills the larval stages. Organophosphates are not stable at high pH. The pond should eventually clear when treated with Dimilin®, but it will take longer because it does not kill the adults. It is recommended that each user obtain EPA and applicable local environmental agency guidelines regarding safe use and disposal of treated pond water, or contact an EPA certified veterinarian or pest control company for advice. Koi are valuable pets, but caring for them should not harm the environment, other pets, or human life. The use of carbon filtration following treatment with one of these products might be one way to sufficiently remove the chemical. *Do not apply these products to ponds in which the water enters environmentally sensitive areas, or remove them first by carbon filtration.*

Leeches and fish mites are uncommonly found, but are possible parasites of koi. Salt is effective against leeches, but fish mites are more difficult to eradicate. They will not survive drying, so they can easily be eliminated from nets and objects. Mites (which are arachnids) do not have the same chitin as insects or crustaceans, and do not seem to respond to Dimilin® or insect growth regulators. Anti-mite veterinary products can be tried, but thus far, the safety of those products has not been established. It is recommended that a KHA call for help if mites are suspected.

In general, external parasites cause flashing, respiratory distress, overhydration, chronic mortalities, clamped fins, excess mucus, and decreased appetite and are often associated with a secondary bacterial infection. . All of these signs are non-specific. Typically, koi recover without the use of an antibiotic except in the extremely sick fish, which should be treated in a hospital tank. Gill and fin biopsies are indicated, and 0.2 -0.3 % salt is advisable (see the section on the use of salt in koi ponds). However, every attempt to determine the cause should be done prior to adding the salt, so that a complete and accurate assessment can be made which will enable the KHA and/or veterinarian to direct the next course of action.

Internal Parasites

Internal Parasites are not as common in koi as they are in other species of fish. Coccidia (single cell parasites that have multiple life stages including a spore or a type of dormant stage) are commonly seen in goldfish imported from the Far East. These types of parasites are undoubtedly an under-diagnosed, under recognized problem of koi. *Myxosporidia and Microsporidia* (two other groups of spore-forming single cell internal parasites) are also seen in *Cyprinids.* Spores or the growing stage of the parasites can be found in histopathology sections. The spores of myxosporozoans, which are easily identified in wet mount, can be found at necropsy. The life cycles of these parasites are complex, and undoubtedly involve an intermediate host or hosts (suspected to include one or more types of invertebrates), although some or all of them might potentially be transmitted to fish by eating dead infested fish or by passing to other fish via contact with urine or feces from a fish that is shedding these organisms. It would be nice to have a laboratory tests available for detecting carrier koi or koi that have been exposed to these parasites, but unfortunately, such tests are not currently available. No effective cure has been found for myxosporidia or microsporidia. At the present time, these parasites should be considered to be untreatable.

Single cell blood parasites and other diseases have not been found to date in koi in this practice, and based on the distribution of such organisms in other species, that may be due to the fact that those types of parasites are mostly, if not exclusively, found in tropical climates. They can be diagnosed by a veterinarian or pathologist by examining properly stained blood smears. Presumably, medicines used for treating mammals afflicted with these types of diseases can be used to treat koi, but no definitive studies have been done to support that supposition.

The most common internal parasite of other fish species is a single cell flagellated parasite called *Hexamita* or *Spironucleus.* These parasites are found in the gut and therefore can sometimes be diagnosed by finding them in fecal or stool samples. Often, though, they are only observed in post-mortem samples of gut. Although common in tropical cichlids, they have not yet been seen in this practice in koi. The type of movement that they have, which is easily seen under 40x objective of the microscope, is fast and random. The parasite itself is not easily visualized, except in special preparations. Water will often kill the parasite; so the use of normal saline (0.9%) is recommended to preserve these delicate parasites for better viewing. The preparations must be viewed immediately, since the organisms quickly die and disintegrate. Dead *Hexamita* are not easily diagnosed, except by a pathologist in stained histopathology sections. Metronidazole appears to be effective against *Hexamita.*

Parasitic round worms (Nematodes) and spiny head worms (Acanthocephalans) can live as adults in the gut, or as larvae in the tissues of fish. In practice, finding the eggs of worms in fecal samples of koi has not been rewarding thus far. Other stages of worms have been found in the muscle and gut of post-mortem examinations of many fish species, but are also not commonly found in koi. The worms found in the muscle are the intermediate stages of worms that are parasitic to other species, including humans and might be of concern to Sushi eaters. However, koi are not among the species of fish eaten (at least not the expensive show koi). Crustaceans may be the intermediate host of spiny head worms, so live food, such as water fleas or plankton, might be carriers if they are grown in the presence of the spiny head worm i.e., from a natural pond.

Digenetic (two host) trematodes, or true flukes (different from monogenetic skin and gill flukes) are parasitic in fish and have been found in carp. Although digenetic flukes can plague a fish, most often fish serve as the intermediate host for predators, including birds and humans (again, Sushi eaters beware). Snails are the carriers, so it is advisable to eliminate snails from the pond, or not introduce them in the first place. Having said that, if snails are present and have been for a long time, and no new fish have been added, then it may be advisable to leave the situation alone. It is a judgment call. Don't be fooled into thinking that one snail is harmless; snails are hermaphroditic and have been known to self fertilize in a pinch (a remarkable characteristic when you think about it). Flukes can be found in the eyes, skin and gills, among other organs. Elimination may be difficult or impossible, but Droncit® can be tried. The intermediate stage remains dormant until the fish is eaten by a predator, so although they can be unsightly, they are not necessarily dangerous to koi. However, massive numbers found in an organ can cause organ failure and death. Adult flukes can be devastating to a koi population, though, so cases of digenetic flukes should prompt the KHA to recommend the immediate removal of snails, and should then recommend contact with a veterinarian for Droncit®.

Fish, including koi, can be infested with tapeworms. All tapeworms require an intermediate host, usually thought to be a crustacean. Fish can serve as the definitive host, or intermediate host. None have been found to date in the koi examined thus far in this practice. In most species, tapeworms typically do not cause much damage but should be removed when found.

In general, internal parasites cause unthriftiness, reduced growth, and sometimes dropsy or bloat, blood loss and anemia. Stress and secondary infections are possible. All of these signs are non-specific.

Treatment is usually a medicine given by mouth or injection. Feed additives are often used when the fish are eating. Droncit® can be used against flukes and tapeworms. Fenbendazole or mebendazole have been used against adult Nematodes. From the data known from other species, round worm (Nematodes) larvae and eggs are not killed by most dewormers, so it would be appropriate to deworm at least twice at 2-4 week intervals. Veterinarians carry most of these products. No treatment used to date has been reported to be effective against Acanthocephalans. Metronidazole or Albon® (or other type of

sulfonamide antibiotic) might be effective against some species of *Hexamita* and *coccidia*, respectively. These are prescription veterinary products commonly used in dogs and cats, as well as many other species of animals.

The life cycles of all of these parasites are complex and many of them probably require more than one host, although there is still much speculation

Assessing the effectiveness of any parasite prevention or treatment program requires accurate parasite identification, knowledge of its life cycle (including any obligatory intermediate hosts), and repeated examinations. Review these sections in the AKCA Guide to Koi Health and in the textbook for this course. Parasites must be assessed by a microscopic exam on fresh samples. Even large parasites, such as anchor worm or fish lice, which can be seen without the aid of a microscope, have microscopic larval stages. A complete and accurate assessment including a microscopic exam of gill and skin is required to protect the health of koi.

Non-parasitic Infectious Diseases

Viruses- Viral diseases are suspected when no other cause can be identified, and the disease appears to be contagious. Viruses consist of a piece of nucleic acid (either DNA or RNA), often enclosed in protein or a capsule-like structure. Viruses require a host cell to replicate, although some viruses can remain infective outside of the host cell for a long time. Viruses are grouped according to similar properties of composition, methods of replication (reproduction), diseases they cause, etc. Viruses are too small to be seen with the light microscope, although some viruses cause the cell to produce structures (inclusion bodies) that can be seen with a light microscope in histology slides. Viral particles can be seen in tissues that have been processed for electron microscopy (EM), which is only available at this time for fish in research centers (far from routine). However, finding a viral particle in EM in tissues from a sick fish is a long way from proving that the virus is the cause of a disease. Verification of viral disease require several steps, including 1)identification of a viral particle in the tissues of sick fish, 2)virus isolation in the laboratory, and 3) causing the same disease with the isolated virus in another fish. If these steps are not all completed, then a virus is *suspected, but not proven* to be the cause of a particular disease. Since viral diseases are not curable, prevention (virus identification, avoidance and vaccination) is the best method of control. Many tests and vaccines have been developed to protect many species of animals, including some fish. Exposure is usually determined by assessing specific anti-viral antibodies in the blood. Virus isolation.confirms active infection. Viral DNA or RNA is detected by PCR (Polymerase Chain Reaction) tests. Since there are no commercially available vaccines to protect koi against viruses at this time, *the best way to prevent a viral disease in koi is to avoid exposure and the best way to avoid exposure is quarantine and disinfection.*

Fortunately for koi, the two most common viral diseases can be easily diagnosed without complicated laboratory tests. Carp pox is caused by a *Herpes* virus. This virus causes visible, white, almost waxy appearing small projections on the skin. This problem can be seen in one or many fish in a pond, and is most often seen during the cooler temperatures of spring. *Herpes* viruses are usually host specific; other species of fish do not seem to be affected by this virus. “Herpes” viruses have one important thing in common: infected hosts have the viral DNA in them for life, and under the right conditions (ie extreme stress), infective Herpes viruses can be shed again later in life. For koi, this means that once infected by Carp Pox, always infected. However, they probably should not be considered a risk to other fish unless “pox” are visible.

The second common virus seen in koi is *Lymphocystis (*an *Iridovirus).* Unlike *Herpes, Lymphocystis* is probably not host specific; the same “disease” is found in both fresh water and sea water fish, and current thought is that it may be caused by the same virus. This virus also causes white projections of the skin, although they are usually larger and more irregularly shaped than pox lesions. Sometimes it can be difficult to distinguish the two by just looking. However, an experienced physician, veterinarian,

pathologist, virologist or fish biologist can easily identify enlarged cells of *Lymphocystis* by doing a microscopic exam of the stained cells.

Neither Carp Pox nor Lymphocystis is considered to be lethal. Although contagious, they do not seem to spread easily to other fish in a population, and mortalities due to these viruses are almost unheard of. Affected fish can be isolated, but this is probably not absolutely necessary, unless you specifically want the population of koi to be declared free of these viruses i.e. a valuable breeding population. (See specific pathogen free—SPF fish). Fish that have had lesions at any time in their lives are *assumed* to be carriers for life, whether or not they have visible lesions. Treatment (tumor removal) is not usually necessary; unless there is a problem with eating or movement, and may in fact need to be avoided because it might release viral particles into the water. The lesions usually subside as the temperature increases, although *Lymphocystis* has a wider temperature range than carp pox. Acriflavin® reportedly can be used to treat Lymphocystis, but is not a widely accepted treatment and since it is potentially carcinogenic (cancer causing), it is not recommended for the KHA.. Both Lymphocystis and Carp Pox are self limiting, and most koi will survive infection, so treatment is usually not necessary.

Sadly, there are two other important and deadly viral diseases of koi that were recently found to be in this country: Koi Herpes Virus (KHV) (not to be confused with the Herpes virus of Carp Pox), and Spring Viremia of Carp (SVC). Tests that are currently available for SVC and KHV are virus isolation and PCR tests. In the virus isolation test, a sample of tissues is removed from the dead or dying fish, homogenized, and put into a laboratory dish containing healthy fish cells to see if the fish cells will be killed. As you might imagine, this test is highly specialized, lengthy and costly, but if the fish cells are damaged in the laboratory, there is no doubt that infective virus was present in the suspect fish.

The PCR test compares a piece of isolated, purified DNA (or RNA) from the *known virus* to the suspect tissue, and if they match, then the *presence of the viral DNA (or RNA) is confirmed*. The PCR test is very sensitive, and will detect minute amounts of DNA or RNA—an exposure to the viral DNA or RNA. However, this test is not conclusive for infective virus. Gills and mucus or skin can have pieces of viral DNA or RNA on them that are not necessarily part of an infective virus (ie, contamination from instruments, exposure from the water, hand, mucus, etc)—*a false positive*. Kidney tissues are less subject to this problem. In contrast, depending on which piece of the DNA or RNA is used to set up the test, the virus in the suspect fish might have mutated (which happens often to viruses), so it may no longer contain the specific area of DNA or RNA (known + sample) used to set up the test. The test would then appear to be negative, when in fact an infective virus is present (*false negative*).Another type of false negative can occur if the viral DNA or RNA incorporates into the host cell and does not replicate. In that case, the PCR test would be negative in all tissues except the one that harbors the silent viral DNA, and then it is almost impossible detect. Healthy, recovered fish infected with Herpes viral DNA would fall into this category of false negatives. At the time the PCR test is negative, the fish is not shedding virus, and is therefore not a risk. However, it is a potential future risk to other fish.

One of the viruses of koi known as Koi Herpes Virus (KHV) or Carp Nephritis and Gill Necrosis virus (CNGV), is *suspected* to be a Herpes virus. The virus is suspected to have come in to this country with imported fish. Several research centers have studied this virus and have published articles about this disease. At 68-85° F, KHV causes severe damage to gills, kidneys, skin and epithelial tissues; death is fast and mortality is high. (see the AKCA Guide to Koi Health and the virus alert article). Symptoms include eating until almost dead, no or minimal internal damage apart from the normal adhesions found in old female koi, damaged gills (often covered with white, yellow bacterial growth), rough skin with little mucus, and death. Some fish have an unusual notch in the nose. Large females and very young koi seem to be most susceptible. Treatment with chloramine T was found to be helpful in reducing mortalities due to severe secondary bacterial gill infection, but chloramine can also be very toxic to fish. Heating koi to 86° F for 4-5 days has been reported to improve survival, but fish that survive must be considered to be potential carriers of the virus until proven otherwise. The KHA should seek professional advice on the diagnosis and use of these treatments because of the legal ramifications. If survivors have natural immunity to KHV and do not carry the virus, then saving koi is the right move. If, however, survivors have latent virus that could reappear later, then saving koi would only keep the

virus around to infect more koi. The possibility of spreading the virus from recovered fish that might be carriers is very real, and discussions about eliminating fish that are confirmed carriers will occur over the next few years. Vaccination will be an important, welcome addition to our ability to save and protect koi.

Gills damaged by KHV

The private owner, however, is largely exempt from having to make radical choices unless they want to add to their collection or show fish in a Japanese style koi show, which is not advisable under any circumstances.

Spring Viremia of Carp (SVC) is caused by a rhabdovirus that has killed koi in Europe and other countries for years, and has now been *confirmed in koi and other carp the United States.* **SVC is a reportable disease, and if it is even remotely suspected, a qualified fish veterinarian should be contacted immediately.** If suspected, the fish should be quarantined to avoid contact with other fish. Signs of this virus include, dropsy, abnormal behaviors and mass mortality at 40-60 ° F. (Review the virus alert article and the course textbook for signs and pictures). Mortality is usually high. Unlike KHV, which seems to affect only koi and carp, this disease affects goldfish and other Cyprinids, including wild populations and bait fish. The USDA is exploring method(s) of controlling the spread of SVC in this country including quarantine, health certificates, importation guidelines, vaccinations, testing programs etc. Official guidelines should be available soon.

Vaccination will likely be the best control for most viral diseases, although with great effort and restrictions, some viruses can be prevented from entering this country. Vaccinations are also very difficult in fish because their immunity is affected by temperature. We can expect more viral diseases of koi to be identified as koi become more popular, spread world wide, and are kept in high densities. However, we can also expect more solutions, vaccines, tests, prevention measures and natural immunity to also occur. Research on these viruses is currently underway in many laboratories, so hopefully, the impact of koi viral diseases will be greatly reduced the near future.

***Bacterial Diseases*-Despite popular opinion, there are relatively few cases of primary bacterial diseases, or diseases that are *caused* by bacteria.** The vast majority of cases seen in practice to date have been secondary infections. The primary causes include any of the causes listed previously, but especially poor water quality, parasites and injury (including injury from chemicals used to treat fish). The exception to this rule is in the spring, when the water is warming and the bacteria grow faster than the koi's immune system can eliminate them (47-62º F, also known as "Aeromonas Alley"). Even so, the condition could be considered to be secondary to temperature changes. Faster warming in the spring might reduce the incidence of disease outbreaks. Another technique that shows promise is the reduction of pathogenic bacteria using probiotics. Within the past few years, commercial products have become available which seem to reduce the numbers of common bacterial pathogens from the pond water.

Though definitive testing remains to be done, it is well known that a reduction in the number of pathogens in the environment reduces the risk of infection. This is an area worth watching.

There are many times when an antibiotic is required to successfully treat koi, and injectable antibiotics are superior in effectiveness and least harmful to the environment. However, the KHA **should check their local and state laws, because in most cases, injectable antibiotics should be obtained and used under the direct supervision of a licensed veterinarian.** Alternatives such as medicated feed are less effective, but are still a minimal risk to the environment. The use of antibiotics in the pond is the least effective and the most damaging to the environment and biological filter, and should be avoided (see treatment options section). Tricide-Neo® may offer a good alternative to injectable antibiotics.

This section may be the most important section in the KHA course, because it will present a slightly different approach to the use of antibiotics in koi. However, if the KHA is successful in reducing the incidence of husbandry related diseases, there should also be correspondingly fewer cases that will require antibiotics. Accurate record keeping and more veterinary involvement should also increase the knowledge base for koi and ultimately improve the quality of care for koi.

The most common bacteria isolated from koi are species of *Aeromonas* and *Pseudomonas* (the names of the bacteria are subject to change now that DNA technology is being used to classify species of bacteria). The most common species of *Aeromonas* are *salmonicida and hydrophila*, although in the southern United States, *sobria* has been isolated relatively often. Refer to the AKCA Guide to Koi Health and the course text for details concerning antibiotics, their usage and for information about bacterial culture and sensitivity. Many species of *Aeromonas* and *Pseudomonas* live in the water and cannot be avoided. Therefore it is vital that the immune system, water quality, skin and protective mucus all remain ideal so that bacteria will be kept under control resulting in healthy koi.

Flexibacter columnaris are bacteria that can affect the skin and gills and are associated with poor water quality with a high organic load. Wet mounts of this type of bacteria can be diagnostic and will be discussed in the laboratory. They form a sort of "haystack" appearance. These bacteria are easily eliminated by cleaning up the water, and recommending salt, potassium permanganate, or sometimes an antibiotic. Another *Flexibacter* (also known as *Cytophaga psychophilia*) is known to cause ulcers and muscle damage especially near the tail fin, and deaths in cold water fish, such as salmon. If suspected in koi, the fish should be warmed if at all possible and add salt to the pond (see treatment section). In koi, antibiotics do not work below 55º F and do not work well between 55-65º F. These bacteria might be identified by experts trained to read stained preparations of skin.

The most common signs of bacterial infection are streaks of blood in the fins or under the skin, "pop-eye", sores or ulcers on the body, lack of appetite, clamped fins, faded color, dropsy or death. None of these signs are specific for bacteria, but happen commonly when fish are infected. The most common primary bacterial disease is caused by *Aeromonas spp,* which typically causes skin ulcers and is also known as hole-in-the-side disease of koi. The liver and kidney are filters of the body, and are therefore affected by bacteria as they concentrate in these organs. They also are the best organs to use for obtaining bacterial cultures, although this is only practical if the fish will be euthanized. Blood cultures are now being used and they show great promise. They have the definite advantage of not harming the fish to obtain.

WARNING! Koi have occasionally been diagnosed with *Mycobacteria*, a type of bacteria that causes Tuberculosis in humans, which can cause a disease called "fish handler's nodules". People who have cuts in their hands are at greatest risk. Fish with this disease often lose weight (although this is an unreliable sign). Suspect fish with chronic weight loss should be reported to the owner. The diagnosis is confirmed by doing special stains on infected tissue taken during a post-mortem examination. *Mycobacteria* must be distinguished from *Flavobacteria.* Water and feces can contain the bacteria, so the KHA should wear gloves to handle suspect fish or water and wash hands after handling them. The stains and diagnosis should be done by a reputable veterinarian and pathologist to avoid a mistake. **For the safety of humans**, **treatment is not recommended for a fish with *Mycobacteria.*** Soil contains *Mycobacteria*, and therefore earthworms, *Tubifex* worms and other worms are suspect carriers of

Mycobacteria to fish that eat them. Avoid feeding live worms to koi, or at least rinse them thoroughly to remove soil first (which is no guarantee, but hedges your bet).

Aeromonas and *Pseudomonas* can also infect humans.

It is recommended that people who are immunocompromised (AIDS, HIV+, chemotherapy patients, organ transplant recipients, people on corticosteroids) avoid handling sick fish and therefore should not be a KHA. When in doubt, contact your personal physician.

Fungi- There is a common external fungal problem of koi called *Saprolegnia*. It has a white cottony appearance. Unlike parasites, which live on or in live fish, *Saprolegnia* colonize dead tissue. In other words, it is a secondary problem. The primary problem or diagnosis must be determined in order to successfully eliminate this problem. . Avoidance is impossible because the fungus lives in water. Removing the dead tissue and the cause of the dead tissue will eliminate the problem. (Review the AKCA Guide to Koi Health). For the KHA, potassium permanganate baths or swabs, or Betadine® swabs of the affected area are the best two choices for very sick fish, and then an antifungal ointment can be applied on the first day of treatment. Antibiotics may also be needed if the wound is penetrating or involves an ulcer. (See AKCA Guide to Koi Health, course textbook, and laboratory manual for more details about treatment).

Although reported to be a possibility, internal fungal diseases have not yet been seen in this practice in koi. Diagnosis of internal fungal diseases in other species of fish has been confirmed by post-mortem analysis. If a diagnosis of internal fungus is made, then treatment with one of the systemic (pills) antifungals (i.e.griseovulvin) can be attempted by a veterinarian, but the owner should be given a very poor prognosis.

TREATMENT OPTIONS

Fish are sometimes difficult to treat because they live in a water environment. Regardless of how big or how many fish are kept in a pond, some treatments should be done in a separate treatment facility. The more expensive the fish, the more valuable a treatment tank may be. The tank does not have to be fancy or expensive. The least expensive method is to purchase a portable show tank, plastic storage container, (kiddy pools have been used successfully) and have a small filter and aeration available, or do daily water changes or have a slow continuous flow of water (See quarantine procedures). It is important to maintain a separate filter system to avoid cross contamination of infectious agents. There are several common types of treatments available for fish.

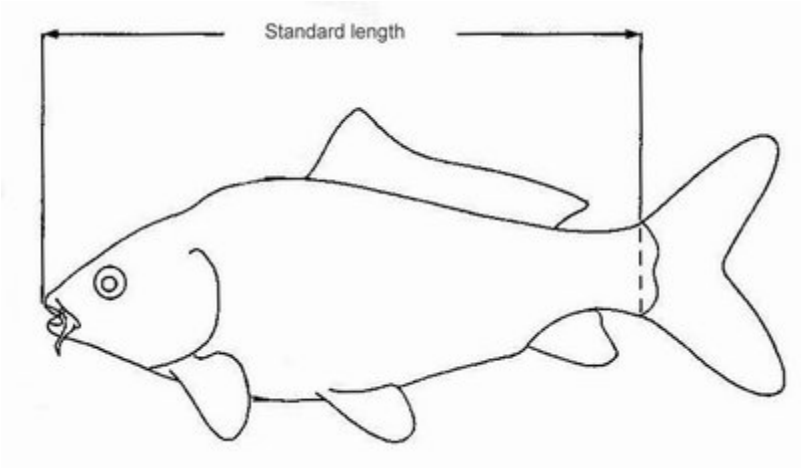
	Advantages	**Disadvantages**
Bath–treatment of all of the fish in the pond or tank.	Easy	May harm filter
IT IS THE LEAST DESIRABLE,		May be expensive
BUT SOMETIMES NECESSARY		Few medicines are effective
		May harm environment/biofilter
Can damage gills		
DO NOT USE ANTIBIOTICS IN THE POND		Difficult to remove
Dip–short term exposure of medicine in a separate bucket or tank	Easy	Must handle the fish
	Low Cost	Few medicines are effective
	Won't harm filter	Can potentially damage gills
Tricide is effective, but will kill bio-filter so keep It out of the pond		

Feed Additive	Usually Easy	May be unavailable Sick fish don't eat Difficult to dose May not be very effective Can foul water Might affect normal gut bacteria
Injections *	Precise Dosing Accurate Effective	Must handle fish Can potentially scar Might need to sedate Requires a prescription Has potential side-effects

Injections are usually only part of the treatment plan, which is based on a complete and accurate diagnosis. A total approach will be far more effective and produce superior results than a treatment aimed at only one of the problems identified.

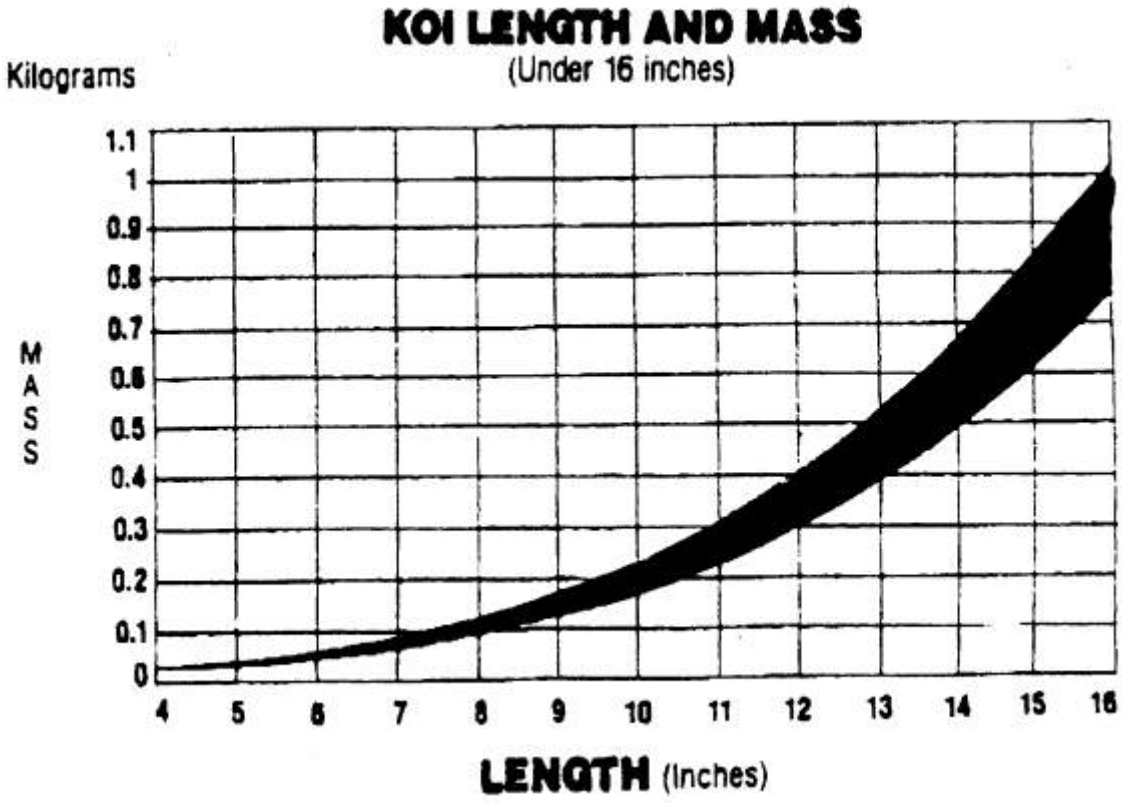
Bath and dip dosages are based on concentration and therefore the volume of water must be known. Food and injectable medicine dosages are based on fish weight. However, fish length is more easily measured than weight, and is used for koi routinely. If your fish are of average size, there is a chart that can be used to determine its approximate weight from the length. . Keep records of your own fish and determine a personal weight/length chart for more accurate results (see weight/length chart in the AKCA Guide to Koi Health. .*NOTE: STANDARD LENGTH IS MEASURED FROM THE TIP OF THE SNOUT TO THE CAUDAL PEDUNCLE, WHERE THE TAIL (CAUDAL) FIN BEGINS; TO FIND THE STANDARD LENGTH, ESTIMATE THE TOTAL LENGTH AND TAIL FIN LENGTH AND CALCULATE*

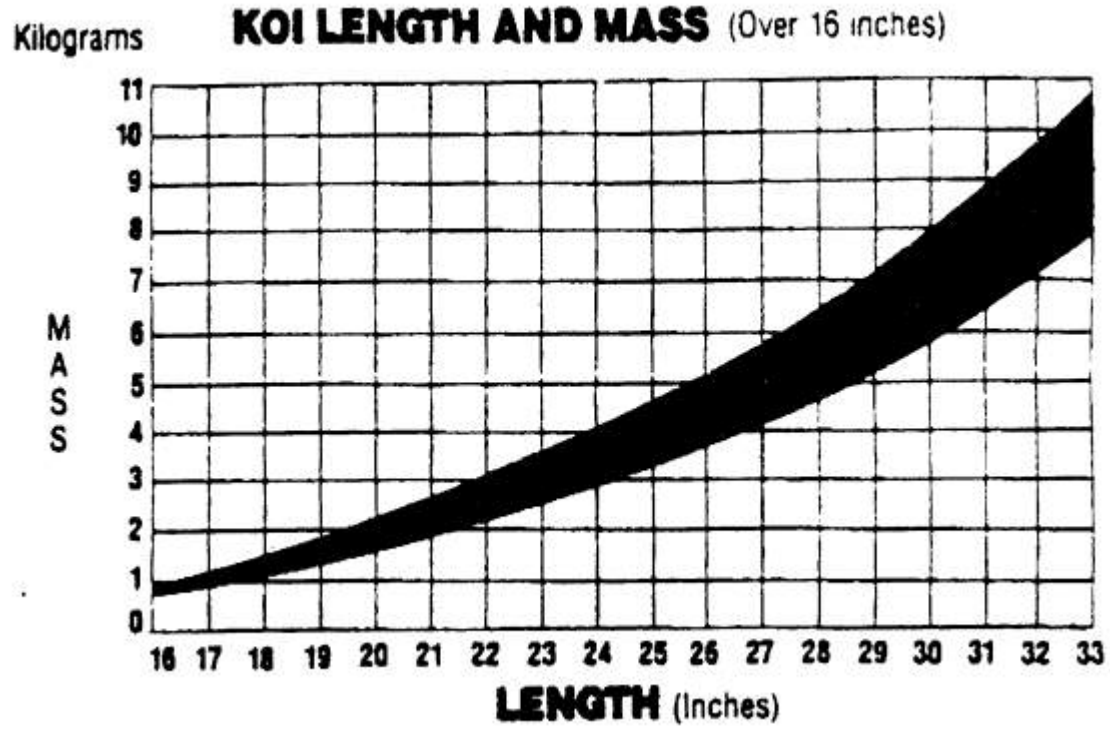
TOTAL LENGTH - TAIL FIN LENGTH = STANDARD LENGTH



The standard length (SL) of koi is measured from tip of snout to caudal peduncle, where tail fin begins. (The total length or TL, is the length of the fish from snout to end of tail fin.) Fins are variable in length, so the standard length is used. **Previous publications use total length.** Note that medicine dosages are

reported in the metric system (mg/Kg). (One inch = 2.54 cm, 1 lb = 453 g, 1 Kg = 1000g, 1 Kg = 2 . 2 lb)





Fish, like reptiles, are cold blooded; that is their body temperature changes with environmental temperatures. In order to compensate for the decreased clearance of medicine in colder temperatures, reptile veterinarians often lengthen the interval at which medicine is administered. For example, if a medicine needs to be given twice daily in a human at 98.6°F, then a reptile might only receive the medicine every 2 days at 70°F, or every 7 days at 50º F. A table of values for reptiles can be used as a general guideline for koi. The dose amount is the same, but the dosing interval is longer. This can be important in using potentially toxic medicines (such as gentamicin). The same principle applies to bath and dip treatments, too. However, that adjustment is usually to accommodate the slower growth rate of parasites in colder water, rather than metabolism of koi, since most bath/dip medicines are not taken into the koi.

The following is a general guideline for the treatment schedule of many medicines for koi:

Every 1-3 days if temp is 70-80° F

Every 4-7 days if temp is 55-70° F or 80º F+

The dosage interval is based on the Q 10 rule of chemical reactions, which states that as the temperature changes by 10º C, the rate of a chemical reaction will correspondingly change approximately 1-3 fold. The rate of change is not consistent in a biological system; it will vary as the temperature varies far from the "ideal" body temperature, which in koi is 70-75º. If a mammal, whose body temperature is 37-39º C, must have a certain medicine twice daily, then logically speaking, a fish whose body temperature is only 20º C, will need to have the medicine given much less frequently, because it will be cleared from the circulation and from the body at a slower rate.

Drug clearance also depends on the type of medicine and whether it is cleared by the gills, the kidney or liver, the method of administration, circulatory patterns, solubility and carrying capacity of the humans, and many other species (dogs, cats, horses), but research data on fish, in general, and koi, in particular, are basically not available. Drug dosages for koi (both amount and interval) are an educated guess based on basic knowledge of comparative physiology, and clinical experience. There are no hard and fast rules, but using reptile medical guidelines has been largely successful when applied to koi.

FOR BEST RESULTS:
WHENEVER POSSIBLE, SLOWLY ADJUST THE TEMPERATURE OF THE POND OR TANK TO 70-75 ºF, AND KEEP IT AT THAT TEMPERATURE DURING TREATMENT. ADDITIONAL AERATION IS RECOMMENDED WHEN ADDING SALT OR RAISING THE TEMPERATURE AND IS ESSENTIAL WHEN DOING FORMALIN OR POTASSIUM PERMANANATE TREATMENTS.

Above 85º F, when koi are usually suffering from heat stress, or below 55°F, when the koi's immune system is not fully functional, koi may not respond to treatment. Below 55º F, antibiotic treatment for bacterial infections has routinely failed.

Food treatments can be done at various intervals, depending on the medicine. Antibiotics are generally prescribed daily for 7 consecutive days.

Warning: these are general guidelines, and will vary depending on the medicine needed, life cycle of the organism being treated, and conditions under which the treatment is being done (review the AKCA Guide to Koi Health, and the course textbook).

EFFECT OF GILL DAMAGE

Fish have gills, which are filamentous organs that are in direct contact with the water (review the anatomy and physiology section of the course and supplemental texts). Gills enable the fish to breathe, of course, but they are also the primary organs responsible for water and salt balance and ammonia excretion in association with the kidneys. There are very few cell types in the gills of fish and the majority of the gills are composed of a thin epithelial cell next to a capillary cell which is a very short distance for oxygen to diffuse from the blood into the red blood cells and for carbon dioxide to diffuse out. Since oxygen levels are much lower in water than in air, the gills have a very large surface area to accomplish this task. However, this vast surface area in contact with water also makes the fish very vulnerable to insult and damage. Regardless of cause, gills can only respond to injury in a limited way: cells can die (necrosis), cells can reproduce (hyperplasia), excess mucus can be produced, and inflammatory cells can infiltrate. All of these changes cause the gill filament to thicken, which increases the distance that oxygen has to travel resulting in decreased oxygen uptake

Fish gills are also important in regulating salt and water uptake. In koi, which are fresh water fish, the fish's blood and cells are saltier than the surrounding water, so they tend to gain water and lose salt. When the gills (or skin) are damaged, then the fish tends to gain more water and lose more salt than usual. In the long run, the gills may become inflamed, may produce too much mucus, grow too many cells, and become thick with cells, mucus, fluid or dead cells, which results in the over hydration of the fish in addition to lack of oxygen. Over hydration can lead to dropsy and tissue damage. Koi can die from overhydration (the exact opposite problem of terrestrial animals or salt water fish). In fact, fish will die if kept in distilled water. There must be some sodium and chloride ions in the water to survive.

To combat this, the koi spends energy to accumulate salt from the water. There are mucus cells that protect the gills and there are support cells and capillary cells. Damage to the gills is a very serious problem, no matter what the cause, and is difficult to repair. Common causes of gill damage in order of importance include poor water quality, parasites, toxins (including water treatments), bacteria, viruses, and other miscellaneous causes including transport and handling. Experienced fish professionals assess gill damage and function as part of the examination of gill tissue taken at biopsy. This technique will be covered in detail in the laboratory.

ANTIBIOTIC USE IN KOI

Antibiotics are medicines that will control the growth of (bacteriostatic) or kill (bacteriocidal) bacteria. Bacteria can be divided into two main groups based on the composition and staining properties of the cell wall (gram – and gram +). Most fish bacteria are gram -. Antibiotics that are only effective against gram + bacteria will not be of any use for most fish pathogens. Antibiotics that are potentially useful against gram – bacteria *might* not work because the bacteria are resistant. Bacteriostatic antibiotics stop the growth of bacteria, bacteriocidal antibiotics kill bacteria. Certain classes of antibiotics are not compatible with other classes, and should not be used at the same time.

Antibiotics, like all medicines, have risks and benefits, and each side effect may be species specific. For example, Chloramphenicol can be dangerous to people because one of its potential side effects is to shut down blood cell production; therefore, it is not recommended in veterinary practice except under very unusual circumstances, and then only with warnings to owners to wash hands and use appropriate caution. NuFlor® is a member of the Chloramphenicol group. Baytril® has been known to interfere with cartilage of young growing dogs, and since fish gills contain a large amount of cartilage, the possibility exists that Baytril might damage gill cartilage. Gentamicin is known to cause kidney and ear damage in mammals, and kidney damage in fish is suspected following the use of gentamicin. None of the antibiotics have been scientifically tested on koi, although many have been used successfully. Once exposed to an antibiotic, a population of bacteria may have one or a few individuals that are resistant to

its activity and they will survive. The survivors live to reproduce an entire population of resistant bacteria, and can pass this information to other bacteria, which makes that antibiotic useless against this new population of bacteria. In other words, *exposure to an antibiotic selects for a population of bacteria that is resistant to that particular antibiotic.*

If the immune system is compromised, then treatment will fail. The immune system of koi is temperature sensitive; it is not fully functional at temperatures below 55° F. Correspondingly, antibiotics do not work at temperatures below 55°F, or when the fish is compromised by poor water quality, poor nutrition, parasites, viral diseases or anything that can reduce the function of the immune system. (Review stress in the physiology section).

Antibiotic treatment will also fail if the bacteria causing the problem are resistant to the antibiotic being used. Although there are some antibiotics that will treat some single cell parasites, they generally are only effective against bacteria, and only then with limitations. The KHA program promotes responsible, limited and appropriate use of antibiotics appropriately obtained.

The most common mistake made in the treatment of fish is the misuse of antibiotics, or using them in the absence of a complete diagnosis, (parasite, water quality or any one of the non-infectious diseases), or using them without concurrently treating the primary problem. Koi recover from many problems without an antibiotic if they are in good health and water conditions are optimal. Conversely, koi will usually *not* recover even when the correct antibiotic used, if their general health is compromised or water conditions are poor.

Antibiotics do not cure viral, parasitic or other infectious diseases or non-infectious diseases of koi unless; ***they do not cure anything****. Antibiotics are effective in reducing the number of* ***bacteria*** *so the immune system can work. If the immune system is compromised for any reason, then treatment will fail.* ***Antibiotics do not work when the water temperature is below 55º F.***

BACTERIAL CULTURES AND SENSITIVITIES

Bacterial cultures are done by a qualified laboratory from samples taken from a sick fish by an experienced person. When done properly, cultures can provide information about the particular bacteria present in a disease outbreak. The sensitivity test will provide information about what antibiotics will work in the lab and which ones show bacterial resistance, and are therefore likely to fail. Bacterial culture and sensitivity tests take days to complete because the bacteria must be grown in the laboratory, isolated, identified, and re-grown in the presence of antibiotics. Waiting days for the results can be disastrous for a population of sick koi. Generally, treatment with an antibiotic is started while the results are pending. **So why do bacterial cultures at all?** The answer is complicated, but worth the trouble. First, if the antibiotic chosen is not effective, it will tell the veterinarian which one to try next. Second, if the antibiotic used *should* be working according to the test but is in fact *not* working, then a second cause for the disease is suspected, and should be addressed. Third, fish populations have regional differences, and those differences in bacterial populations and their sensitivity patterns can be studied so that "best choice' antibiotics will be based on scientific evidence and not just trial and error. Fourth, if a fish does not respond to antibiotic *and* there is no growth of bacteria in the culture, then the disease is probably not caused by bacteria and other causes of the disease (i.e. virus or toxin) should be considered. Fifth, if a bacteria *is* isolated and *does* respond to a particular antibiotic in the lab but not in the fish, then a reason for this failure must be determined (such as inability to get into the fish, inability to get to the site of infection in the fish, immune system failure, multiple organ failure, inappropriate dosage or method of administration) and corrected if possible.

For example, bacterial cultures were helpful in ruling out bacteria in several cases in which the diagnosis still remains a mystery. In these frustrating cases, the water was checked for many toxins, nutrition and other factors were eliminated, no parasites were found, no obvious cause was identified in histopathology sections, and no bacteria were isolated. Without bacterial cultures, the disease would have been assumed to be due to some strange resistant bacteria, and indeed, it may be possible, but none

were found in histopathology either. As a result of these tests, it was reasonable to send samples to test for the new *Herpes* (KHV) virus, which was also negative. To this day, these cases remain unsolved, but there have been no new cases either. Bacterial cultures were very helpful in determining what it was not, and demonstrated that antibiotics were not useful in the treatment plan. Indeed, antibiotic treatment had failed in this case.

Details of how and when to obtain a bacterial sample will be covered in the laboratory. Review the information in the AKCA Guide to Koi Health and the textbook for these sections. Interpretation of the cultures and dispensing of antibiotics is beyond the scope of the KHA course, but questions about this subject can be addressed on line and in the laboratory during the discussion/problem solving sessions.

POND EVALUATION FOR THE KHA

Most problems of koi can be attributable to water quality that is less than ideal. However, whether the problem is bacterial, parasitic, toxic, or traumatic, **koi will not respond to treatment if water and nutrition problems are not corrected concurrently.** In fact, many problems of koi *can* be treated without prescription medication if conditions are correct. In contrast, fish that are kept in water that is less than optimal are not only more susceptible to disease, they are also much more difficult, if not impossible, to successfully treat. (Refer back to the information in the previous sections).

The KHA will need to evaluate the entire pond, beginning with a brief history. Use the history/evaluation form to formulate an idea of what is happening to the pond. The first evaluation of the fish should take place from a distance so that the natural behavior of the fish can be observed. Once this is done, the KHA should approach the pond slowly to complete the observations. The next step should be an evaluation of the water, the fish, calculation of pond volume and estimate of the number and size of the fish in the pond. Finally, the KHA should offer to examine a fish for wounds and parasites. _When all of the information is available, _discuss the findings and corrections with the owner. Finally, if the situation calls for it, the KHA should offer to contact a veterinarian for prescription medication.

The findings should be discussed in detail and recommendations should be recorded on the evaluation form. When possible, the KHA should help the owner correct the underlying problems, because treatment of any kind is doomed to fail unless the underlying problems are concurrently corrected. Know the dealers in your area, so that equipment and treatments can be made available to the owner (i.e. increase filtration, pumps for aeration, uv (ultraviolet lights), zeolites, sodium thiosulfate, Amquel®, etc.)

Once the recommendations are made, and emergency treatments have been completed, offer to return to follow up on the progress of the fish. Remember, koi are cold blooded animals, and changes occur slowly. It is not unusual for koi to take several weeks for a wound to heal. It will heal fastest when the temperature of the pond is 70-75º F. It may not heal at all at temperatures below 55º F.

KHA RECORD KEEPING

One of the most important tasks that the KHA will be doing is keeping complete and accurate records. In order to standardize the approach, it is recommended that each KHA use a single form. Not only will this simplify and standardize the evaluation of a pond, but it will also facilitate submission to a veterinarian when needed. The following forms are provided for this purpose. They may be updated or amended from time to time as the need arises. Complete the form with as much accurate information as possible. Repeat parasite checks can help eliminate the possibility of asymptomatic carriers and evaluate the effectiveness of parasite removal.

KHA INFORMATION SHEET

KHA region Date_____

Pond Location: email/contact:

History:

Quarantine?

Water Source: Tap____ Well____ Other_____

Temp ____ Ammonia ____ Alkalinity____ pH _____ Heavy Metals _____ Oxygen_____
Hydrogen Sulfide _____ Hardness_____ Other _____

Pond: size _____ shape gal_____
Calculated by dimensions ____ by salt method_____ by flow meter_____

Filter types: Maintenance:

Pump and turnover rate_____
Temp___ Ammonia ____Nitrite ____Nitrate____ pH____ _Alkalinity____ Hardness ____
Oxygen____ Heavy Metals ____Hydrogen Sulfide _____ Other :

Fish: # fish ___ Size range of fish _____ Species of Fish:

Problems:

Recommendations:

Results:

Veterinarian or Advanced Hobbyist help offered: Yes/No Help Contacted: yes/no If yes, list:

Month_____ Year _____ KOI POND DAILY LOG Owner_____

Date	temp °F	pH	ammonia NH 3	nitrite	nitrate	alkalinity	DO oxygen	chlorine	hardness	salt %	Treatment

Comments:

NOTE. Although the information obtained from cases may be reported to the AKCA, other KHAs, contributors to the KHA program, or veterinarians for the purpose of increasing the knowledge base of koi and/or for obtaining advice on a particular case, ***KHAs should refrain from using the pond owner's name in any discussions unless specifically authorized by the owner.***

DISEASE PREVENTION IN KOI

As ridiculously simple minded as it sounds, *the first line of defense for preventing diseases in koi is hand washing and disinfection of nets and equipment.* When you attend a koi show, observe the number of attendees that will handle koi without washing their hands or share nets without disinfection in between. No one would dream of doing that in a hospital, day care center, or veterinary clinic. If disinfection of equipment is difficult or impractical, such as in koi shows or high volume dealers and breeders, then it is suggested that the equipment be limited to one collection of koi.

One of the best disinfectants is dilute chlorine bleach, and is the disinfection agent of choice for tanks, and most equipment. Chlorine bleach is not only very effective, but also can be removed by water rinses and sodium thiosulfate. However, it can accelerate wear or cause damage to nets. Methylene blue, benzalkonium chloride, quaternary ammonia, potassium permanganate and Betadine® have all been used to disinfect nets. They are used in concentrations recommended for general disinfection. *ALL OF THEM ARE TOXIC TO FISH, SO NETS MUST BE RINSED WELL BEFORE USE IN THE POND OR TANK (S*ee appendix of KHA laboratory manual for more details).

So, if hands can be washed and nets and equipment can be disinfected, what else can cause disease transmission? Anything that comes in contact with fish (plants, decorations etc.) and even the fish themselves can potentially transmit an infectious disease. This does have some implications for koi shows. "Japanese" style koi shows are easier to judge, but transmission of disease is always a potential risk in this situation. No one can guarantee that diseases will not be transmitted during a koi show, but the risks can be minimized by careful screening for diseased fish and proper precautions. Ultimately, it is up to each owner to decide whether or not to participate.

One of the most important ways of controlling disease transmission from fish to fish is to quarantine.

Quarantine

Quarantine is the best method to date to screen for diseases, and prevent them from entering a pond or koi facility. There are many reasons why koi owners and dealers are not willing to quarantine. 1. There is not enough time. 2. There is not enough room or no isolation tank or facility available. 3. The owner is very anxious to view the newest fish in the pond, and the dealer is anxious to sell stock. Whatever the excuse, the outcome is frequently the same: sick or dying fish. That is to say, there is not enough time or money to do it right, but there is always time and money to correct it or do it over. In the koi world, that can mean the loss of many valuable fish.

How long should a quarantine period be? It depends on so many factors: including temperature, life cycle of the disease causing organism, condition of the koi, quality of the water, what disease you want to identify or exclude, and other factors. The most general guidelines are that new koi should be held in quarantine for at least 4-8 weeks at 70-75°F. In warmer temperatures, the life cycle of most of the common diseases are shorter, so that their presence will be known in that time period. However, in the koi world, everything is temperature dependent. "Ich", for example, will not be active at lower temperatures, but will remain alive and will begin to reproduce when the temperature is favorable ("Ich "can grow at 40-45º F, but are most prevalent at 68-77º F, which overlaps with the temperatures of "Aeromonas Alley ". The presence of both could be disastrous for the fish. Temperatures above 80ºF are usually lethal for this parasite). Healthy fish from a pond or facility with excellent husbandry will have a better chance to survive, but may also take longer to break down. A stressed fish, newly transported fish, undernourished fish, etc, may break down sooner. Some fish are believed to become asymptomatic carriers. That is, they harbor a pathogen that they are able to control, but a new host that has not seen that pathogen before will not be able to control it.

Koi have the same problem. Even healthy koi harbor a population of organisms that are harmless to them, but can be deadly to fish that have no immunity to it. National and international shipments of koi present the ideal situation for rapid transmission of disease. Documented cases of such outbreaks occur regularly, and are probably under recognized and under reported.

The KHA has the unique opportunity to have a tremendous impact on koi health by doing one simple thing: recommend and practice koi quarantine. If a disease out break does occur in quarantine, it can be quickly diagnosed, and hopefully treated before it affects other koi. Furthermore, the KHA program can record and report these findings to other members of the KHA program and the AKCA so that this information will be transmitted quickly to prevent the spread of disease.

There are many reasonable ways in which to quarantine. Proper quarantine will involve accurate evaluation of health, early detection of a problem and early intervention. There is no one best method. However, a general guideline is presented in this section. Modification of the general guideline is based on local conditions and constant updating to suit the needs of the local population.

GENERAL QUARANTINE GUIDELINES

It is recommended that owners quarantine all koi (new or returning) on the owner's property before putting into the pond. The quarantine tanks do not have to be expensive or elaborate. New plastic containers of any kind (storage, trash containers, kiddie pools) can be used, as long as they are not coated with anything that is toxic to fish. There are commercially available tanks and even show tanks have been used successfully. Quarantine tanks or facilities can also serve as treatment tanks when needed. They are well worth the investment.

Show tanks are portable and collapse for easy storage. They make good quarantine tanks. Each koi club may want to invest in one or more and rent or lend them to local members. The quarantine tank will require frequent monitoring and water changes. They should be out of the sun, easy to drain, disinfect and refill, and drained where they will not harm the environment. Quarantine tanks, like all new tanks, should be filled with water overnight and emptied. Between uses they should be disinfected with dilute bleach, rinsed and dried. There should be no residual smell of bleach. In an emergency, they can be treated with bleach, rinsed, rinsed with sodium thiosulfate, rinsed again, and then filled. After filling, test the water for residual chlorine and use more dechlorinating agent if needed.

Ideal temperature for quarantine is 70-75º F to look for signs of KHV, good healing and parasite removal. Temperature to see signs of SVC is 40-60° F, but parasites will often be missed at this temperature and ulcers or healing is very slow. Temperatures between 60º and 80º can be used. Above or below those temperatures, koi do not do well. Since quarantine is done on newly transported fish, extremes in temperatures should be avoided. Newly transported fish should be floated for a couple of hours, until the temperature is within 2-4 º. Gently transfer the fish to the quarantine tank without adding the transport water. Chances are the bag water is full of ammonia, has a low pH and is full of fecal material. These should not be added to the quarantine tank. Once in the new tank, cover the tank to darken it, aerate it, and let the fish adjust quietly to their new surroundings and water. On the first day, add 2-3 lbs of salt/100 gal of water. On the third day, a gill and fin clip can be done to evaluate for parasites, and treatment can be done. Begin feeding on the third day, but do not overfeed. Monitor water quality daily and adjust as needed. The treatments that are done in quarantine depends on the parasites or problems identified (review treatment section of the laboratory manual).

In two weeks (or longer at lower temperatures), if the fish in quarantine remain healthy, put 1-2 of your own pond fish into quarantine and maintain them for another 1-2 weeks. The new fish might have diseases that are new to your fish, but your fish might have diseases that are new to the incoming fish. Either way, the two populations need to be exposed to each other in quarantine so that problems can be dealt with in quarantine. During this time, parasite checks should be done every other day for the first week, and every 3rd day during the second week.

Water quality must be watched closely. The smaller the volume of water, the more frequently water changes will need to be done. Active bio-filters can be started with ammonia or ammonium chloride and maintained in the absence of fish. Once established, then can be fed weekly with a little ammonia or ammonium chloride and then they will be available for use in the quarantine or treatment tank. They can be kept in a small volume, such as new plastic trash containers, but they must have constant aeration for

an adequate supply of oxygen to keep the bacteria alive. Many experienced owners keep a portable filter in the main pond that can be moved to a quarantine or treatment tank as needed. This has the advantage of being ready and the disadvantage of possibly harboring disease causing organisms. This is of less importance for the owner's own fish, but is of more importance if the filter will be used for someone else's fish. Keeping a filter in reserve may also be helpful for emergencies of any kind. It's a good idea to be prepared. In the absence of live biofilters, maintain water quality with ammonia removers and /or water changes as necessary. It will not do any good to quarantine the fish for infectious disease, if they are lost to poor water quality.

THERE IS NO SUBSTITUTE FOR DISEASE PREVENTION.

GLOSSARY OF TERMS FOR THE KOI HEALTH ADVISOR

ANTIBIOTIC- A medicine that may slow the growth of, or kill bacteria. Bacteria that become resistant to an antibiotic will not be controlled when exposed to that particular antibiotic. Antibiotic resistance is a growing problem in the fish industry in America, and the patterns of resistance are changing continually. See culture and Sensitivity and bacteria.

ANTISEPTIC- A solution of iodine or other compound that can kill disease causing organisms on fish. Some antiseptics can be used on fish, but some will damage fish tissues or remove protective mucus.

AQUATIC ANIMAL HEALTH SPECIALIST- A professional who has received special training in basic water quality, aquatic animal husbandry, and fish health (including diseases, diagnosis, and treatment-- i.e. fish and wildlife students, fishery biologists, aquarists and veterinarians. However, only the veterinarian is specifically licensed to dispense prescription medication for fish. Don't be afraid to ask about someone's credentials or get recommendations before you accept advice. You would do no less to find a qualified doctor or dentist or to find a veterinarian for other pets.

ASYMPTOMATIC CARRIER - see cure.

BACTERIA-are microscopic cells surrounded by a cell wall. Some bacteria can reproduce in a little as 20 minutes resulting in a new population within a few hours. Unlike viruses, most bacteria can live outside of the host. Many are normally found in water. Some water bacteria, including Aeromonas, can cause disease in fish that are ill or injured (secondary infections). Some species of Aeromonas, like salmonicida, are thought to reside in fish tissues, and may be a primary cause of disease. Bacteria are classified as gram - or gram + on the basis of a test that stains the cell wall red (-) or blue (+). Most bacteria that cause diseases in fish are gram -. This property not only aids in classification of bacteria, but also helps determine which antibiotics are effective against them. Penicillin, for example, only works on gram + bacteria, and has little to no value in fish medicine, except in rare circumstances. Bacterial populations contain millions of cells. The odds are that at least one of them will be resistant to (unaffected by) a particular antibiotic. If an antibiotic is used in a fish to kill or eliminate sensitive bacteria, then the surviving resistant bacteria produce a new population of bacteria that are resistant to this particular antibiotic. No antibiotic removes all bacteria; an antibiotic merely reduces the number of growing bacteria to a low enough level so that the fish's immune system can, hopefully, remove or control the rest.

BIOPSY- A procedure in which a small amount of fish tissue is taken without harming the fish. The two most common biopsies are skin and gill. Samples of gill and skin taken with clean scissors are put under the microscope to look for parasites or other signs of disease. Examination of gill biopsies may also reveal changes that might suggest a water quality problem, constant irritation or even damage resulting from a previous treatment (i.e. formaldehyde). Other biopsies may require various degrees of.32
sedation or anesthesia and are done as needed, but much less frequently. Some biopsies are sent to the laboratory for processing just like human or dog samples. Information obtained from biopsies is used to determine the proper treatment and/or results of treatment.

CLINICAL CURE- is the result of a treatment that has improved fish health. No signs of the disease remain. See Cure.

CULTURE AND SENSITIVITY- Bacteria isolated from a sick fish are sent to a qualified laboratory in
a special culture swab. They are grown on a special culture plate in the laboratory, are exposed to an antibiotic, and if the bacteria do not grow near the antibiotic, they are considered to be sensitive to the

antibiotic. If they grow in the vicinity of the antibiotic, they are considered to be resistant. There is an intermediate category called moderately sensitive. This test takes days, so in general antibiotic therapy is begun before results are available. If the fish is not responding to treatment, the test will help the aquatic animal health specialist determine which other antibiotic might be used. Patterns of resistance are also helpful in determining which antibiotic to use in the first place. Once antibiotic therapy is started, cultures of bacteria are less likely to grow; so it is important to take cultures before starting an antibiotic whenever possible.

CURE- The ability of a treatment to eliminate a particular disease. Some diseases, such as a vitamin deficiency, can be cured by the addition of the appropriate vitamin in the diet or by injection. Treatment of some infectious diseases only result in a clinical cure. That is, the fish does not have any detectable signs of disease (are asymptomatic), but the cause (usually an organism) is still present, and given the correct circumstances, it will be able to cause disease again. Such fish are called asymptomatic carriers. Asymptomatic carriers are not ill; but they are not truly cured. They may transmit a disease to other fish or they may become ill themselves if they are stressed or their immune system is compromised in some way.

DIAGNOSIS- is the determination of the cause of a disease. Diseases can be infectious, non-infectious, or environmental. Infectious agents are divided into multicellular (flukes, lice), single celled animals or protozoa (Trichodina, Ich), bacteria, viruses and fungi. Non-infectious diseases include vitamin or nutritional deficiency, wounds or trauma, and tumors (cancer or benign.
Common causes of environmental disease in koi are poor husbandry and overcrowding. There can be multiple causes of fish disease and mortality. The most common cause of treatment failure is an inaccurate or incomplete diagnosis resulting in incomplete or inadequate treatment. The earlier a correct diagnosis is made, the better the chances are that the fish will be saved. Misdiagnosis or an incomplete diagnosis may not only delay help, but in some cases it has hastened the death of the fish.

DISINFECTANT- A solution used to kill disease-causing organisms on surfaces such as nets, buckets, etc. Chlorine bleach, when diluted and used properly, is one of the best disinfectants used in aquaculture. However, since chlorine is harmful to fish, items disinfected by this method must be rinsed well and/or exposed to commercially available dechlorinating agents before using them with fish. The active ingredient in most dechlorinating solutions (sodium thiosulfate) is generally regarded safe for fish even in excess, and it is recommended that all pond owners keep some in the vicinity of the pond in case of emergency. It is also the treatment of choice to remove chlorine from chlorinated tap water used in the pond. Note! *Sterilization* is the complete removal of all living and infectious particles. Disinfection only reduces the level, but some infectious particles or pathogens may remain (ie. spores). If the targets organisms are killed, then routine disinfection may be adequate for disease control (ie. control the spread of KHV). However, routine disinfection is not considered to be adequate for instruments used to collect samples for PCR testing unless the entire viral DNA or RNA is removed—sterilization is preferred.

GRANULOMA- An area of cells that appear to collect in a circular pattern around a central point, which is often a foreign substance or bacteria (such as Flavobacteria or Mycobacteria). Some granulomas are large enough to be seen without a microscope, and can cause visible bulges in the organs in which they are found. All suspicious lumps or white appearing found areas found in fish tissue should be subjected to a special stain called acid fast to search for Mycobacteria. These fish should be.33
considered to be potentially infectious to humans, and should be handled with appropriate precautions. Identification can also be confirmed by bacterial culture and sensitivity.

HUSBANDRY (koi)- The sum total of providing a proper environment and proper nutrition necessary to
keep your koi alive and healthy. Proper husbandry will allow the animals to live a longer, healthier life.
IMMUNITY- is the ability to eliminate a particular disease-causing organism. The fish's immune system is primitive compared to mammals, but is thought to function in a similar manner by producing white blood cells that either eliminate disease-causing organisms directly, or that produce antibodies (specific types of proteins) that respond to a specific type of disease-causing organism. A fish's immune system may be able to recognize a foreign substance from a previous exposure, and react faster and stronger than when first exposed (memory response), which is the basis of vaccination. NOTE! Fish, unlike mammals, are cold blooded. That is, their temperature is the same as the environment, and temperature has a profound effect on the immune system of fish. Below 50 degrees F, koi may not have a fully functional immune system, so the ability to fight off disease will be compromised.

NECROPSY- is an examination of a dead animal to determine the cause of death. It is comparable to an autopsy, which is performed on people. In some cases, information can be gained from this examination either to help the remaining live fish, or to help recover damages from loss due to lightning, poisonings, etc. Also, internal organs can be inspected in a necropsy in a way that cannot be done in a live fish, and some organ damage that was not apparent in the live fish can be ascertained. However, while necropsies can be helpful, often more information can be gained by examining a live sick fish because many parasites become undetectable and opportunistic bacteria quickly overgrow the body.

PCR- Polymerase Chain Reaction- is a test in which a sample of fish tissue is compared to a known sample of virus or pieces of viral RNA or DNA in the laboratory. The test uses a piece of known DNA or RNA to establish the presence of the virus. If the sample from a sick fish matches the known viral sample, then the virus is the likely cause of the illness. However, viruses can mutate, and mutated, infective virus might not have the exact piece of DNA or RNA from the known standard used in the test. In this case, the infective virus is in fact there, but not detected (false negative). Alternatively, the piece of DNA or RNA from a destroyed, non-infective virus can be present (in the water, on the gills, from contamination from hands or instruments in taking the samples) but not causing disease, yet it will be detected in this test (false positive) This type of test is not fool-proof, and is not very useful in screening healthy fish. It is, however, particularly helpful in identifying KHV or SVC virus in sick fish.

PRESCRIPTION- Stedman's Medical Dictionary says this:
1. A written formula for the preparation and administration of any remedy.
2. A medicinal preparation compounded according to formulated directions, said to consist of four parts: 1) superscription, consisting of the word recipe, take, or its sign, A; 2) inscription, the main part of the prescription, containing the names and amounts of the drugs ordered; 3) subscription, directions for mixing the ingredientsf and designation of the form (pill, powder, solution, etc.) in which the drug is to be made, usually beginning with the word, misce, mix, or its abbreviation, M.; 4) signature, directions to the patient regarding the dose and times of taking the remedy, preceded by the word signa, designate, or its abbreviation, S. or Sig.
The KHA needs to be aware of the legal aspects of a prescription as it relates to the Veterinary Practice Act of each state, which is : *A medication or treatment restricted for use on or by the order of a licensed veterinarian, who has examined the fish, arrived at a diagnosis and dispensed or prescribed medication for that fish or group of fish for that incidence only. The medication may not be used for any other fish or group of fish or transferred to another owner. Many medications fall into this category, but note that INJECTABLE ANTIBIOTICS USED IN KOI ARE PRESCRIPTION MEDICATIONS.* For the KHA, that means a veterinarian must be involved in obtaining and using all prescription medications, especially for koi that are not owned by the person administering the treatments.

QUARANTINE- is the isolation of fish in a separate tank with its own waer supply and filter for a few days to a month. Fish may be in quarantined anytime there is a problem that requires attention, but it is particularly valuable for new fish. Newly arrived fish will often be sick or stressed from shipment. By keeping them isolated, new fish will be able adjust to new water and surroundings, and diseases can be isolated, diagnosed and treated before other fish are exposed. Once the quarantine period is over, it may be advisable to put one or two of the established fish in the quarantine system. Then, if either population of fish has an asymptomatic carrier that can cause a disease outbreak, it will be detected before it is introduced into the pond. It is much easier to contain and treat a disease in a quarantine system than to treat a whole pond full of sick fish.

SEPTICEMIA- The condition of being septic, or seriously ill, from pathogenic organisms such as bacteria. Septicemia occurs when bacteria are present in the blood and often are found growing in multiple organs. This condition is often fatal. Blood cultures may reveal the bacterium or bacteria that are causing the disease.

SPECIFIC PATHOGEN FREE (SPF). SPF fish are known to be free of, or never exposed to, a *specific* pathogen. This does not mean that they do not have normal bacteria and organisms living on and in them. They are not necessarily free of all diseases or organisms-- it simply means that since hatching, they have been kept isolated in a facility that is known to be free of a particular or specific pathogen, which means that the fish was never exposed to a particular or specific pathogen. If a complete history is known, then the fish can be declared to be SPF fish for that particular disease (ie. KHV).

STERILIZATION- The complete removal of all living and infectious organisms by extreme heat and pressure (ie. by autoclave) or by gas (gas sterilization). Disinfection only removes some of the infectious agents, but sterilization is complete removal of organisms, spores, and anything that can cause disease. A specific targeted organism may be completely killed by disinfection, and under some circumstances that may be sufficient (ie at a koi show), but disinfection is not the same as sterilization.

THERMOCLINE- a stratified body of water in which the upper layer contains warmer, oxygen rich water, and the lower level contains colder, oxygen poor water. It is generally seen in deep, natural lakes in northern climates, and will not occur in shallow ponds that are well mixed, filtered and aerated.
VACCINES- are products made from killed or harmless disease causing organisms, introduced into the fish's body in the feed, by bath or by injection in order to stimulate the immune system. Killed bacteria can be made into bacterins, or vaccines that will protect against the specific types bacteria used in the vaccine. Viruses used in vaccines are either killed, or have decreased disease causing potential (modified live). Vaccine manufacturers provide information for administering the vaccine and its safety and effectiveness, which is dependent upon proper administration technique, storage and use in healthy fish. No vaccine will work if it isn't administered properly, and some could be potentially harmful..34 There are only a few fish vaccines available in the United States to date and even fewer available for koi. This is an exciting new field with promise for the future.

VIRUS- A microscopic piece of DNA (deoxyribonucleic acid) or RNA (ribonucleic acid) that must incorporate into a host cell to reproduce. Viruses may be host specific, such as Koi Herpes Virus (KHV), or viruses may attack many hosts (Lymphocystis virus). There is no specific treatment that will cure a viral illness. Many fish viruses have been identified, but many more will undoubtedly be discovered. To date, the only reliable method for preventing a viral illness in koi pond is early detection of a viral infection and prevention of exposure of
non-infected fish by quarantine or removal of suspect fish. Currently, there are no fool-proof diagnostic tests or
vaccines for koi viruses readily available. However, research is ongoing in this area, and both may become available in the future.

VIRUS ISOLATION- Blending or homogenizing tissues from a sick fish and adding the liquid from these tissues to a bottle of healthy fish cells to see if they healthy cells will be killed in the laboratory by a suspected virus. The test is tedious, difficult and highly specialized. If a virus is isolated, it is absolute proof that the virus was present in the sick fish. Unfortunately, because of the degree difficulty of the test,
the absence of growth does not necessarily mean that the suspected virus was not present.

GOVERNMENT AGENCIES:

EPA- Environmental Protection Agency- The body that oversees all chemicals and treatments that are applied to the water and the discharge of the water once a chemical, pesticide or treatment has been used. Specialty business inspections, discharge guidelines, pesticide licenses, water quality and soil and air pollution are under EPA jurisdiction.

FDA- Food and Drug Administration- The body that regulates medicines for all species. Some medicines are available legally over the counter, without a prescription. All prescription medications must be dispensed by or on the order of a licensed practitioner. A veterinarian is responsible for prescriptions for all species (including koi) except humans, for which licensed human medical/dental etc. practitioners are responsible.

USDA- United States Department of Agriculture- the body that is responsible for the safety of food and the health and of domestic animals, including those that that are imported into this country or transported across state lines (interstate). The USDA provides guidelines for vaccination, disease control, health certificates, and the USDA maintains an accreditation program for veterinarians to help maintain the safety of livestock, pets and any animals within the United States. Health certificates for sale or transportation of animals are overseen and regulated by the USDA and must be signed by USDA accredited veterinarians. At the present time, there is one disease of ornamental fish that must be reported to USDA if suspected: Spring Viremia of Carp (SVC). However, KHV is being studied by the USDA. Each state can issue its own health certificate requirements. At the present time, no health certificates are required for sale, importation or transportation of koi in the United States. That could change at any time.

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