IT'S ALL IN THE GENES
DOGS CAN INHERIT MORE THAN PRETTY LOOKS FROM MOM AND DAD
BY NORMA BENNETT WOOLF

Introduction

Ranger and Sassy are Labrador Retrievers. Ranger is black, Sassy is black, and they produced six black puppies in their first litter. A year later, Linda Roberts repeated the breeding; this time, there were seven puppies, five black and two yellow.

So what happened? Although they produced only black puppies in the first litter, Roberts knew that yellow puppies were possible because Ranger's sire was yellow and Sassy had yellow siblings. The appearance of yellow puppies in this litter illustrates two principles of genetics -- you can't always tell what the pups will look like by looking at the parents, and the pairing of genes is akin to a roll of the dice: it's almost impossible to predict which combinations will crop up.

The black-and-yellow Labrador example is simplistic to illustrate these principles. In reality, color inheritance is far more complex, but not nearly as complex as that affecting structure and health.

Color is actually governed by several sets of genes, some that produce the color itself, others that influence intensity, pattern, amount and distribution of white markings, or distribution of pigment on individual hairs. Structure is controlled by genes that affect bones, muscles, tendons, ligaments, and growth rate, and health depends on gene interaction as simple as that governing progressive retinal atrophy (the dog either has it or he doesn't; there's no halfway) or as complex as that influencing various autoimmune diseases, seizures, or various circulatory defects.

Genetic potential is also dependent on environmental factors such as stress, nutrition, and infectious disease. For example, a puppy that suffers from serious disease or malnutrition at a young age may never grow to the size intended in his genes.

Genes and Structure

The most common structural problem affecting dogs is hip dysplasia.

Canine hip dysplasia is a general description of malformation of the hip joint that ultimately leads to arthritis. The hip joint is a ball-and-socket arrangement that allows for mobility of the dog's rear. The ball is the femoral head, the knob at the top of the upper leg bone or femur. The socket is the acetabulum, a scooped out area on the pelvic structure. The two parts must fit together and be lubricated by sufficient joint fluid to maintain structural soundness and avoid arthritis. Hip dysplasia is joint malformation that occurs when the ball and socket are misaligned, loosely fitted, or misshapen. Dysplastic dogs experience pain, generally are not as active as healthy dogs, and may need expensive corrective surgery as they age. Hip dysplasia is an inherited condition and diagnosis before breeding is necessary to keep breeding stock healthy and limit the occurrence of the disease in offspring.

Nutrition also plays a part: studies show that puppies pushed to rapid growth manifest more hip problems than siblings allowed to grow at a slower rate. Many veterinarians recommend that puppies be fed adult maintenance dog foods with less than 25 percent protein and be kept slightly hungry so their bones are not pushed into rapid growth that may be detrimental to good hip formation.

Hip dysplasia can be diagnosed only by x-ray of the hip joint. The Orthopedic Foundation for Animals pioneered hip dysplasia diagnosis with the hip extended x-ray to check for joint malformation and arthritic changes, but its method cannot measure joint looseness.

PennHip, the method developed at the University of Pennsylvania School of Veterinary Medicine, takes up the slack; it measures joint laxity as well as identifying joint malformation and arthritic changes to help breeders decide which dogs to breed and which to remove from a breeding program. Hip dysplasia can be mild or debilitating. Mild cases may need no more than an occasional aspirin; moderate cases can be corrected by surgery, and severe cases can result in painful crippling and euthanasia, even of pups less than a year old. Myths about hip dysplasia abound and obscure both the seriousness of the disease and the opportunity to reduce its occurrence. For example, the presence or absence of hip dysplasia cannot be detected by observation. Dogs that seem perfectly agile as pups and young adults may actually be mildly dysplastic in one or both hips. Diagnosis is possible only by x-rays of the dog's hips.

Breeders can choose from several methods of hip dysplasia diagnosis. Dogs can be x-rayed as puppies and the pictures submitted to one of three registries. The Orthopedic Foundation for Animals is a nonprofit foundation that uses readings by three radiologists to read each x-ray. If the dog is less than two years old, OFA issues a preliminary hip status report. If the dog is older than two, they report that the dog is either dysplastic or not and, if not, how it rates in comparison with other dogs of its breed. This second rating is issued as fair, good, or excellent.

PennHip, the system developed at the University of Pennsylvania and now owned by International Canine Genetics, uses a series of three different x-rays to determine the dog's hip status. The Institute for Genetic Disease Control uses the same x-rays as required by OFA but will report a dog as dysplastic or not at 12 months of age. Any veterinarian experienced in x-ray procedures can take pictures for an OFA or GDC reading. Only those specifically trained in the PennHip method can submit to that registry.

The American Kennel Club includes OFA certification numbers in its records of each registered dog and prints them on litter registration papers.

Puppy buyers should ask breeders for certification that breeding stock has been certified free of hip dysplasia by the Orthopedic Foundation for Animals or PennHIP, the testing process of International Canine Genetics. In order to pass the test, dog hips must be x-rayed and evaluated by canine radiologists. OFA will evaluate x-rays of dogs two years old and older and issue a number certifying that the dog has fair, good, or excellent hips. PennHIP evaluates the hips by looking at joint looseness as well as bone formation.

Unfortunately, there are no guarantees; even if breeders go to the expense of hip x-rays and breed only those with good or excellent hips, puppies can still develop bad hips. In the past few years, some radicals have blamed purebred breeders for the incidence of hip dysplasia and used this accusation to encourage people to adopt mixed breed dogs from shelters. But the charge does not echo the facts on two fronts: actually, responsible breeders lead the effort to eliminate hip dysplasia and mixed breed or crossbred dogs can also have the disease. Any breed or mix can be dysplastic; however, there are almost no statistics regarding the incidence of hip dysplasia in non-purebreds as these dogs are seldom x-rayed.

Puppy buyers can help the effort by purchasing purebred puppies only from breeders who x-ray their breeding stock and provide a contract that stipulates some recourse if the pup does develop dysplasia. Owners or adopters of non-purebred dogs can also help by sterilizing their pets before they become sexually mature to prevent any possibility of producing affected offspring.

Other structural problems caused by inheritance are elbow dysplasia, dwarfism, osteochondrosis (abnormal formation of bone and cartilage), spinal disc diseases, Legg-Perthes disease (a hip malformation occurring mostly in small breeds), and patellar luxation (loose kneecap).

Autoimmune Diseases

This is a group of diseases marked by failure of the immune system. It includes sebaceous adenitis, pemphigus, and VKH (skin diseases); hemolytic anemia; systemic lupus; polyarthritis; and some thyroid disease. Although these diseases seem to be genetic, they are often triggered by stress. Some seem to be specific to a few breeds, while others affect many breeds. Little is known about the mode of inheritance; that is, whether they are simple as progressive retinal atrophy and sebaceous adenitis are in some breeds or are, like hip dysplasia, a complex association of many genes. Environmental influence is suspected in the onset of some autoimmune problems, but research is slow in proving a definite link.

Autoimmune diseases are the subject of many research projects. The Genatodermatosis Foundation in Dayton discovered the genetic base for sebaceous adenitis in Standard Poodles to help breeders eliminate this chronic skin disease in their dogs. Using this research as a base, GDF is now working on the disease in Akitas.

Dr. Jean Dodds has done much research in thyroid diseases, including a potential connection with the bleeding disorder von Willebrand's Disease and the influence of multivalent vaccinations on the incidence of thyroid problems.

It is possible that the incidence of autoimmune diseases follows particular lines of dogs but does not always manifest as the same disease. For example, one puppy in a litter may develop polyarthritis, while another may develop pemphigus or lupus or VKH and others may show no disease at all.

Although great strides in genetic research have been made in the past few years, researchers are barely in the doorway of full understanding of canine inheritance. Researchers at several universities are working on the canine genome project, a massive undertaking to identify the hundreds of thousands of genes situated on the 39 pairs of chromosomes that make the dog a dog. (Humans have 23 pairs of chromosomes.) They will examine blood samples from thousands of dogs and compare the results to determine the chromosomal location of traits and abnormalities. The American Kennel Club has established a genetics foundation to pursue such research, and the University of California Davis has spawned the Institute for Genetic Disease Control to provide open registries for genetic problems.

Conscientious purebred breeders join veterinarians in their concern for the genetic health of their dogs. Pet buyers can help by researching the breeds they favor, asking questions, and buying from breeders who have the right answers.