# An Introduction to **Canine** Structure

## WHAT TO LOOK FOR WHEN BREEDING FOR FUNCTION

Version 1.0

The Functional Dog Collaborative

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# A Note for Veterinarians

and other veterinary professionals

It takes a team of educated people to produce healthy puppies who will go to responsible homes. Ideally, veterinary professionals will take potential breeders seriously and offer them help.

When a future breeder shows up at a vet clinic with their young dog for routine care and is told that their breeding prospect must be neutered or spayed without further discussion from the veterinary team, it can be disheartening for potential breeders. This may cause them to move forward with their breeding plans without veterinary advice or input, as they fear judgment or dismissal. Regardless of your personal feelings about breeding, a harm reduction approach advocates for open discussion of the options available to potential breeders.

When a breeder is approaching you for your professional advice, we hope that you will discuss the pros and cons of breeding as it relates to both the individual dog being considered and the population of dogs as a whole. As time allows, we also hope that you will consider an in depth discussion about the potential gene pool, while keeping sight of the need to breed the best dogs available. When veterinary professionals or others in the animal field are approached about breeding dogs, we should be sensitive to the client's hopes and dreams for an upcoming litter, and help the potential breeder to see the traits they will be passing along. It's a fine line to travel when we want to encourage great breeding practices while being realistic about which dogs should be passing along their genetic material.

Our goal is that veterinarians can use the synopses ("100 word takeaways") in this document to discuss an individual breeding candidate's structure and behavioral health with the potential breeder, and can refer that potential breeder to the larger document for further education.

Thank you for your efforts and your contributions to ensuring a future full of happy, healthy pets.

# INTRODUCTION

Welcome to the world of breeding dogs! Regardless of what breed or type of dog you are considering breeding, we can all agree on one thing: we want to produce puppies who will live long, healthy, comfortable lives and make their people happy.

In order to achieve this goal, you need to start with a solid understanding of canine structure in general, and then work with the appropriate professionals to make sure that your dogs can pass on the desirable traits to the next generation. Consult with your veterinary team to ensure that your dogs are healthy, and to help you to better understand any specific concerns related to the dogs you plan to breed. Breeders should also consult with trainers and behavior consultants to ensure that their dogs have the desired behavioral characteristics to support their breeding goals. You will also want to consult with other breeders of the same breed or type of dog that you are considering breeding to get specific advice on what you are breeding towards or away from and how to choose a mating that will advance those goals.

This document seeks to be a resource on canine structure for those who are breeding or advising on breeding healthy, happy, stable dogs. It is by no means exhaustive, and we have included some resources at the end to help you to dig deeper once you have gone through the basics.

## THE 100 WORD TAKE AWAY

Veterinarians, trainers, behavior consultants, and other breeders are all part of the community involved in deciding to breed a given individual. We each have a different and important role to play in the process. It's important that we only breed socially mature dogs who are likely to produce physically- and behaviorally-healthy puppies. Choosing which animals to breed is a team approach that requires careful study and consideration, including input from multiple professionals.

# HOW TO LOOK AT A DOG

We all look at dogs all of the time. We see them in our homes, playing with friends, and sniffing to find just the right spot to pee. But what should we be considering when we are looking at the breeding dog?

To begin with, look at how your dog moves. Does she move smoothly and fluidly? Or does it look like every step takes effort? Is his left side moving in harmony with his right? How about his front and back legs - do they move in concert with one another, or do they look like they are fighting to see which end of the dog is stronger? Do the legs move nicely in line with the body or do they wing out to the side? If you want to learn to truly see dogs, look at as many dogs in motion as you can - try to watch hundreds of dogs. Regardless of breed or purpose, a healthy dog should move freely and easily, and should not look like motion is an effort. [1][2][3][4]

Next, get your hands on your dog's body. Feel your dog's neck, back, shoulders, pelvis, and legs. Does the left feel approximately equally muscled and strong as the right? Are there any notable areas where the dog is tender, or where something does not feel quite right? Does your dog flinch or show pain if you are manipulating any part of his body? If your dog feels anything less than strong and balanced (left to right and front to back), seek the advice of a licensed veterinarian. If the veterinarian rules out pain and your dog still objects to being touched or if she is obviously fearful, seek out the advice of a dog trainer who specializes in working with dogs with behavior issues.

Once you have a feel for the major parts of the dog, look at the details as they relate to your potential breeding candidate, and make some judgment calls. For instance, if you are breeding service dog candidates who must walk beside a power wheelchair for 14 hours a day, then a short legged breed whose ancestors dug into the burrows of vermin or a dog with a very short muzzle with trouble breathing are not likely to be successful. If you want to breed a dog who is going to enjoy fishing and camping with a family of active teenagers, then perhaps breeding back to dogs who have a double coat, who love to swim and fetch, and who have a very moderate structure is going to work well.

Remember that rejecting a dog due to a structural or behavioral issue can positively impact the future of the dogs you produce, while including a dog with a problem can have the opposite effect; you may make matters much worse for generations to come. The following sections will help you to learn about and judge the details.

## THE 100 WORD TAKE AWAY

When examining a breeding prospect, watch them in motion first. Sound, healthy dogs should move smoothly and fluidly, and should be balanced left to right and front to back. Next, feel the dog all over and note any asymmetry. Any evidence of pain should be referred to a veterinarian. Any evidence of aggression or fear should be referred to a behavior consultant or trainer, after ruling out pain. The goal of any breeding should be to produce puppies who are equally or more structurally and behaviorally sound than their parents.

# THE STRUCTURE OF THE HEAD

## MUZZLE

When examining the differences between various breeds, a major distinguishing feature is the shape of the head, specifically the length of the muzzle compared to the length of the skull. The length of the muzzle in various breeds exists on a continuum from extremely short to very long, referred to as brachycephalic, mesocephalic and dolichocephalic.

BRACHYCEPHALIC
MUZZLE SHORTER THAN SKULL

MESOCEPHALIC
MUZZLE SAME LENGTH AS SKULL

DOLICHOCEPHALIC
MUZZLE LONGER THAN SKULL

Looking at the muzzle-to-skull ratio from the side is a "down and dirty" measure. A more accurate way to do so is to measure the width of the skull relative to the total length, called the cephalic index. Learning how to measure the cephalic index goes beyond the intent of this document, but let's look at the three categories of head shapes, starting with the moderate head shape

## MESOCEPHALIC MUZZLE

The mesocephalic conformation of the head is typical of the ancestral type. We can see this proportioning in the grey wolf, who is descended from the same ancestor as the domestic dog. The muzzle is in balance with the head, and the tongue, teeth, and soft palate are proportional to the bony structure.

The mesocephalic head is the most moderate of the three types of heads, and has the fewest health problems associated with it. The mesocephalic head allows for the most normal dentition (arrangement of teeth), allowing the dog to chew, bite, gnaw, and carry things easily. A level scissor bite (see discussion of dentition, below) is the normal bite for such dogs. The tongue and soft palate are proportional to the bone structure and allow the dog to have an appropriately open airway. The nares (nostrils) are usually in proportion to the rest of the head, allowing for a clear airway. This delicate balance between the sizes of the various structures allow the dog to breathe normally both when asleep, and when awake and exercising.

Recommendations: When there is no other reason to do so, breeding towards a moderate head shape is optimal. This means that where a mesocephalic dog being considered for breeding has a slightly short muzzle, care should be taken not to inadvertently breed towards brachycephaly by choosing a mate with an even shorter muzzle. Where a dog has a slightly longer muzzle, care should likewise be taken not to breed towards an even longer muzzle in the offspring.

### THE 100 WORD TAKE AWAY

The length of the muzzle in various breeds exists on a continuum from extremely short to very long, which we refer to as brachycephalic, mesocephalic and dolichocephalic. In many ways, the mesocephalic head is the most natural shape and the type to breed towards. With all of the soft and hard tissues in balance, the dog is able to breathe, eat, chew, bite, and gnaw normally.

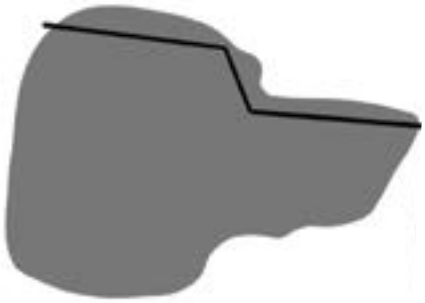
## DOLICHOCEPHALIC MUZZLE

The dolichocephalic breeds of dogs include the sighthounds and some of the herding and guarding breeds. Many of these dogs perform sight-based hunting activities.

The extremely long noses of dolichocephalic dogs may possibly have advantages in terms of dumping heat in desert-based breeds, or in allowing the dog to take larger breaths when running, but there is little research to support or disprove this. It cannot be denied, however, that the dolichocephalic head shape is most common in dogs from parts of the world that are extremely dry, such as the tundra or the desert.

There are a few issues that come up more frequently in the dolichocephalic than either the mesocephalic or brachycephalic dogs. To start with, there is evidence that the dolichocephalic dogs are more prone to getting a fungal disease called aspergillosis, caused by the aspergillis fungal spore.

[5] Overbites are common, and can cause problems if severe (see discussion of dentition, below). The eyes of dolichocephalic dogs can be affected as well. They tend to have optimal vision for predation (a wider field of vision and better distance vision), with less ability for focusing close by, and static object discrimination (distinguishing a hurdle from the ground for instance). [6] Some dolichocephalic types may be more susceptible to CEA, or Collie Eye Anomaly (see discussion of eyes, below).



MESOCEPHALIC

Recommendations:
While many people like the look of a dog who is dolichocephalic, breeding towards moderation is usually a safer bet when breeding for health.

### THE 100 WORD TAKE AWAY

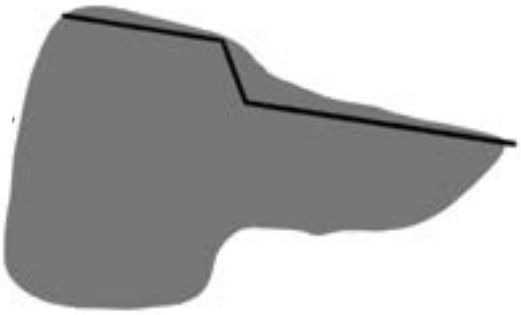
Dolichocephalic dogs may experience issues related to vision, aspergillosis, and/or dental malocclusions. Absent environmental/functional reasons (such as potential improved heat-dumping abilities due to an elongated nasal structure), it's recommended to breed towards moderation.

## BRACHYCEPHALIC MUZZLE

Brachycephalic, or flat-faced, dogs have short, round faces and eyes that face strongly forward. Brachycephalic dogs are beloved by many, and brachycephalic breeds are some of the most popular ones in many countries, probably at least in part because of the attraction many people have to their juvenile facial characteristics. [7] These extremely short muzzles are common among the toy breeds, although larger working dogs may have this structure too. Boxers, some of the mastiffs, and the ancestor of today's English Bulldog were selected to have shorter muzzles in order to provide them a stronger bite when fighting or hunting. [8]

The genetics of brachycephaly involve multiple genes. The interaction of head shape with size of tongue, soft palate, and nostrils is complex; selecting for a shortened muzzle, for example, may not result in a reduced soft palate size to go with it.

Brachycephalic breeds have very forward facing eyes and a very short nose, making them look puppy-like. As we breed dogs to be more and more juvenile-looking, their faces and heads get rounder, and their eyes appear larger, which can result in the tongue, soft palate, and teeth no longer fitting within the mouth. In extreme cases, the eyes do not fit deeply in their sockets and can be prone to proptose (move out of the socket).



DOLICHOCEPHALIC

The dogs who have extreme versions of this kind of face may need to have teeth removed because the teeth crowd one another out, become impacted, or grow crooked (see discussion of dentition, below). Additionally, because the eye size and placement are affected by the head shape, certain eye conditions are more common (see section on eyes, below).

When breeders select for a shorter muzzle but do not also select for a smaller tongue, then the tongue which might fit normally in a longer mouth becomes compressed and broadens, effectively blocking the airway, and in severe cases total airway obstruction can occur. [9] Often the soft palate will also be affected; just as the tongue may be larger than the bony structures will support, so might the soft palate be relatively oversized, sometimes requiring surgery to allow for adequate breathing. Additionally, the soft tissues of the nose may also be affected, with smaller nares (nostrils). When the tissues of the mouth and nose block the breathing of the dog, the dog may suffer from sleep apnea, and be more prone to heat stress in warm weather or during exercise.

Some brachycephalic breeds with high-domed heads are at risk of Chiari malformation and syringomyelia. These are both painful disorders characterized by a mismatch in the size of the brain and the space within the skull for the brain. Both can drastically reduce the welfare of the dogs who are affected; syringomyelia can be a particularly painful disorder. Both disorders are closely correlated with a domed head shape, and require MRI to diagnose.[10]

In terms of breeding soundness, many brachycephalic dogs have difficulty giving birth naturally, due to the combination of large heads in the neonates and small pelvises in the dam. [11] Brachycephalic dogs are more likely to require Cesarean sections [12]; abdominal surgery is painful and a welfare issue.

Brachycephalic dogs with screw tails may suffer from vertebral abnormalities; for more information, see the “Tail” section.

Canine brachycephalic obstructive airway syndrome (BOAS) is the respiratory disease related to the congenitally flattened facial and skull anatomy discussed above. BOAS causes respiratory distress, heat and exercise intolerance, and gastrointestinal signs (air swallowing). A variety of tests are available to measure exercise intolerance and impaired recovery after exercise:

- The Respiratory Function Grading Scheme (RFGS) is the best validated test with the most

evidence behind it. The guidelines for this test include breeding recommendations for dogs at each grade (0-III). This test originated in the U.K., but has now been licensed by the Orthopedic Foundation for Animals (OFA) and is available in the U.S.[13]

- If the new RFGS test is not available in your area, you may consider older tests, such as the six minute walk test (distance walked in 6 minutes is measured) or the 1000 meter walk test (duration to complete the distance is measured). Measurements are taken of the distance walked, heart rate, respiratory rate, rectal temperature, and (in veterinary studies) pulse oximetry. The dog is allowed to set their own pace and rest as needed. The heart rate is usually higher after the 6 minute walk in dogs with obstructive airway syndrome and is not significantly higher in normal dogs. Distance walked is also less in obstructed dogs (in one study, about 500 meters walked in normal dogs, compared to about 380 meters in obstructed dogs). [14][15]

Dogs with obstruction should be evaluated by a veterinarian, as obstructed breathing is a welfare issue. A veterinary specialist may recommend further evaluation with advanced imaging such as computed tomography (CT).

Recommendations:
When considering breeding a dog with a shortened nose, consider more than just the superficial look of the dog. You must also consider the internal structures of the mouth including the tongue, teeth, and soft palate to ensure that the adult dog will be able to eat, drink, run, and sleep normally. Testing is available to evaluate function and structure.

BRACHYCEPHALIC

## THE 100 WORD TAKE AWAY

Dogs with a brachycephalic head conformation are often considered highly attractive, but may be more likely to experience quality of life issues due to enlarged tongues, large teeth that may be impacted, or elongated soft palates, which may mean that the dog could require surgery simply to breathe. Brachycephaly is associated with other complications such as an increased risk of dystocia, ophthalmic issues, or vertebral abnormalities. Health testing for brachycephalic dogs will be more extensive and costly than other muzzle types.

# DENTITION

A dog's dentition or "bite" refers to the alignment of their teeth and jaws, which is crucial for their ability to eat, chew and maintain oral health.

Malocclusion, a condition where the teeth do not align properly when the jaw is closed, can occur in various forms such as overbites, underbites, crossbites, or wry bites. These misalignments can lead to issues like difficulty gripping and tearing food, which may affect the dog's ability to eat. Additionally, severe malocclusion can cause wear and tear on specific teeth, leading to discomfort, pain and potentially infections if left untreated.

SCISSOR BITE

Another condition related to the dog's bite is cleft palate, a congenital defect where the roof of the mouth has a split or opening. Cleft palates can interfere with a dog's ability to suckle as a puppy, and later affect their ability to eat and drink normally. Both malocclusion and cleft palate require veterinary assessment and, in some cases, corrective surgery to ensure the dog's bite functions properly and they can live a healthy, comfortable life.

## SCISSORS BITE

A level scissors bite is the normal bite for dogs, where the upper and lower canines interlace, and the lower incisors fit snugly under and within the upper incisors.

## UNDERBITE

An underbite in dogs, also known as prognathism, is a dental condition in which the lower jaw protrudes forward beyond the upper jaw. This results in the lower teeth overlapping the upper teeth when the dog's mouth is closed. Some dog breeds are more predisposed to underbites due to their genetics and facial structure. Examples include Boxers, Bulldogs, Boston Terriers, Shih Tzus, and Pekingese. However, underbites can occur in any breed or mixed-breed dog.

In severe cases, the lower teeth can protrude significantly beyond the upper teeth. This can lead to problems such as difficulty chewing, uneven wear on the teeth, and oral health issues.

## OVERBITE

Mandibular brachygnathic bite, or overbite, occurs when a dog's upper jaw protrudes beyond the lower jaw. As a result, the upper teeth overlap the lower teeth more than they should. Overbites can be mild or severe. Mild cases might not cause any issues, but when the dog's teeth are spaced out or do not meet properly, this may interfere with the dog's ability to pick things up, gnaw bones, or even chew food. Severe overbites can lead to dental problems, difficulty eating, or discomfort.

UNDERBITE

## WRY BITE

Wry bite refers to a condition in which the jaws are misaligned horizontally. This means that the lower jaw is shifted to one side relative to the upper jaw.

OVERBITE

Dogs with wry bite can have a noticeable asymmetry in their jaw alignment. This misalignment can affect their ability to chew properly and may cause uneven wear on their teeth.

Recommendation: severe bite misalignment or cleft palate reduce a dog's quality of life, impact its health, and can even require surgery to correct. Avoid breeding a dog with severe issues, and avoid breeding towards the extreme. Therefore, when a dog with a mild malocclusion is being considered for breeding, care should be taken to choose a mate that has more normal dentition, in order to breed away from a more severe condition.

WRYBITE

## THE 100 WORD TAKE AWAY

A dog's dentition or "bite" refers to the alignment of their teeth and jaws, crucial for eating and oral health. A level scissor bite is the normal bite for dogs, where the upper and lower canines interlace, and the lower incisors fit snugly under and within the upper incisors. When a dog's teeth are misaligned, it can impair chewing and lead to dental issues. Misaligned bites include underbite, overbite, and wry bite (which involves horizontal jaw misalignment). Severe cases may cause pain, infections, and difficulty eating. A cleft palate is a congenital defect affecting a dog's ability to eat.

# EYES

Your breeding prospect should be evaluated for healthy eyes, and genetic eye conditions should be avoided to the best of your ability. Some eye conditions that have a genetic component include:

- Cataracts
- Glaucoma
- Progressive Retinal Atrophy
- Collie Eye Anomaly (CEA)
- Entropion
- Proptosis
- Blocked tear ducts
- Distichiasis

CEA, entropion, and proptosis can be an unwanted effect of selective breeding for particular head shapes. That is, dogs with disproportionately long or short muzzles are more susceptible to certain conditions.

For example, CEA can cause small or deeply-set eyes, but can also cause retinal detachment and blindness. It is associated with the very long muzzle of the Collie.

Entropion is a condition where the eyelid rolls inward, causing the eyelashes to rub against the cornea. Entropion can lead to irritation, corneal ulcers, and vision impairment if not corrected, and can be very painful for the dog.  It is more prevalent in breeds with round heads and shorter muzzles, such as Cocker spaniel, Shar-pei, English Springer Spaniel, American Bulldog, Rottweiler, Chow Chow, and Pug, where selective breeding for skull shape, facial skin folds, and prominent eyes has increased its occurrence. [16]

With proptosis, the eyeball pops out of the socket and the eyelids collapse behind it, essentially holding the eye out. This is a disaster that can happen in any dog due to trauma (usually a dog fight or vehicular incident), but it occurs most commonly in brachycephalic breeds due to their shallow sockets and protuberant eyes. [17]

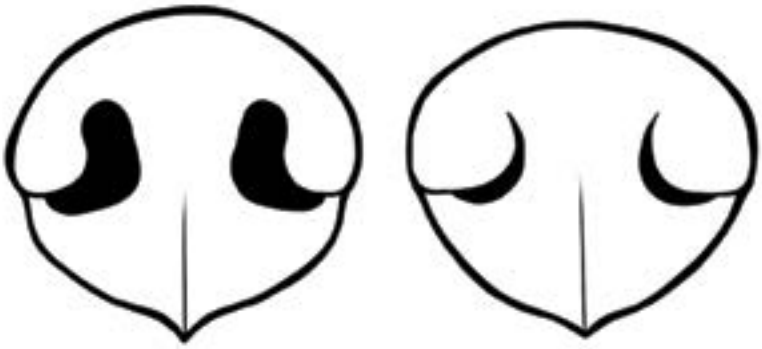
Distichiasis refers to extra eyelashes that grow in the wrong place. Treatment varies depending on the number of lashes, their location, and the severity of secondary symptoms.

# NARES

Consider a dog's nose - their most impressive organ! Used for sniffing, sneezing, panting and breathing, entire chapters are written about the dog's nose. [18][19]

From a healthy breeding perspective, however, we should focus on the nostrils. Nares (nostrils) may be open or narrow ("stenotic"). As discussed above, stenotic nostrils are commonly associated with brachycephaly and can contribute to airway obstruction. [20]

Wider nostrils are more flexible and provide for increased airflow, and the shape of the nostrils should be considered in choosing breeding pairs. Stenotic nares are a serious welfare issue and many people consider producing dogs with impaired airflow to be unethical. [20]



# EARS

So much of our dogs' distinctive appearance and character comes from the shapes of their ears, from the long, pendulous ears of a bloodhound, to the feathery wings of a Papillon, to the prick ears of the Spitz breeds. And so much of our dogs' body language is expressed through those ears!

While the appearance and movement of the ears are important to observe, there are health issues associated with ears that must be considered as well. [21] Brachycephalic breeds such as the Chinese Shar-Pei, Bulldog, and Chow Chow often have narrow ear canals, and this anatomy predisposes them to more ear inflammation and possibly infection. Excessive hair in the ear canal can lead to matting, parasites, or infection.

Chronic severe ear infections can inflame the facial nerve that runs from the brain near the ear canal. Ear problems that have gone on for a long time can cause the ear to become calcified and bone-like, often necessitating the removal of the entire ear canal, which is called an ablation. [22] If your dog has repeated ear infections, this is a consideration when breeding, as it is a heritable condition, whether it is due to anatomy or some other cause, such as allergies.

### THE 100 WORD TAKE AWAY

Consider the shape and set of your dog's ears and eyes and the shape of their nares. Avoid breeding dogs with frequent ear inflammation or infections. Avoid breeding dogs with genetic eye conditions, or with narrow nostrils that contribute to breathing problems.

# TOPLINE/BACK

The topline refers to your dog's back – literally the top "line" of the dog if you're viewing them in silhouette from the side. The shape of the topline is influenced by your dog's spine, muscles, and legs.

It can be helpful to think of a topline as a roof on a house. The roof is influenced by the size of the walls. If one of your walls is shorter than the others, the roofline will dip down on that side of the house. There are lots of different roofs that work well for different house designs. There are also many different toplines that work well for different dog "designs"!

What doesn't work well is a roof that dips down in the very middle. This is also true for dogs. While there are many different functional and useful shapes to a dog's topline and spine, a topline that dips down in the middle of your dog's spine is concerning. [2] A "sagging" topline is one that gets low in the mid-back, between your dog's shoulders and hips. If your dog has a sagging topline, consider having them evaluated by a sports medicine or rehabilitation veterinarian to assess if there is a structural issue or a core strength issue.

The best way to evaluate your dog's topline is to look at your dog standing squarely. This is sometimes called a "stack," because we hope that each piece of your dog's body "stacks" on top of other pieces in a functional way, so that all of the parts fit and work together.
To stack your dog, have them stand with their front feet even and their front legs perpendicular to the ground. Then move their back legs so that their back feet are even, and their hocks are perpendicular to the ground.

Now look at your dog's spine. Is it straight or are there some sections where it goes up or down? A straight or level topline is one that's parallel to the ground. Some types of dogs will have a roached topline or a rise over the loin, where their spine goes up over the lower part of their back and then comes back down. Many dogs that need to be extra flexible at a sprint have this structure, coupled with a longer spine. Dogs who were developed for strength will have a shorter, more muscular

topline than dogs who are bred to go fast. Some breeds are shown with a sloping topline by adjusting their rear feet to be in a different position than the traditional stack, but when that dog stands squarely you'll see that they actually have a level topline.
Sometimes a dog adopts a rounded or hollowed out topline due to unfit muscles, or even nervous tension, rather than a developmental abnormality. A good clue is if you can use your hands to correct the topline (lift under chest or belly, gently draw the rear legs further back in stance etc.).

STRAIGHT TOPLINE

ROACHED TOPLINE

SLOPING TOPLINE

If you can manually straighten your dog's topline, it is not likely an abnormality of the vertebral column that can be inherited.

When you run your hands down your dog's spine, pay particular attention to muscling, twitching, or areas of heat. Is your dog evenly muscled left-to-right? Does the skin twitch and flicker when you touch any particular areas? Are there areas of the spine that feel warmer than the surrounding tissue (indicating inflammation)? A functional spine allows your dog to move easily, without pain, at every gait (walk, pace, trot, canter, and gallop) and to change directions easily. Spines that are strong and flexible allow dogs to reach, stretch, and rest without struggle.

If there are any questionable areas to your dog's topline on visual or hands-on examination, that's a good reason to talk to your vet.

## THE 100 WORD TAKE AWAY

The topline is the area of your dog's back along their spine. Many different shapes can be functional, depending on what your dog was bred for. A sagging topline is always cause for concern. On physical examination, your dog's back should feel evenly muscled, with no areas of skin- or muscle-twitching when you stroke your dog. The temperature of your dog's back should feel even, with no hot spots (which could indicate inflammation).

# FRONT & REAR LEG ASSEMBLY

Discussions of structure often talk about a dog's "angulation." Angulation refers to the angles of the bones on the front and hind legs, and how they relate to each other. Unfortunately, angulation has not been well addressed in veterinary studies. While there is a rich understanding among the breeding and conformation communities about what is "good" or "bad" angulation and how it might affect how dogs move, we don't have scientific evidence of what the consequences of "bad" angulation are. It might lead to increased risk of arthritis in old age - or it might not. The discussion below, therefore, lays out the common assumptions about angulation, with the understanding that a wide range of moderate angulation is functional, and that variations within that range may or may not have consequences for a dog's orthopedic health.

## FRONT LEGS

In this section, we will examine the front end: the shoulder, legs, and chest. The bones of the front end are the shoulder blade, upper leg (humerus), lower leg (radius and ulna), wrist joint, pastern and paws. (See the section on paws for a more detailed discussion.) The angles of the bones in relation to each other may affect how much effort the dog's body must exert while in motion and the joints' ability to absorb the impact of walking, running and jumping. [2] The smooth versus choppy or uneven gaits that you learned to observe in the first section may be affected by the angulation of the bones. [2]

Viewed from the side, the shoulder blade slants forward about 30 degrees and the upper leg bone slants at a similar angle back toward the ground. [1, 4] The lower leg bones form a straight line to the ground. [2] Moderate angulation such as this is thought to provide adequate surface area for muscles to attach to the bones. [1,4]

While the angles of the shoulder blade and upper leg bones may be more or less slanted, excessively straight angles, leg bones that are bowed or crooked, or front legs that are too far forward or back, may cause strain on the joints over time. [2] Rotation of the ulna ("bowed" or "crooked"

front) is associated with risk of arthritis, and is associated with shortened legs (chondrodysplasia). [23]

Viewing a dog from the front, we can evaluate the angle of the shoulder blades from the top (the withers) and how much they angle away from each other around the ribcage. The shoulder blades are not connected to the body by a bony joint; the only connection is muscle.

The angle of the shoulder blade as viewed from the front is related to the "spring" of the ribs, that is, whether the rib cage is rounded or flat. A more rounded rib cage will cause the shoulder blades to angle out more from the withers, and a flat rib cage will cause more perpendicular angulation. This angle of the shoulder blades is also related to how far apart the shoulder blades are at the withers. For a medium-sized dog with a moderate rib cage, the shoulder blades are generally about 2 to 3 finger-widths apart when viewed from the above.

The leg bones should be straight and not twisted when the dog is standing comfortably, with toes facing generally forward. [1] A dog that "toes in" has feet that are turned in towards each other so that the toes point in at an angle (Pigeon-toed in humans). Toeing out is the opposite - the toes point away from each other (sometimes referred to as easty-westy). [1,3] Surprisingly, many wild canids have been observed to be easty-westy, raising questions of the utility of forward-facing toes!

## THE 100 WORD TAKE AWAY

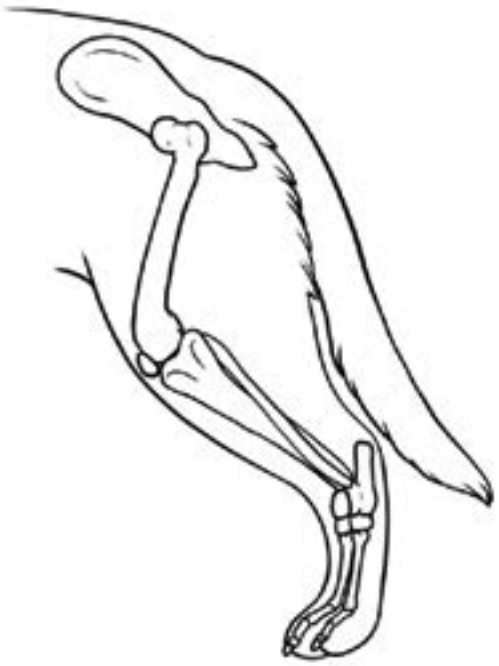
Discussions of structure often talk about a dog's "angulation," the angles of the bones on the front and hind legs, and how they relate to each other. Though there is a lack of scientific studies supporting any particular level of angulation causing or avoiding problems, it is generally accepted that a moderate range of angulation will be more functional. In a front end with moderate angulation, when viewed from the side, the upper bones of the front leg will slant at an angle toward the ground, and the lower bones will form a straight line to the ground. Viewed from the front, the lower legs will be straight and parallel. The size of the rib cage will affect the angles of the leg bones as seen from the front. The toes should face generally forward, not be pointed in towards each other or out, away from each other. The dog's motion should be smooth.

# REAR LEG

A dog's rear legs are made up of the pelvis, upper leg bone (femur), lower leg (tibia and fibula), hock joint, pastern, and paw.

The pelvis slopes at about a 30-degree angle. The angle of the pelvis is reflected in the croup, the line between the high point of the hip bones and the tail. The angle of the upper and lower leg bones should be in balance with the front, and the hock should be straight up and down.

The length of the bones in the legs affect the angles of the skeleton, as well. A sloped pelvis combined with long bones will cause crouched legs or a high back end. [1]



Both too straight and too angulated rear legs are believed to be problematic for the dog. Kinetic energy is absorbed by the body. If there is little angulation, the jolts of kinetic energy are thought to be absorbed by the bones instead of muscles or tendons, or by the spine instead of the joints. Too much angulation may cause instability or overstretching of the muscles and tendons. [2, 4] When the movements of a dog are symmetrical, their strain is distributed evenly. This way no individual joint or sinew gets excessive strain.

# FEET & PAWS

Dogs have the same bones in their feet as humans do, but they walk on their fingertips and toes. A dog's hock joint corresponds to our heel and their pastern joint to our wrist.

The shape of dogs' paws varies between breeds depending on the breed's original function. [26] Dogs that were bred to move over rocky or uneven ground tend to have compact feet (called cat feet); dogs that were bred to run fast in relatively straight lines, such as the Greyhound, tend to have a more elongated foot shape (called hare feet). In hare feet, the first and second bones of the

two middle toes are longer than those of the outer toes, so the middle toes are longer. There also tends to be less padding under the toes, giving them a longer, lower shape than cat feet. [27]

"CAT" FOOT

HARE FOOT

Many dogs have paws that are somewhere in between the cat and hare foot. They have moderately long toes and medium-thick pads. [27] However, whether compact or elongated, a dog with healthy paws will stand with its toes close together, pointed in the same direction, with the toenails pointed toward the ground and the weight distributed on all the toe pads. The angle of the pastern is thought to receive and cushion the impact with the ground and therefore should be neither too steep nor too angled. [1]

SPLAYED FOOT

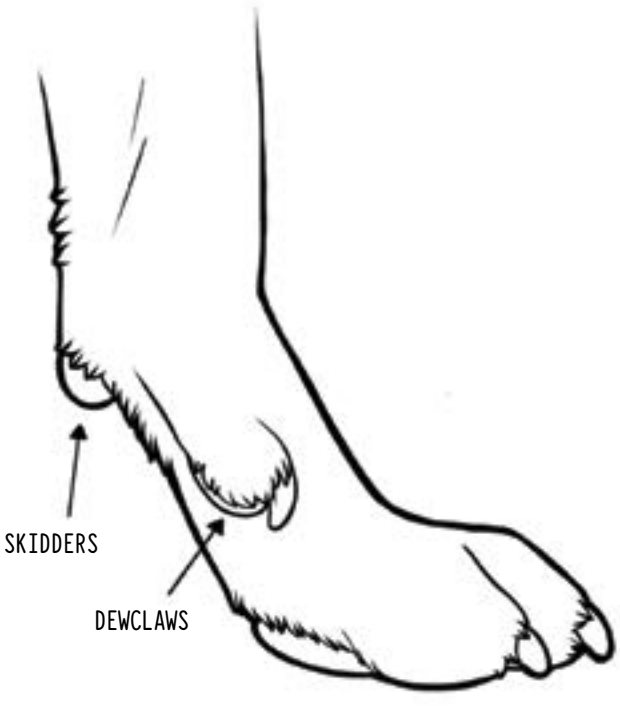
If a dog has splayed feet (the toes spread apart from each other when the dog is standing), or flat feet (the weight is on the back pad instead of the toes), the feet may be less able to absorb the impact of running or jumping, and may reduce the ability of the toes to work as a unit and increase the risk of toe injuries. [26] Splayed or flat feet may be caused by poor nutrition or environmental conditions, like standing for long periods of time on a hard surface like concrete. In that case, proper nutrition and exercise can strengthen the foot and bring the toes into alignment.

## DEWCLAWS AND SKIDDERS

You may have noticed a pad on the back of your dog's front legs. This is called the skidder, and does actually make contact with the ground at times. It protects a bone that sticks out where the pastern meets the leg bone. There is never a toenail there, and every dog has them.

All dogs are born with an extra toe on the inside of the front legs, called the dew claw. While the skidder is on the back of the leg, the dewclaw is on the side (it would be the thumb in a human). Many breeders remove puppies' front dew claws to reduce the risk of dew claw injuries. However, dew claws are often functional toes with joints and tendons like any other toe, which can help a dog dig into the ground when running or climbing. [26]

Some dogs are born with dew claws on the hind legs; those are generally vestigial and not functional, and are often removed. Some breeds tend to have extra toes or dewclaws, and those are not removed.




### THE 100 WORD TAKE AWAY

Dogs' paw-shapes are described as hare foot, cat foot, or in between. While one is not better than the other, they may function better in one environment or another. Consider leaving dew claws intact and discuss with your veterinarian whether vestigial toes should be removed.

# TAIL

One of the things we most love about our dogs is being greeted with that happy tail wag at the end of a long day. Dog's tails do more than wag with joy, though. From a slow, stiff wag held high over the back showing arousal (and not always the friendly kind), to the clamped-down tail of a dog in fear, dogs communicate with other dogs and with us humans using their tail.

Tails have other functions as well, from helping with balance, to midair adjustments while jumping, to swatting insects and controlling scent. [4]

The main distinguishing feature between different dogs' tails is the tail "set," that is, the placement in relation to the spine and hind legs. A dog's tail can be high set, low set, or in between.

Aside from the set, the appearance of a tail is influenced by the coat and the shape of the tail itself. The shape can vary from a slight curve to coiled. Very long, thin tails can be prone to injury when the dog strikes it on furniture or other objects while wagging or playing ("happy tail").

Very short tails are caused by genetic changes to the spine that can cause or contribute to health problems. Short, curly tails, known as "screw tails," are part of the standard in Boston Terriers, English Bulldogs, and French Bulldogs. This tail type is caused by vertebral malformations which are associated with a kinked spine ("kyphosis") [28], which in turn is associated with neurologic disorders and can increase the risk of disc herniation [29,30]. The curly but not short Pug tail is also associated with vertebral abnormalities [29]. Short tails can obstruct the anus or grow back into themselves, causing pain and potentially requiring surgical correction.[31]

### THE 100 WORD TAKE AWAY

Consider the shape and set of your dog's tail. Is it set high or low? Does it have a pleasant shape? Does it get injured easily? Avoid short, kinked tails, which are the result of vertebral changes and can cause health problems.

# REPRODUCTIVE ANATOMY

## MALES:

Male dogs should have two visible testicles that are located in the scrotum. Testicles that are located in the abdomen or inguinal region are called "cryptorchid." A dog can be a unilateral or bilateral cryptorchid, depending on whether one or both testicles are undescended. Cryptorchid testicles are a health risk, as they can twist ("torsion") and are at higher risk of testicular cancer. Therefore, they should be removed. A bilateral cryptorchid dog will almost certainly be sterile; a unilateral cryptorchid will not. Because of the health risks and because cryptorchidism is heritable, cryptorchidism is considered undesirable in a breeding dog.

## FEMALES:

Heat cycles will vary depending on size, breed, and lines. Unpredictable or irregular heat cycles, “silent” heats, and split heat cycles may have a genetic component and should be considered carefully in breeding decisions.

Recessed or “hooded” vulvas refer to when the external genitalia has excessive tissue or inadequate clearance from the body, which can cause moisture to pool or collect inside the vulva when the bitch urinates. This predisposes bitches to urinary tract or yeast infections. [32] While this issue sometimes resolves after the first heat cycle, it may have a genetic component and should be considered carefully in breeding decisions, especially if some of the offspring are likely to be neutered prior to sexual maturity.

### THE 100 WORD TAKE AWAY

Male dogs should have two visible testicles that are located in the scrotum. In females, unpredictable or irregular heat cycles, “silent” heats, and split heat cycles may have a genetic component and should be considered carefully in breeding decisions. Recessed or “hooded” vulvas predisposes bitches to urinary tract or yeast infections. This issue may have a genetic component and should be considered carefully in breeding decisions, especially if some of the offspring are likely to be neutered prior to sexual maturity.

# OTHER CONSIDERATIONS

This document focuses on canine structure, but there is much more to breeding a healthy dog, and not enough space to cover it all here!

Behavioral traits are dependent on the genetics of the parents, the dam’s stress levels while pregnant, the kind of care the dam provides, how the puppies are socialized before they go home, what kind of home they go to, and more. While covering behavior is outside of the bounds of this document, selectively breeding for and supporting resilient dogs is a critical piece of the puzzle of good breeding practices. Canine body language and behavior is just as crucial a part of a breeder’s education as is canine structure.

Similarly, there is more to physical health than structure, and any breeding dog should be carefully assessed to ensure they are healthy. This includes not only genetic testing for known genetic dis-

orders, but health screening appropriate for the breed or mix. What's "appropriate" varies widely based on the dog's breed ancestry and the breeder's goals for them, so, again, it's outside the scope of this document. Learning what appropriate tests are for your breeding stock is another equally important piece of the puzzle.

# CONCLUSION

There is a lot to consider when choosing to breed a dog. Ethical breeding decisions prioritize the health and welfare of the puppies, and the suitability of the offspring for their intended homes. The goal is ultimately to produce healthy puppies that will thrive in the environment they will find themselves in, whether that be farm, city, or suburban family home. When selecting a breeding pair, breeders must weigh each dog's strengths and weaknesses, striving to complement and improve upon areas of concern rather than doubling up on faults. We hope this overview has given you a chance to look at your dog in a new light, enjoy their strengths, and make educated choices about whether they are a good candidate for breeding. For more information, check out the Functional Breeding group on Facebook.

# CREDITS

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