

Anatomy and Physiology Part 3

Lymphatics ~ Respiratory ~ TMJ

When we meet for Level 3 you will be learning 3 procedures.

The Lymphatic Procedure

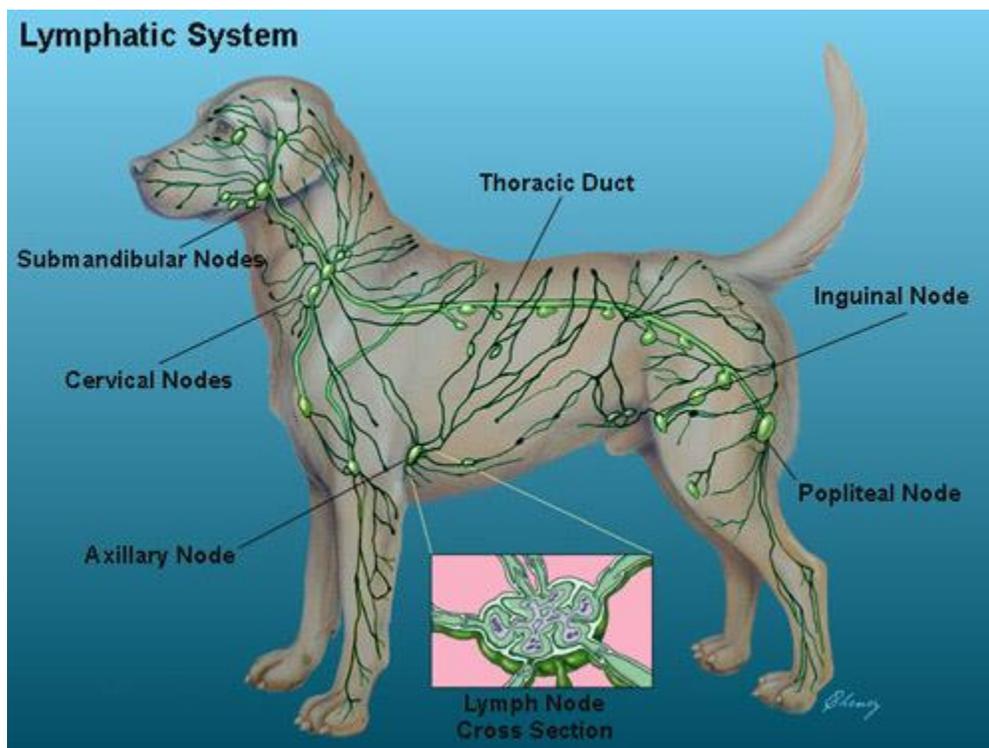
The Respiratory Procedure

The TMJ Procedure

The following questions are geared to give you background knowledge of the three.

The Lymphatic System

1. Provide a diagram of a Canine Lymphatic System.



pmhtherapy.com/wp-content/uploads/2012/03/canine-lymphatic-system2.jpg

The lymphatic system of dogs and many other mammals including cats, rabbits, cows and pigs are quite similar to that of humans. The design, purpose and location mirror our system. The Lymphatic System is responsible for keeping interstitial tissue throughout the body free of toxins, cellular waste, bacteria, infections, etc... Often the immune system becomes compromised if the Lymphatic System is not cleaning and clearing itself

properly. Manual Lymphatic Drainage (MLD), hands-on therapy, will help to optimize, improve and maintain your animal's health!

2. What is the Lymphatic System?

What Is the Lymphatic System? A dog's lymphatic system is a complex and vital system primarily responsible for the transportation of lymph and for participating in many immune functions of the body. The lymphatic system occurs throughout the body and is made up of small glands called lymph nodes, which are connected to each other by a series of vessels called lymphatics. Other important organs in this system include the bone marrow, spleen, thymus and gut-associated lymphoid tissue (GALT), which is the lymphatic tissue associated with the gastrointestinal (GI) tract. Read more at: <http://tr.im/sIMu6>

Where Is the Canine Lymphatic System? The lymphatic system is located throughout the body and has many components: Lymph nodes or glands are small round, oval or bean-shaped structures that are located at various locations throughout the body. The lymph nodes are connected to each other by a series of vessels called lymphatics, which carry lymph from place to place. Some lymph nodes lie along the surface of the body (along the neck, under the arms, in the groin, behind the knees), while others lie deep within the body (chest and abdomen). The bone marrow lies within the central shaft of bones, primarily the long bones of the body. The spleen is located near the stomach in the left forward part of the abdomen. The thymus is located in the front part of the chest cavity, between the trachea (windpipe) and the ribs. The GALT is made up of lymph tissue scattered throughout the GI tract including the tonsils and intestines. Read more at: <http://tr.im/sIMu6>

What Is the General Structure of the Lymphatic System in Dogs? The lymphatic system is composed of a network of lymph vessels referred to as lymphatics, as well as certain organs and tissues, including the lymph nodes, bone marrow, spleen, thymus and GALT. Lymph is a milky fluid that flows throughout the system. It contains proteins, fats and a type of white blood cell called lymphocytes. Lymph is collected from the fluid of various tissues and eventually is returned to the blood circulatory system. The lymphatic system provides another route by which fluid can flow from distant tissues back into the blood stream, one that is separate from capillaries and veins. It also carries proteins and other substances away from tissues that cannot be removed or transported directly into the blood system. Similar to the blood circulatory system, the lymphatic system is comprised of fine channels that lie adjacent to the blood vessels. These lymphatic vessels eventually merge into a rather large vessel called the thoracic duct. As the lymph is carried from distant parts of the body, it is collected into larger and larger vessels until the vessels all converge in the chest and deposit the lymph in the large vein (cranial vena cava) leading to the right atrium of the heart. The lymph moves through the lymphatic vessels toward the lymph nodes. The lymph nodes lie at varying points along the course of the lymphatic chain and can form clusters in some areas of the body. Lymph nodes have a dense fibrous outer coating, called a capsule and are filled with white blood cells and spaces containing lymph fluid. Several types of white blood cells predominate in the lymph

nodes, particularly lymphocytes, plasma cells, and macrophages. The bone marrow consists of connective tissue, the cells of which form a delicate meshwork within the marrow cavity. The marrow cavity is permeated by numerous thin-walled blood vessels. Within the spaces of this tissue, the immature and adult stages of different blood cells exist. The spleen is the largest body of lymphatic system. It is a dark red organ that is supplied with numerous blood vessels. A tough capsule of fibrous tissue covers the spleen. The splenic "pedicle" is located along one surface and serves as the entry and exit point for blood vessels. The internal structure of the spleen consists of: Red pulp – areas for red blood cell storage and for the trapping of immune proteins called antigens White pulp – areas of special immune response cells called lymphocytes and reticuloendothelial cells Marginal zone – an area that separates the white and red pulp and helps to filter the blood The thymus is an organ that varies in size depending on the age of the individual. It is largest in young animals and shrinks to a very small size in the adult. GALT is present throughout the gastrointestinal tract. Peyer's Patches are aggregates of lymphoid tissue found in the small intestine and are a type of GALT. Read more at:

<http://tr.im/sIMu6>

What Are the Functions of the Lymphatic System in Dogs? The lymphatic system has several very important functions: absorbing excess fluid from tissues and returning it to the bloodstream, absorbing fat from the gastrointestinal tract, transporting white blood cells and certain proteins, and playing an important role in the immune system, particularly in the production of antibodies (immunoglobulins). The lymphatic system filters and removes debris from the tissues of the body. Cells produce proteins and waste products. The lymph absorbs these products and carries them away from the tissues because they are often too large to be effectively absorbed and removed by the bloodstream. The lymphatic system, functioning along with the circulatory system, absorbs nutrients from the small intestines. A large portion of digested fats is absorbed via the lymphatic capillaries. Fat absorbed from the small intestinal lymphatic capillaries or lacteals is termed chyle. The lymph nodes filter out cellular waste products and foreign material in the lymph fluid, including potentially dangerous infectious particles like bacteria and viruses. They trap material received from the lymphatic vessels and provide a site for white blood cells to mount an immune response. They act as a barrier against the entrance of these foreign substances into the bloodstream. The chief function of the bone marrow is the production of various red and white blood cells. The spleen is an integral part of the immune system and it filters abnormal cells from the blood. It also helps make and store blood cells. The thymus is a very important part of the immune system in the newborn. It is the site where the earliest immune cells are made and where immune functions take place in the young animal. GALT's main function is to provide immunologic defenses at the surface of certain areas of the body, such as the tonsil and the lining of the intestinal tract. These are areas where the body is often exposed to foreign materials and infectious agents. Read more at:

<http://tr.im/sIMu6>

What Are Common Diseases of the Canine Lymphatic System? Due to the distribution and complexity of the lymphatic system, many disorders may affect all or some part of it. The most common disorders seen in dogs include the following: Lymphoma or lymphosarcoma is a tumor

of white blood cells. It is a malignant cancer, and it may affect one or more parts of the lymphatic system. Lymphoma may occur as a solid tumor associated with the lymph nodes, the intestines, kidneys, liver, spleen, thymus or other parts of the body. It may also develop as a circulating form that is confined largely to the bone marrow and blood stream. Lymphoma is one of the most common cancers seen in dogs, and has been treated with chemotherapy protocols for a number of years. Lymphadenopathy is enlargement of the lymph nodes. It may represent lymphosarcoma, but may also develop for other reasons. Lymph nodes may enlarge when they are reacting to foreign substances or infection. They become larger as white blood cells proliferate within the nodes. Such reactions may also occur following vaccination or with any chronic inflammation within the body. Lymphadenitis is inflammation of the lymph nodes. It may involve one or several lymph nodes, depending upon the cause. Common causes include wounds, skin infections, infections within the soft tissues of the body, nonlymphatic tumors, and areas of active healing. Chylothorax is the accumulation of chyle in the chest cavity from rupture, obstruction, or abnormal development of the thoracic duct. It may develop secondary to heart disease, tumors of the thorax, diaphragmatic hernias, trauma, fungal infections, heartworm disease, and for unknown reasons. It is more common in Afghan hounds and Shiba Inu dogs than in other breeds. Lymphangitis is an inflammation of the lymph vessel. It often arises from trauma, foreign bodies, and infections. It may occur at the same time as lymphadenitis. Lymphangiectasia is an obstructive (blockage) disorder that causes dilation of the lymph vessels, particularly in the intestinal tract. Lymphedema is an accumulation of lymph in the soft tissues of one or more of the limbs. Congenital forms occur in some dogs (e.g. poodles, Labrador retriever, Great Dane) due to deformities in either the lymphatic channels or the lymph nodes themselves. Acquired forms may occur with blockage or destruction of lymph vessels from trauma, surgery, inflammation, infection, tumors, or radiation therapy. In some cases the soft tissue swells so much that the limb may be painful or dysfunctional.

What Types of Diagnostic Tests Are Used to Evaluate the Lymphatic System in Dogs? Several tests are particularly helpful in evaluating the lymphatic system. Depending on the part or parts of the lymphatic system involved, a combination of tests may be recommended by your veterinarian. A complete blood count (CBC), biochemical profile, and urinalysis are recommended to help evaluate organ functions, to detect evidence of infection or inflammation throughout the body, and to assess the types of white blood cells present in the circulation. Blood tests that screen for infectious diseases such as the systemic fungal infections, the tick borne diseases and certain bacterial infections (e.g. brucellosis) may be of benefit in cases with lymphadenopathy or abnormal circulating numbers of white blood cells. Chest and abdominal X-rays and ultrasonography are useful to evaluate abdominal organs including the spleen, intestines, liver, kidney and abdominal lymph nodes. They also detect the presence of fluid in the chest, such as in the case of chylothorax. A bone marrow aspirate or biopsy is performed for diseases involving the bone marrow. Fine-needle aspiration of enlarged lymph nodes or other abnormal tissues, followed by cytology (microscopic analysis of the cells) may be diagnostic for lymphoma, reactive lymphadenopathy or lymphadenitis. In some cases an actual biopsy (piece of tissue) is needed for diagnosis. Analysis of fluid retrieved from the chest can confirm

the presence of chylothorax. Bacterial cultures may be submitted if bacterial infections are suspected Read more at: <http://tr.im/sIMu6>
<http://www.petplace.com/article/dogs/diseases-conditions-of-dogs/body-structure-function/structure-and-function-of-the-lymphatic-system-in-dogs>

3. Describe Lymphatic congestion.

Lymphangiectasia is a pathologic dilation of lymph vessels.^[1] When it occurs in the intestines of dogs, and more rarely humans, it causes a disease known as "intestinal lymphangiectasia."^[1] This disease is characterized by lymphatic vessel dilation,^[2] chronic diarrhea and loss of proteins such as serum albumin and globulin. It is considered to be a chronic form of protein-losing enteropathy.

It is also known as "lymphangiectasis".^[3]

Cause[[edit](#)]

Biopsy of the small intestine shows dilation of the lacteals of the villi and distension of the lymphatic vessels.^[4] Reduced lymph flow leads to a malabsorption syndrome of the small intestine, especially of fat and fat-soluble vitamins. Rupture of the lymphatics causes protein loss into the intestines.

The most common cause of lymphangiectasia was congenital malformation of the lymphatics.^[5] Secondary lymphangiectasia may be caused by granulomas or cancer causing lymphatic obstruction, or increased central venous pressure (CVP) causing abnormal lymph drainage. Increased CVP can be caused by pericarditis or right-sided heart failure. Inflammatory bowel disease can also lead to inflammation of the lymphatics and lymphangiectasia through migration of inflammatory cells through the lymphatics.^[6]

Signs and symptoms[[edit](#)]

Chronic diarrhea is almost always seen with lymphangiectasia, but most other signs are linked to low blood protein levels (hypoproteinemia), which causes low oncotic pressure. These signs include ascites, pleural effusion, and edema of the limbs and trunk. Weight loss is seen with long-term disease.^[6]

Diagnosis[[edit](#)]

Diagnosis is through biopsy. The presence of hypoproteinemia, decreased blood lymphocytes, and decreased cholesterol support the diagnosis. Hypocalcaemia (low calcium) is also seen due to poor absorption of vitamin D and calcium, and secondary to low protein binding of calcium. Medical ultrasonography may show striations in the intestinal mucosa indicating dilated lacteals.^[7]

Treatment[[edit](#)]

Treatment is multifactorial. A diet very low in fat and high in high quality protein is essential.^[8] Treatment of humans can also involve the use of MCT (medium-chain triglycerides) oil and/or the drug Octreotide. In dogs, fat soluble vitamins (A, D, E, and K) should be supplemented. Corticosteroid treatment may be required for life. Antibiotics can be used to treat bacterial overgrowth. With a very low serum albumin, transfusion with blood plasma or an infusion of hetastarch may be necessary to treat the signs until the diet can take effect.^[9] Lymphangiectasia is rarely cured but can remain in remission for a long time. It can be fatal when unresponsive to treatment

Affected breeds[[edit](#)]

Breeds commonly affected by lymphangiectasia and/or protein-losing enteropathy include the Soft-Coated Wheaten Terrier, Norwegian Lundehund, Basenji, and Yorkshire Terrier.^[10]

<https://en.wikipedia.org/wiki/Lymphangiectasia>

4. What are the signs and symptoms of Lymphatic congestion?

Symptoms of Canine Lymphoma

The symptoms of lymphoma usually commonly mimic the symptoms of many other diseases or disorders. Most owners of dogs with multicentric or disseminated lymphoma first find pronounced enlargement of the lymph nodes on the underside of their dog's neck, beneath and slightly behind the chin. These are the submandibular lymph nodes (the mandible is the lower jaw bone). Affected dogs normally do not seem painful when their submandibular lymph nodes are palpated and show no other unusual symptoms. Other signs that owners may notice include one or more of the following:

- Depression
- Lethargy (profound)
- Exercise intolerance
- Fever
- Dehydration
- Weight loss
- Loss of appetite (inappetance; anorexia)
- Vomiting
- Diarrhea
- Constipation
- Dark tarry stool (melena; digested blood showing up in the stool)
- Distended abdomen
- Abdominal discomfort
- Increased thirst and intake of water (polydypsia)

- Increased volume of urinate (polyuria)
- Cough
- Difficulty breathing; shortness of breath (dyspnea)
- Difficulty swallowing
- Drooling
- Skin nodules or masses (single or multiple)
- Skin scaling
- Bruised or ulcerated skin lesions
- Hair loss (alopecia; uncommon)
- Itchiness (pruritis; uncommon)
- Neurological signs: circling, disorientation, lack of coordination (ataxia), seizures, behavior changes, vision abnormalities

Multicentric lymphoma - usually shows up first as painless but enlarged peripheral lymph nodes. Owners may see or feel these in areas under the jaw, in the armpits, in the groin area or behind the knees. Enlargement of the liver and/or spleen can also occur, causing the abdomen to distend. This is the most common form of lymphoid cancer in dogs.

Gastrointestinal (alimentary) lymphoma - is a malignant form of cancer that can show up anywhere along the gastrointestinal tract (stomach, small intestine, large intestine, rectum). Clinical signs of gastrointestinal lymphoma include vomiting, diarrhea, weight loss, lethargy, depression, diarrhea and melena. Low serum albumin levels and elevated blood calcium levels commonly accompany alimentary lymphoma, although these can only be detected by veterinary evaluation of blood samples. This is the second most frequent form of lymphoma in dogs.

Mediastinal lymphoma - where the cancer is localized to tissues in the chest cavity - can cause fluid to build up around the lungs. This can lead to coughing and labored breathing (dyspnea), mimicking the signs of congestive heart failure.

Lymphoma of the skin (cutaneous lymphoma) - is uncommon in dogs. When it does occur, it usually shows up with hair loss (alopecia) and visible bumps on the skin. It can also be itchy (pruritic) and vary widely in appearance, ranging from a single lump to large areas of bruised, ulcerated and/or hairless skin.

Lymphoma of the central nervous system (CNS) - is very uncommon in dogs. When lymphoma is localized in the CNS, dogs typically present with neurological signs such as circling, seizures, behavior changes and incoordination.

Dogs at Increased Risk

Lymphoma is most common in middle-aged to older dogs, although dogs of any age can be affected. There is no recognized gender predisposition for this disease. However, some breeds reportedly have an increased risk of developing lymphoma, including the Golden Retriever, Basset Hound, German Shepherd, Boxer, Scottish Terrier, Airedale Terrier, Bulldog, Poodle and Saint Bernard. A strong familial association has been established in some lines of Bull

Mastiffs, Rottweilers and Otter Hounds. Pomeranians and Dachshunds reportedly have a decreased risk of developing lymphoma. The reasons for these breed differences in risk of lymphoma development are not well understood.

There may be an association between canine lymphoma and exposure to certain environmental herbicides, household or agricultural chemicals, smoke and/or electromagnetic radiation, although the reason for the connection remains unclear. Dogs living in industrial areas where paints, solvents or other chemicals are common tend to have a higher incidence.

Goals

The objective therapeutic goal is to achieve complete remission of the cancer. Subjectively, the goal of treatment is to restore the patient's pain-free quality of life for as long as possible. Chemotherapy protocols are complicated and rapidly evolving. A veterinary oncologist (cancer specialist) is the best person to discuss and advise owners about treatment options for canine lymphoma.

Staging

A veterinarian normally will "stage" lymphoma to help the dog's owner decide on a treatment protocol. The stages of lymphoma in dogs basically are as follows:

- Stage I - only one lymph node (or lymphoid tissue in one organ) is involved.
- Stage II – multiple lymph nodes or a chain of lymph nodes in a localized area are involved.
- Stage III – Widespread, generalized lymph node involvement; most or all peripheral lymph nodes are affected.
- Stage IV - any or none of the above, plus liver and/or spleen involvement.
- Stage V - any or none of the above, with bone marrow involvement, blood involvement or involvement of any non-lymphoid organ.

Each stage can further be classified into substage A (the dog has no observable symptoms of illness), or substage B (the dog is showing signs of illness, such as loss of appetite, lethargy, weight loss, or the like).

Treatment Options for Lymphoma in Dogs

Chemotherapy is defined as the treatment of illness or disease using chemical agents. Some chemotherapeutic medications can be given orally, while others must be given intravenously (IV) on an inpatient basis. Moreover, chemotherapeutic protocols may involve administration of only one drug or a combination of drugs. Multi-agent chemotherapy typically results in better remission rates and a more rewarding overall outcome than does single agent therapy. Chemotherapy targets rapidly-dividing cells.

Treatment protocols are rapidly changing, and chemotherapeutic drugs can have severe and potentially fatal side effects. Current protocols for treating canine multicentric lymphoma can

involve use of a number of different drugs, including cyclophosphamide, vincristine, prednisone, L-asparaginase and doxorubicin, among other. Other chemotherapy drugs, such as chlorambucil, lomustine, cytosine arabinoside and mitoxantrone, are sometimes used in the treatment of lymphoma as well, either singly or in addition to other drugs. It is extremely important to closely monitor white blood cell counts and remission status throughout the course of chemotherapy.

While used much less commonly than chemotherapy, radiation therapy is being explored to treat lymphoma in combination with drug treatment. Early research suggests that certain chemotherapeutic protocols, used in combination with radiation, improve remission rates and extend the disease-free interval in dogs with multicentric malignant lymphoma.

Dogs with lymphoma isolated to a single or several lymph nodes, and those with focal gastrointestinal lymphoma, may be able to be treated successfully by surgical removal of the lymph node or mass followed by chemotherapy and/or radiation. Chemotherapy with or without radiation treatment has improved survival times in dogs suffering from mediastinal lymphoma. Cutaneous lymphoma can be treated with single or multi-agent chemotherapy, although the disease tends to become refractory to treatment and the results are much less rewarding.

Stem cell transplantation is commonly used to treat people with lymphoma and is another possible treatment option for dogs. In fact, much of the basic research on stem cell transplantation was generated from dogs. When cost is a restricting factor, steroid drugs such as prednisone can be prescribed to help alleviate the symptoms of lymphoma, although this will not significantly affect the survival rate. Prednisone may also cause the cancer to become resistant to other chemotherapeutic agents and typically is only used if more aggressive treatment is not an option.

Prognosis

Some cancers do not respond particularly well to chemotherapy. Fortunately, canine lymphoma – especially the common multicentric form – usually does. Radiation treatment is available for some types of cancer as well and is being used increasingly in conjunction with chemotherapy, with the hope of improving remission rates. During any chemotherapy treatments, the patient will need frequent blood tests and monitoring to be sure that the treatment is not adversely affecting his or her organs or overall health. Of course, in pets and in people, there can be a number of unpleasant side effects from chemotherapy and/or radiation treatment, including severe gastrointestinal upset, allergic reactions and hair loss, among others.

Current treatment protocols can help to extend a dog's life after a diagnosis of lymphoma. Dogs with lower stage lymphoma have a better prognosis than those with higher stage disease. Unfortunately, lymphoma is almost always progressive and, ultimately, fatal. Treatment of lymphoma rarely cures the disease. Instead, it hopefully will make the patient feel a bit better, and live a bit longer, with a significantly improved quality of life if remission is achieved.

5. What are the benefits of Lymphatic drainage?

Lymph Drainage for Animals

Lymph drainage is recognized as an important aspect of healing and health restoration in humans. Lymph drainage can be encouraged with the application of a number of drainage techniques. These techniques are taught in human osteopathy, chiropractic and some of the allied health therapies but to date have not been widely recognized as useful modalities in treating animals.

What is less commonly known is that equine or canine lymph drainage can also be achieved. Lymph drainage is a refined manual therapy that is applied over the body watersheds draining back to specific lymph nodes. Animals find the treatment very relaxing and it is beneficial to the overall health. Probably the most important benefits are the stimulation of lymphatic circulation, stimulating the immune system, and the autonomic nervous system. It also helps eliminate stagnation of fluid in the skin, viscera, mucosa, muscles joints and periosteum as well as reducing pain due to tissue stagnation. Naturally it helps with the elimination of waste products, reduces edema and is useful in fat or obese animals.

It is also possible to employ a lymphatic pump, which will drain a much larger area and in effect help the entire lymphatic system. Whereas this is a somewhat new physical therapy procedure it is of enormous value to equine physiotherapists and equine veterinarians alike. I have been using lymphatic pump in horses for over three years, and as I believe that it has to be taught properly so that it can be applied correctly. There exists a risk if the procedure is not done correctly or if too much is done.

In small animals it is useful in refractory ear and mouth infections, particularly in short nosed dogs. In horses it is great for reducing swelling in the limbs. Probably the most valuable uses of lymph drainage is in post surgical cases. The great part about lymph drainage is that it is totally non invasive natural and it is priming the body for natural recovery.

<http://www.animaloptions.com.au/lymph-drainage-animals/>

6. What is the role of Lymphatic drainage in kidney health and function?

The lymphatic system performs three important tasks in the mammalian body.

1. It is closely tied to the *cardiovascular* system and helps maintain the fluid balance between the blood vessels and the tissues.
2. The lymphatic system plays a large role in immunity.
3. This important system also absorbs digested fats from the small intestine.

The components of the lymphatic system are divided into two groups – the primary organs and the secondary organs.

1. **Primary Organs:** The thymus gland and the bone marrow are primary organs. They regulate the production and differentiation of lymphocytes – the cells that make up the immune system.
2. **Secondary Organs:** The secondary organs include the lymphatic vessels, lymph nodes, aggregated lymphoid tissue, and spleen. These secondary organs are involved, to some extent, in all three lymphatic functions.

Primary organs

Thymus

The mammalian thymus has two lobes and is situated slightly above the heart and ventral to (below) the trachea. It is relatively large at birth, but after sexual maturity, it begins to degenerate and is quite small in older animals.

The main function of the thymus is to "educate" certain white blood cells of the immune system called 'T-lymphocytes,' or 'T-cells.' T-cells identify foreign cells in the body, such as invading bacteria, and mark them for destruction by other immune cells. The T-cells mature in the thymus gland and are "taught" to distinguish between self and non-self cells. If they develop correctly, they are able to recognize the difference between those cells that are supposed to be in the body and those that are foreign. Those T-cells that fail to recognize this difference are destroyed by the thymus so they cannot harm the body. After maturing in the thymus, the T-cells move to the secondary organs, where most of them will remain.

Bone marrow

Bone marrow is the soft material in the cavities of bones. It is a network of connective tissue fibers, fat cells, blood vessels, and blood-producing cells. Bone marrow produces both red and white blood cells, including the lymphocytes. Both T-lymphocytes and B-lymphocytes are produced in the bone marrow. The young T-cells move to the thymus for final development, but the B-cells remain in the bone marrow during maturation. Once the B-cells are fully developed in the bone marrow, they are also released into circulation and most of them take up residence in the secondary lymphatic organs.

The B-cells are white blood cells that are sensitive to antigens and produce antibodies against them. Antigens are any chemicals that produce an immune response in the body, such as toxins, foreign proteins, particulate matter, or bacterial cells. When an antigen is present, the B-cell becomes active and begins to produce antibodies against that antigen. Antibodies are special proteins that bind (attach) to antigens and mark them for destruction. Antibodies are antigen specific, and the immune system is able to remember each antigen it fights. Once a B-cell makes antibodies against a certain antigen, e.g., a bacteria, it keeps a memory of that antigen. If

the antigen appears again, the B-cell can produce a large number of antibodies very rapidly. In this way, a second infection with that bacteria is often prevented.

Secondary organs

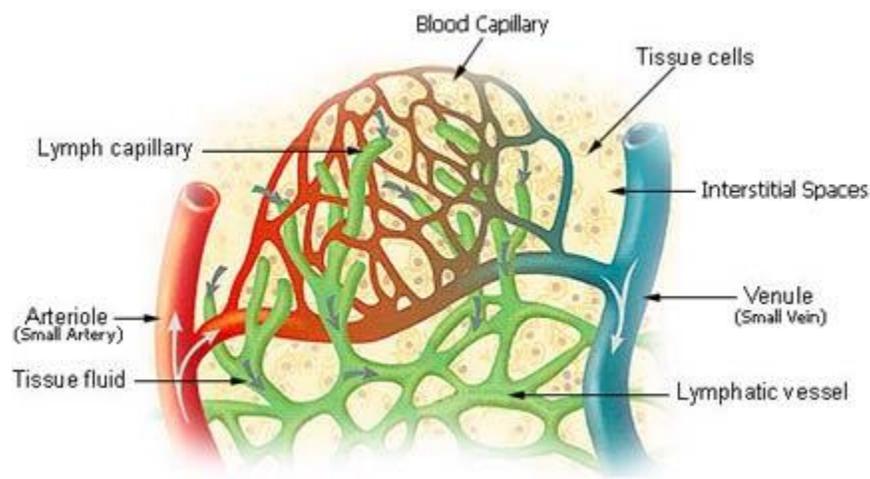
As mentioned, the secondary organs include the lymphatic vessels, lymph nodes, aggregated lymphoid tissue, and spleen. While the primary organs are only involved in the immune function of the lymphatic system, the secondary organs are collectively involved in all three functions:

1. Immunity
2. Fat absorption
3. Fluid regulation

Lymphatic vessels

The lymphatic vessels link together all of the secondary organs and also connect to the cardiovascular system. They provide a route for the one-way flow of lymph from the tissues of the body to the heart. Lymph is the clear, yellowish fluid that is collected from the *interstitial* spaces (the spaces between the cells of a tissue) into lymphatic capillaries.

Lymphatic capillaries are interwoven with the blood capillaries. Fluid and proteins are forced out of the arterial end of the blood capillary and into the interstitial space. About 90% of the fluid is reabsorbed in the venous end of the blood capillary, but none of the proteins are able to reenter the blood vessels because they cannot fit through the tight junctions of the cells. The lymph capillaries have extremely loose cell junctions, however, and they are able to absorb the remaining 10% of the fluid along with the plasma proteins. Once inside of the lymph vessels, the fluid is then termed "lymph."



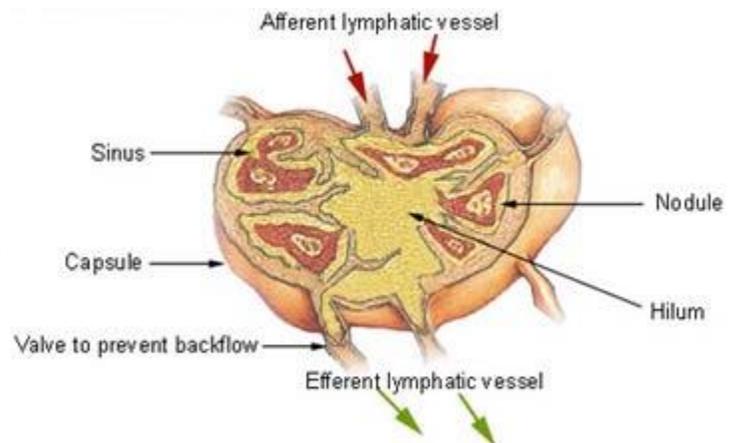
The lymphatic vessels are structured similar to veins, with thin walls and valves to prevent backflow. They are not muscular vessels, and external forces such as limb movement regulate the flow of lymph. Once in the capillaries, the lymph moves into progressively larger vessels,

passes through the lymph nodes and/or spleen, reaches the large ducts, and enters the blood circulation near the junctions of the jugular and subclavian veins in the upper chest. Thus, the fluid and proteins are eventually returned to the blood, which helps maintain the proper balance of fluid between the blood vessels and the tissues. All of the lymph from the lower body, left arm, and left thorax are drained through the thoracic duct into the junction of the left jugular and subclavian veins. The fluids from the neck, right arm, and right thorax empty into the right lymphatic duct which joins the venous system at the junction of the right jugular and subclavian veins.

Near the small intestine, where fats are digested and absorbed, the lymphatic vessels have a special function and, therefore, a special name. They are involved in the absorption of digested fat from the small intestine, and are called "lacteals." After a meal the fluid within the lacteals generally has a fat content of 1-2%, and it appears cloudy. This cloudy lymph in the lacteals is called "chyle."

Lymph nodes

Lymph nodes are round or bean-shaped structures that are widely distributed throughout the body. Imbedded in connective tissue or fat, they are concentrated in the cervical, axillary, and inguinal regions – the neck, armpits, and groin, respectively. They are typically less than ½ inch in length, depending on the size of the animal. The lymph nodes filter the lymph before returning it to the veins. They are arranged so that all lymph has to pass through at least one node before returning to the veins.



Lymph nodes are enclosed by a capsule of connective tissue and comprised of several compartments called "lymph nodules." The nodules are masses of T-cells, B-cells, and macrophages. Macrophages are specialized cells that ingest and destroy foreign material. The nodules are separated by spaces called "lymph sinuses." The vessels that deliver unfiltered lymph are called "afferent vessels," and there are several per node. The lymph is then filtered for antigens and particulate matter, and an immune response is generated, if necessary. The filtered lymph leaves the node through one or two efferent vessels near an indentation called the "hilum." Blood vessels also enter and exit the node at the hilum.

Aggregated lymphoid tissue

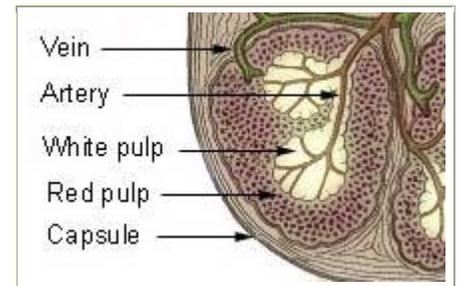
Aggregated (clumped) lymphoid tissues are collections of lymphoid tissue that are not encapsulated (in a capsule). They have varying degrees of size and organization. The most

highly organized and widely known examples are tonsils and Peyer's patches. The tonsils are found at the back of the oral cavity. Peyer's patches are found in the lining of the small intestine. Tonsils and Peyer's patches have specialized epithelial cells that are capable of transporting antigens, and though they do not filter lymph, they are generally surrounded by capillaries. The main purpose of the aggregated lymphoid tissue is defense from invasion at the *mucosal* surfaces. These are sites where large numbers of bacteria and other microorganisms are present and can easily enter the body. These specialized lymphatic cells help to prevent infections from developing at these sites.

Spleen

The spleen is a spongy organ located in the upper left portion of the abdominal cavity along the outside curve of the stomach. It is composed of two types of tissue - the red pulp and the white pulp.

1. The red pulp is mostly used to store blood and break down old red blood cells.
2. The white pulp has the lymphatic function of filtering the blood for antigens.



The spleen traps antigens and is another site for initiation of the immune response. In a sense, it is like a large lymph node. A swollen spleen can be a sign of serious infection and is easily *palpated*.

Conclusion

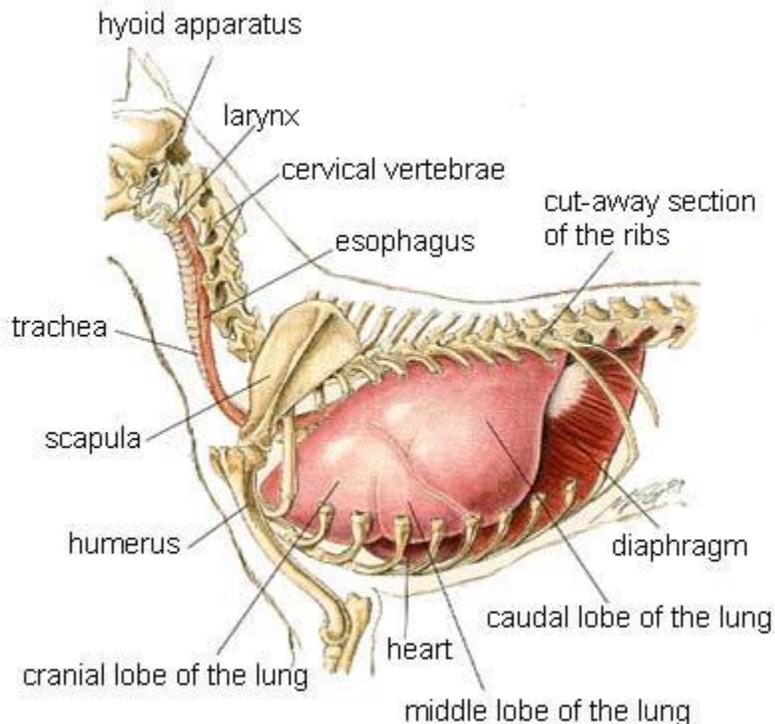
Though the lymphatic system is often overlooked, it is an important part of the mammalian body. By absorbing fats and trapping antigens, it helps to keep the animal healthy and disease-free. Also, the role of maintaining proper fluid balances is essential. Truly, a healthy lymphatic system is necessary to the survival of the animal.

Interesting Facts

- Domestic birds do not have lymph nodes. Instead, there are nodules of lymphoid tissue in the bone marrow.
- If an infection is present in the body, the lymph nodes nearest the site of infection may become swollen or painful. This is caused by an accumulation of cells and fluids involved in the immune response.
- In 24 hours, approximately 50% of the lymphocytes in the blood pass through the spleen.
- In a human, the lymphatic system returns 2.83 liters (3 quarts) of lymph to the heart every 24 hours. That is about a ½ a cup per hour!

The Respiratory System

1. Provide a diagram of the Canine Respiratory System.

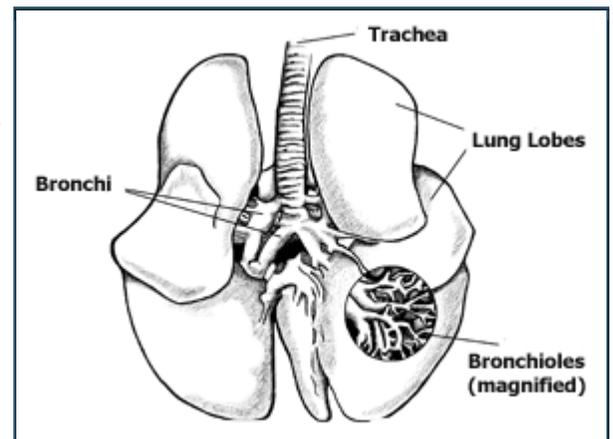


<http://www.vetmed.wsu.edu/cliented/anatomy/images/Dogchest2.JPG>

2. What does the Respiratory System comprise of?

Anatomy

Shortly after birth, once the first breaths are taken, a puppy has a fully functional respiratory system. The respiratory system is basically composed of the nares (nostrils), nasal cavity, sinuses within the skull, pharynx (back of the mouth), larynx (voice box), trachea (windpipe), bronchi (the branches of the trachea going into the lungs), and the lungs. Dogs have right and left lungs, just like humans. Both sides of the lungs are further divided into sections, or lobes. Inside the lungs, the bronchi divide into smaller and smaller tubes, called 'bronchioles,' much like branches of a tree divide into smaller and smaller branches.

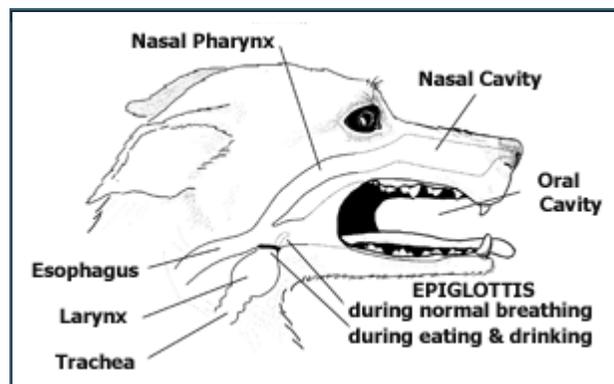


At a microscopic level, the bronchioles end in small structures called 'alveoli'. It is here that the blood makes contact with the individual cells in the lungs and oxygen is exchanged for carbon dioxide. Alveoli are supplied by a vast network of microscopic blood vessels known as capillaries.

The normal breathing process

As a dog inhales, fresh air moves through the nose (or mouth), pharynx, and larynx to the trachea. The trachea carries the air to the bronchi, which in turn supply the lungs. Air exchange occurs in the alveoli and the used air follows the opposite path of new air: passing into the bronchi, into the trachea, through the larynx and pharynx, finally exiting through the nose or mouth.

Breathing is relatively simple and is accomplished by the actions of the rib muscles (intercostals) and the movement of a great internal muscle called the diaphragm. The diaphragm muscle separates the chest, containing the heart and lungs, from the abdomen which holds the intestines, stomach, *liver*, bladder, etc. As this great muscle moves toward the abdomen, it creates a negative pressure and pulls fresh air and oxygen into the lungs, causing the dog to breathe in (inhale). The chest cavity surrounding the lungs is a vacuum, thus allowing the lungs to inflate easily when the dog inhales. When the muscle moves forward (towards the animal's head), it causes the lungs to compress and force air out (exhale), thus ridding the body of used air.



Functions of the respiratory system: The dog's respiratory system serves two purposes. First, it is the exchange mechanism by which the body's carbon dioxide is replaced with oxygen. It is also a unique cooling system. Since dogs do not have sweat glands (except on their feet), they cannot perspire to lower their body's temperature like humans do. To cool their body they must breathe harder (pant). By breathing faster, warm air is exchanged from the body for the cooler outside air. Additionally, moisture within the respiratory system evaporates, further cooling these surfaces. Therefore, the lungs function both to exchange carbon dioxide for oxygen and to cool the body.

<http://www.peteducation.com/article.cfm?c=2+2083&aid=515>

3. What is the function of the Respiratory System?

Question 2 Answers this question also.

4. What is dyspnea?

Dyspnea, Tachypnea and Panting in Dogs

Troubled or labored breathing is medically referred to as dyspnea, and excessively rapid breathing is medically referred to as tachypnea (also, polypnea). The respiratory system has many parts, including the nose, throat (pharynx and larynx), windpipe, and lungs. Air comes in

through the nose and is then carried down into the lungs, through a process referred to as inspiration. In the lungs, the oxygen is transferred to the red blood cells. The red blood cells then carry the oxygen to other organs in the body. This is all part of the physical process of a healthy body.

While oxygen is being transferred to the red blood cells, carbon dioxide is transferred from the red blood cells into the lungs. It is then carried out through the nose through a process referred to as expiration. This cyclic motion of breathing is controlled by the respiratory center in the brain and nerves in the chest. Diseases that affect the respiratory system, or the respiratory center in the brain, can bring about breathing difficulties. Troubled or labored breathing is medically referred to as dyspnea, and excessively rapid breathing is medically referred to as tachypnea (also, polypnea).

Breathing difficulties can affect dogs of any breed or age, and the problem can quickly become life threatening. If your dog is having problems with breathing it should be seen by a veterinarian as soon as possible.

Symptoms and Types

Difficulty Breathing (dyspnea)

- The belly and chest move when breathing
- Nostrils may flare open when breathing
- Breathing with an open mouth
- Breathing with the elbows sticking out from the body
- Neck and head are held low and out in front of the body (extended)
- Problem breathing may occur when breathing in (inspiratory dyspnea)
- Problem breathing may occur when breathing out (expiratory dyspnea)
- Noisy breathing (stridor)

Fast breathing (tachypnea)

- Rate of breathing is faster than normal
- Mouth is usually closed

Panting

- Fast breathing
- Usually shallow breaths
- Open mouth

Other symptoms can be there depending on the cause of the breathing problem

- Coughing

Causes

Dyspnea

- Diseases of the nose
 - Small nostrils
 - Infection with bacteria or viruses
 - Tumors
 - Bleeding
- Diseases of the throat and upper windpipe (trachea)
 - Roof of the mouth is too long (enlongated soft palate)
 - Tumors
 - Foreign object stuck in the throat
- Diseases of the lungs and lower windpipe
 - Infection with bacteria or viruses (pneumonia)
 - Heart failure with fluid in the lungs (pulmonary edema)
 - Big heart
 - Infection with heartworms
 - Tumors
 - Bleeding into the lungs
- Diseases of the small airways in the lungs (bronchi and bronchioles)
 - Infection with bacteria or viruses
 - Tumors
 - Allergies
 - Asthma
- Diseases in the space in the chest surrounding the lungs (pleural space)
 - Fluid caused by heart failure
 - Air (pneumothorax)
 - Blood in the chest (hemothorax)
 - Tumors in the chest
- Diseases of the chest wall
 - Injury to the chest wall (trauma)
 - Toxins from tick bites paralyze the chest wall
 - Botulism toxins paralyzes the chest
- Diseases that make the belly enlarged or bloated
 - Enlarged liver
 - Stomach filled with air (bloat)
 - Fluid in the belly (ascites)

Tachypnea (fast breathing)

- Low oxygen level in the blood (hypoxemia)
- Low red blood cell level (anemia)
- Asthma
- Fluid in the lungs because of heart failure (pulmonary edema)
- Bleeding into the lungs
- Tumors

Panting

- Pain
- Medications
- High body temperature (fever, or during exercise)
- Normal in some dogs

Diagnosis

If your dog is having difficulty breathing, this can be a life threatening emergency and you will need to have the dog seen by a veterinarian as soon as possible. You will need to give a thorough history of your dog's health, onset of symptoms, and possible incidents that might have preceded this condition. During the examination, your veterinarian will carefully observe how your dog is breathing, listening to its chest for evidence of a heart murmur or fluid in the lungs. Your dog's gum color will be carefully evaluated as well, since the color of the gums can indicate whether oxygen is being delivered to the organs (hypoxemia) effectively, or if there is a low red blood cell count (anemia). Your veterinarian may try to get your dog to cough by pressing on its windpipe. If your dog is having extreme difficulty breathing, the veterinarian will give your dog oxygen to help it breathe before doing any more tests.

Standard tests include a complete blood count, biochemical profile, and urine analysis. These will help your veterinarian to determine if your dog has an infection in the bloodstream or a low red blood cell count. They will also show whether your dog's internal organs are functioning normally. Your veterinarian will also draw a sample of blood to test the amount of oxygen and carbon dioxide in your dog's blood. This will help to determine how severe your dog's breathing difficulty is and whether the problem is in the lungs or somewhere else in the chest. Your veterinarian may also draw blood for a heartworm test. Other diagnostic tools that may be used are X-ray and ultrasound images of the chest, both to examine for an enlarged heart that can lead to heart failure, and to see if the lungs appear normal. The internal structure of the abdomen may also be examined using this method. If there appears to be an accumulation of fluid in the chest, lungs or belly, some of that fluid will be drawn off for laboratory analysis.

If your dog does appear to have a heart problem, your veterinarian may also order an ECG (electrocardiogram) to measure the rhythm and electrical activity of the heart, both of which determine the heart's ability to operate normally. If your dog's problem is in its nose or airways, a small camera called an endoscope may be used to get a closer look at these areas. These

procedures are known as rhinoscopy and bronchoscopy, respectively. While your veterinarian is examining your dog with the endoscope, samples of fluid and cells may be taken for biopsic analysis.

Treatment

Treatment will depend on the final diagnosis your veterinarian makes for your dog's breathing problems. Most breathing problems require admittance into a hospital until the patient's inability to take in sufficient oxygen has been resolved. Your dog will be given oxygen to help it breathe and to get oxygen to its organs, and medications may be given, either by mouth or intravenously (IV), to help your dog to breathe. The prescribed medication will be dependent on the cause of the breathing problem. Your dog's activity will be restricted until the breathing problem is resolved or greatly improved. Cage rest may be an option if you have no other way of restricting your dog's movement. In addition, confining exercise to slow, short outdoor walks, and protecting your dog from other pets or active children is an important part of the recovery process.

Living and Management

Once your dog is able to return home with you, it will be very important to follow your veterinarian's instructions closely. Dispense all of the medications as directed, and stick to the scheduled follow-up progress checks with your veterinarian. Your veterinarian will repeat many of the tests that were done when your dog was diagnosed: complete blood counts, biochemical profiles, and chest X-rays. All are important in determining how your dog is responding to treatment.

Depending on the severity of your dog's problem, its activity level may need to be reduced for the rest of its life. Your dog may need to be on medication for the rest of its life as well. If you notice any changes in the way your dog is breathing, it is important to consult with your veterinarian immediately.

http://www.petmd.com/dog/conditions/respiratory/c_dg_dyspnea_tachypnea_panting?page=2

5. What is tachypnea?

Question four has also answered this question.

6. Why is the Respiratory system and the Digestive system dependent on one another?

The Anatomy Of Dog: The Digestive System

The simplest way to consider the dog's own complex "food processor" is via the component parts of the gut, each of which is a food-processing chamber with a specific job. These parts often have their own gland producing enzymes related to their job.

The order of stages is:

1. Mouth and salivary glands
2. Oesophagus (gullet)
3. Stomach
4. Duodenum, small intestine and pancreas
5. Liver
6. Large intestine and rectum.

The mouth

Once a dog is aware that food is available or that it soon will be, the guts swings into action. Saliva is produced in the mouth by the salivary glands to begin digestion of the impending meal. In many dog homes, the opening of a particular cupboard or the sound of the can opener is enough to trigger salivary secretion.

The Functions of the Saliva

Saliva acts as a binder to help hold together a bolus of food, and lubricates the oesophagus to ease its passage.

Saliva contains an enzyme which begins digesting starch in the mouth – this is secreted into the food and continues acting in the stomach.

Saliva also “cleans” the tongue.

The sense of taste is partly dependent on the action of saliva, which washes substances out of foods into the dog’s taste buds.

Evaporation of saliva from the tongue is part of a dog’s method of keeping cool.

From mouth to stomach

The dog takes food into its mouth and chews it using its powerful jaws. The tongue shapes the food into a “bolus”, then moves it to the back of the mouth, lifts it through the pharynx, over the larynx and into the oesophagus, which opens to receive it and closes behind it.

This highly complex manoeuvre, involving dozens of – tiny muscles and finely-tuned nervous control can be summed up in one word – swallowing. In the oesophagus a muscular process called peristalsis squeezes food along the gut like toothpaste in a tube. The oesophagus has thicker walls and is more stretchy than the intestine, so dogs can swallow fairly large solid food items – bones, stones or small toys – although these may then stick in the stomach or small intestine. The oesophagus moves the food, through the chest into the stomach. A valve called the cardiac sphincter opens momentarily to let the bolus of food into the stomach then closes tightly behind it.

Digestion in the stomach

The wall of the dog's stomach is divided into two roughly equal areas the fundic region and the pyloric region. The fundic region contains the fundic or gastric glands which produce acid, and an enzyme which produces pepsin for breaking down protein in the food. The pyloric region has glands which produce mucus to stop enzymes digesting the gut wall and to keep food moist. The duodenum after being held in the stomach for three to four hours, small amounts of food are moved into the duodenum. Glands in the duodenum produce a thick, alkaline secretion which begins neutralizing the acid food from the stomach and also protects the intestine from the acid. Other important digestive enzymes enter the duodenum from the pancreas. By the time food has passed through the small intestine, the enzymes have completed their work and the food has been broken down into its component parts, the bulk of it being absorbed. Much of the water present in the food is reabsorbed in the large intestine before it passes into the rectum and is finally voided as faeces.

The pancreas

This is a mass of tissue sitting in the loop of the duodenum, close to the stomach. The arrival of food in the duodenum promotes the secretion of pancreatic juices. Apart from digestive enzymes, it also produces insulin, to help store glucose. Lack of insulin causes diabetes mellitus.

The liver

The largest single organ in the body of all animals, the liver is a very important "chemical factory". It performs several functions which are linked to the blood, food storage and the removal of toxins ("poisons").

Glands and Hormones

The many glands in the dog's body fall into two groups – Exocrine glands and Endocrine glands.

Exocrine glands

These glands secrete externally and include the salivary, sweat and mammary glands and glands of the stomach, mouth and oesophagus.

Endocrine glands

These glands secrete internally. They send chemical "messengers" (hormones) via the bloodstream and include the pituitary, the thyroid, the ovaries and the testes.

A “feedback mechanism”

The pituitary gland is a small bump on the underside of the brain. Sometimes called the “master gland”, it controls most of the other glands by producing specific stimulating hormones, each of which stimulates one of the other glands to produce its hormone. The hormone produced by the “target gland” then acts on the pituitary to stop production of its stimulating hormone, shutting off the mechanism.

The Digestive System

The digestive organs include the teeth, mouth, pharynx, alimentary canal, and accessory organs. Like other mammals, dogs possess two sets of teeth. The milk or puppy teeth, small and sharp, are fewer than the adult ones. The permanent teeth have usually appeared by the age of six months, with the canine (fang) teeth erupting in the fifth month. The dog has forty-two teeth, twenty in the upper jaw and twenty-two in the lower. The right and left upper jaw each has three incisors, one canine tooth, four premolars and two molars; the right and left lower jaws possess the same number of incisors, canines and premolars, but have three molars.

The incisor teeth act as nippers; the canines can hold firmly on to prey because of two powerful muscles which act to close the jaws. The roots of the canine teeth are extremely long which increases their strength. Food is held and carried by the two premolar teeth, while the molars are designed to slice and crush food, but not to chew it.

Food is reduced to small lumps by the action of the tongue and teeth and lubricated by saliva produced from four pairs of salivary glands. It is then passed through the pharynx, over the closed laryngeal entrance, and into the alimentary canal, where digestion takes place.

The remains of the digested food move into the colon or large intestine. At the junction of the small intestine and the colon is a blind-ending sac, the caecum. Some water is absorbed back into the body from the substances in the large intestine, leaving behind the soft solid mass of faeces which enters the rectum and is voided through the anus.

The digestive juices in the stomach and small intestine contain enzymes which break food down into simple chemicals, soluble in water; the main food breakdown takes place in the small intestine, consisting of duodenum, jejunum and ileum. The large pancreas also produces digestive juices. Bile, which is involved with fat digestion, is emptied from the liver into the duodenum. The liver is an important gland and processes most of the products of digestion, transforming them into chemicals used for body building and repairs, bodily defences, energy, and chemicals for storage.

The Endocrine System

The endocrine system functions through chemical messages, called hormones, carried in the bloodstream. They are produced by endocrine cells and grouped in glands, or contained in organs with additional functions. The pancreas, for example, produces the hormone insulin and also manufactures digestive juices. A hormone may have widespread effects on several tissues

or it may influence a specific process or organ. Imbalance of hormone levels leads to abnormality in an animal's development and function. Not all hormones are essential, but lack of cortisone, insulin, and parathormone eventually leads to death.

The major endocrine organs include the pituitary gland at the base of the brain, and the two thyroid glands at either side of the trachea; parathyroids are tiny glands embedded in each thyroid gland. Two adrenal glands cranial to the kidneys produce corticosteroid and an adrenaline compound. The endocrine cells in the pancreas produce insulin, lack of which results in Diabetes mellitus.

The sex hormones from the ovaries control the female reproductive cycle in conjunction with the pituitary hormones. They are also responsible for the production of the secondary sexual characteristics in the young bitch. Male hormone produced in the testicle is responsible for the secondary sexual characteristics of the male. It also controls the production of spermatozoa.

<http://cynologist.com/index.php/anatomy-of-dog/the-anatomy-of-dog-the-digestive-system>

How Do the Digestive & Respiratory Systems Work Together?

Your digestive and respiratory systems, at first glance, seem very separate in their activities. In reality, however, the systems work together intimately in several ways. The results of respiratory activity allow the digestive tract to function, and vice versa. Furthermore, the systems work together to provide energy to body cells.

Digestive Function

The purpose of your digestive system is to take in food from your environment and break it down on both macroscopic and molecular levels. Through the process of digestion, you break large nutrient molecules into smaller ones that your intestine absorbs into the bloodstream. Cells then take up these nutrient molecules and use them to build new molecules and provide for their cellular energy needs. Cells can also store the molecules for later use.

Respiratory Function

Your respiratory system takes in oxygen from the atmosphere and moves that oxygen into the bloodstream by allowing it to move across the membranes of the lungs into the blood vessels. The circulatory system then carries oxygen to all the cells in the body and picks up carbon dioxide waste, which it returns to the lungs. Carbon dioxide diffuses from the blood into the lungs, and you exhale it into the atmosphere.

<http://www.livestrong.com/article/302607-how-do-the-digestive-respiratory-systems-work-together/>

TMJ ~ Temporomandibular Joint

1. What is the temporomandibular joint?

The temporomandibular joint is the jaw joint, the hinged point in the jaw that is formed by two bones, named the temporal and mandible bones. The temporomandibular joint is also frequently referred to as simply TMJ.

There are two temporomandibular joints, one on each side of the face, each one working in concert with the other. TMJ plays a pivotal role in the normal chewing process, and is in fact essential for proper chewing, so that and any disease of this joint compromises the ability to make normal mouth movements and chew food. An affected animal will feel pain when closing or opening the mouth, or both. Diseases and disorders of the TMJ are referred to as temporomandibular joint disorders.

Though these disorders can occur in any dog breed, certain breeds like basset hounds are more predisposed to TMJ disorders. Open-mouth mandibular locking has been reported in Irish setters and basset hounds.

Symptoms and Types

Difficulty opening/closing the mouth

Mandible bone may be out of place and visible from the side of the face (deviation of the mandible bone)

Pain when chewing food

Vocalizing, whining while trying to eat

Loss of appetite

Causes

Injury or trauma causing fractures to the joint

Stress in joint after carrying heavy objects by mouth

Diagnosis

Most of these animals are presented to their veterinarian's with the complaint that they are unable to eat normally. You will need to begin by giving a thorough history of your dog's health, including a background history of symptoms, when the problems first appeared, and whether there have been any previous traumas or injuries involving the mouth or head. After taking a detailed history, your veterinarian will conduct a complete physical examination on your dog, examining the mouth, bones and the joints in the mouth. Laboratory tests will include a complete blood count (CBC), biochemistry profile, and urinalysis. The results of these tests are often found to be normal, especially if no other concurrent disease is present.

X-rays remain a valuable tool in the diagnosis of TMJ disorders, and your doctor will be likely to use this type of imaging to get a better view of the bones and joints in the face. Magnetic resonance imaging (MRI) can be used as well, and can give a better, more detailed view than standard X-ray. If your veterinarian has an MRI machine in the clinic, this may be the recommended image technique. If something more severe is suspected, such as infection or tumor, your veterinarian may also take a small sample from the muscle tissue of the jaw so that other diseases that can cause similar symptoms can either be confirmed or ruled out.

Treatment

Treatment for TMJ disorders is two-fold and is aimed at eliminating or altering the underlying cause as well as treating the symptoms. In case of complete dislocation of the TMJ, your veterinarian will try to repair it by placing an object at a specific site close to the joint, and gently closing the mouth with a push in order to reduce the dislocation. If this method does not work well or the problem becomes chronic, surgery may be required to correct the defect. Pain killers will also be given to reduce the pain related to these disorders. Muscle relaxing drugs can also be prescribed, if need be, to reduce the muscle tension created as a result of the TMJ disorder.

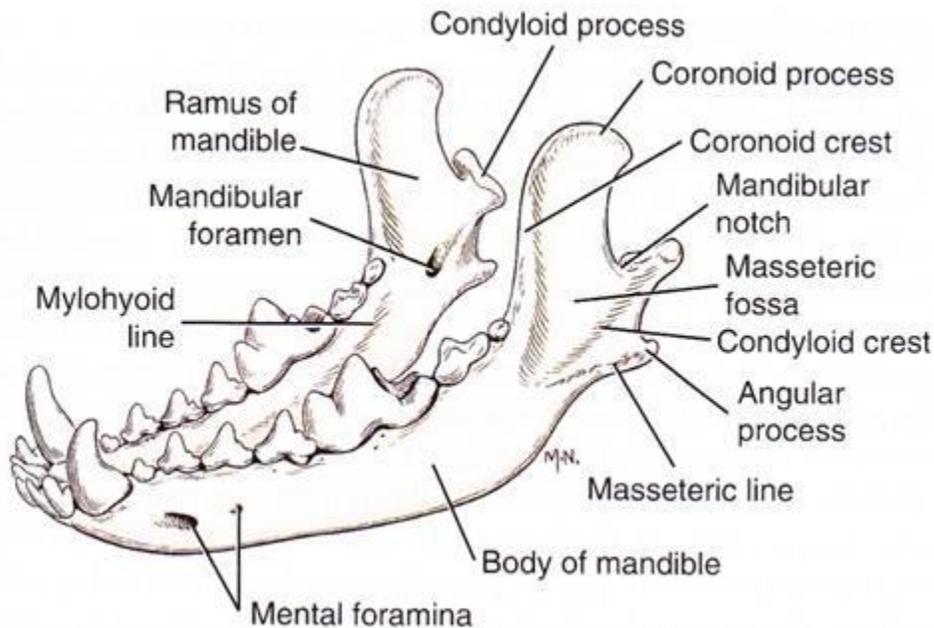
Living and Management

After surgery, your dog may feel sore and will need proper rest in a quiet place, away from other pets and active children. You might consider cage rest for a short time, until your pet can safely move about again without overexertion. Your veterinarian will also prescribe a short course of pain killers until your pet has fully recovered, along with a mild course of antibiotics, to prevent any opportunistic bacteria from attacking your pet. Medications will need to be given precisely as directed, at the proper dosage and frequency. Keep in mind that over dosage of pain medication is one of the most preventable causes for death in household animals.

This condition can be very painful, and regular pain relieving drugs may be required until the symptoms have resolved completely. Your veterinarian may also use a feeding tube to give your dog its required nutrients, especially if your dog is unable to take enough food through its mouth alone. Your veterinarian will also brief you on the correct use of the feeding tube at home so that you can take your dog home to recover in relative comfort and quiet.

http://www.petmd.com/dog/conditions/musculoskeletal/c_dg_temporomandibular_joint_disorders?page=2

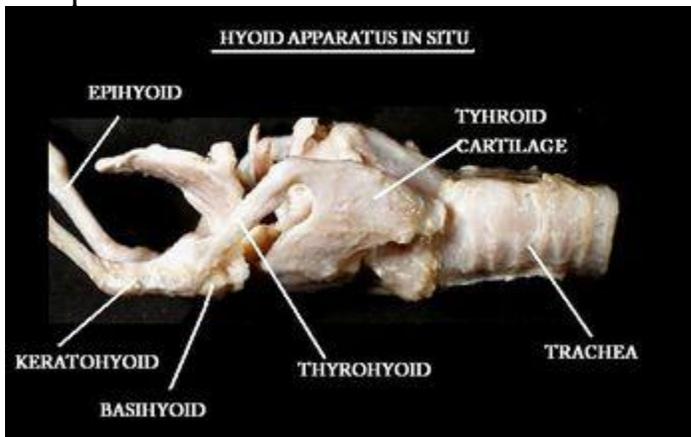
2. Provide a diagram of the Canine TMJ.



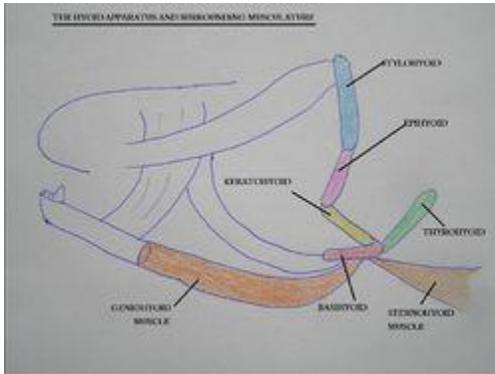
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3. What is the Hyoid Apparatus?

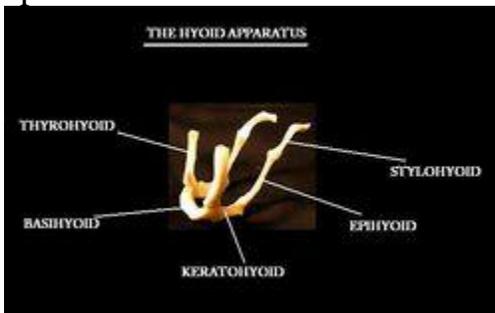
- The hyoid apparatus holds the larynx in place and supports the pharynx and tongue from the skull. It is made up of 5 different bones, which vary in length and size depending on the species.



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- Hyoid Apparatus in situ - Copyright Nottingham
- Structure and Function
- It is attached to the temporal region of the skull by a synchondrosis joint. It is palpable through the pharynx and is visible when the pharynx is viewed through the mouth. The basihyoid is palpable within the intermandibular space.
- The sternohyoid muscle pulls the hyoid caudally and the geniohyoid muscle pulls the hyoid rostrally.



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- Hyoid Apparatus Drawing - Copyright nabrown
- The hyoid bones
- 1. Basihyoid - Unpaired bone.
- 2. Stylohyoid - Articulates with base of skull at the petrus temporal. A paired bone.
- 3. Epihyoid - A paired bone.
- 4. Keratohyoid - A paired bone.
- 5. Thyrohyoid - Articulates with the thyroid cartilage of the larynx. A paired bone.
- Species Differences



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- 
- Canine hyoid apparatus - Copyright Nottingham
- Carnivores: Stylohyoid bones are not palpable.
- Equine: Epihyoid is small, the lingual process is present and they have a well developed stylohyoid muscle.
- Ruminants: Lingual process is present.
- Porcine: Lingual process is present.

3. What is the Stomatognathic System?

In anatomy, the stomatognathic system consists of the mouth, jaws, and closely associated structures.

Stomatognathic diseases are treated by dentists, maxillofacial surgeons and ear, nose and throat specialists, speech language pathologists, and physical therapists.

https://en.m.wikipedia.org/wiki/Stomatognathic_system

4. What does the Stomatognathic System influence?

The combination of organs, structures, and nerves involved in speech and reception, mastication, and deglutition of food. This system is composed of the teeth, the jaws, the masticatory muscles, the tongue, the lips, the surrounding tissues, and the nerves that control these structures.

<http://medical-dictionary.thefreedictionary.com/stomatognathic+system>

TMJ is part of the balancing mechanisms.

These systems allow the brain to know the orientation of the body in three dimensional space.

5. Name the other parts of the body in this system.

General and specialized characteristics of the TMJ

The temporomandibular joint (TMJ) is a cardinal feature that defines the class Mammalia and separates mammals from other vertebrates. As befits its late evolutionary origin, the TMJ also makes a tardy developmental appearance¹. The TMJ is interesting because its constituent bones, the mandible and the squamous temporal, are intramembranous in origin. Thus, the tissue that covers each articulating surface is a secondary cartilage with a fibrous skin, derived from the periosteum. Another nearly constant feature is the intra-articular disc. The disc, even when incomplete, is associated with the lateral pterygoid muscle², which has led some authors to speculate that it arose as a tendon which became pinched by the new joint³.

An additional interesting feature of the TMJ is its role in growth. Intramembranous bones do not have epiphyseal plates, but their growth is effected (or at least affected) by nearby cartilaginous structures. In the cranium, the cranial base cartilages and the nasal septum are thought to be the major drivers of growth at cranial sutures⁴. It seems likely that in most vertebrates, Meckel's cartilage performs a similar role for the multiple bones of the lower jaw. The evolution of the TMJ accompanied the almost complete removal of Meckel's cartilage from the sutureless lower jaw of mammals, thus eliminating this mechanism of growth. The substitute is the secondary condylar cartilage, which is a major growth site in addition to being an articular covering.

Despite its status as a mammalian identifier, the TMJ shows remarkable morphological and functional variation in different species, reflecting not only the great mammalian adaptive radiation in feeding mechanisms, but also a freedom from constraints such as bearing body

weight. The most extreme evolutionary variants include: (1) loss of the synovial cavity in some baleen whales; (2) loss (or possibly primitive absence) of the disc in monotremes, some marsupials, and some edentates (anteaters and sloths)^{2,5}; (3) variations in the orientation of the joint cavity from parasagittal (many rodents) to transverse (many carnivorans); and (4) reversal of the usual convex/concave relationship so that the mandibular condyle becomes the female element (many artiodactyl ungulates such as sheep and cattle⁶). In addition, the relative size of the joint is exceedingly variable. Soft tissue details such as capsular ligaments⁷ and collagen orientation in the disc⁸ are also highly species-specific.

The striking anatomical differences in TMJs are clearly tied to biomechanics. The features mentioned above are either correlates of loading (e.g., size of articular surfaces) or movement (e.g., orientation of the joint) or both. Loading of the TMJ is a reaction force arising from the contraction of jaw muscles; its magnitude depends strongly on the position of the bite point relative to the muscle action line. The evolution of the TMJ is thought to have coincided with a period of low reaction loads, with higher loading having evolved repeatedly in different lineages⁹, including our own. Many commonly used laboratory animals, especially rodents, fall in the category of minimal TMJ loading, especially during chewing. In contrast, carnivorans such as dogs probably sustain TMJ loads that are higher than those in primates¹⁰. Complex movement in three planes of space is also a primitive characteristic of the TMJ, at least if embryology is any indication³, but there is no uniformity in how movements are accomplished. Opening of the jaw usually involves a combination of forward sliding and rotation around a transverse axis, but some carnivorans have lost the ability to slide and some specialized anteaters instead use a rotation around the long axis of the curved mandible⁵. Similarly, transverse movement is usually accomplished by moving one condyle forward and the other one backward, but carnivorans use a combination of lateral sliding and rotation around the long axis of the mandible¹¹.

<http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2821032/>

6. They say the TMJ is the access to the pineal and pituitary gland. What does that mean?

TMJ is the access point to the pineal and pituitary glands because of the location. Everything is so close to the animal's brain that by touching on this joint you are accessing the endocrine system which sends messages to the whole nervous system. The endocrine system provides the chemicals in the body that can respond to specific organs such as the pituitary gland and the pineal gland.

Human **endocrine** glands are essentially identical to **dog** and **cat endocrine** glands, both in structure and function. The **endocrine** glands include the pituitary gland, thyroid gland,

parathyroid glands, pancreas, adrenal glands, ovaries, and testes. The pituitary gland is located near the center and bottom of the brain.

https://www.google.ca/?gws_rd=ssl#q=what+is+the+endocrine+system+in+dogs

The endocrine glands provide the body with chemicals called hormones. Once produced, hormones enter the bloodstream and most (other than *prostaglandin*) produce an effect elsewhere in the body. Not all cells within the body are affected by hormones, and only some cells of a particular organ may respond to a specific hormone.

Some hormones control the release of other hormones. For example, the pituitary gland located at the base of the brain produces many hormones. These hormones act on other glands such as the adrenal glands and cause them to release their own hormones. The pituitary gland is called "the master gland" as it provides more kinds of hormones than any other gland. Pituitary hormones control the hormone release from other endocrine glands, including the thyroid, parathyroid, adrenal, ovaries, testicles, and pancreas.

The pituitary gland produces growth hormone, which controls growth; prolactin, which stimulates the *mammary* glands to produce milk; and thyroid-stimulating hormone (TSH), which stimulates the thyroid gland. Luteinizing hormone (LH) and follicle-stimulating hormone (FSH) are two hormones produced by the pituitary gland which control heat cycles and *ovulation*. The pituitary gland also produces adrenocorticotrophic hormone (ACTH) which causes the adrenal gland to produce *cortisol* and other hormones; melanocyte-stimulating hormone (MSH), which affects pigment; and antidiuretic hormone (ADH) which regulates the metabolism of water.

The thyroid gland, once stimulated, produces its own hormone, thyroxine. The ovaries, once stimulated by FSH and LH from the pituitary, principally produce *progesterone* and *estrogens*. The testes provide testosterone. The pancreas produces the most well-known hormone of all; insulin, which regulates blood sugar. The adrenal glands, once stimulated by the pituitary hormone, ACTH, produce naturally occurring steroids called corticosteroids, *mineralocorticoids*, and adrenal sex steroids.

As one can see, hormones play a very complex role in regulating the body's functions

<http://www.peteducation.com/article.cfm?c=2+2083&aid=277>

The Endocrine System[[edit](#)]

In order to survive, animals must constantly adapt to changes in the environment. The nervous and endocrine systems both work together to bring about this adaptation. In general the nervous system responds rapidly to short-term changes by sending electrical impulses along nerves and the endocrine system brings about longer-term adaptations by sending out chemical messengers called hormones into the blood stream.

For example, think about what happens when a male and female cat meet under your bedroom window at night. The initial response of both cats may include spitting, fighting and spine tingling yowling - all brought about by the nervous system. Fear and stress then activates the adrenal glands to secrete the hormone adrenaline which increases the heart and respiratory rates. If mating occurs, other hormones stimulate the release of ova from the ovary of the female and a range of different hormones maintains pregnancy, delivery of the kittens and lactation.

Endocrine Glands And Hormones[[edit](#)]

Hormones are chemicals that are secreted by endocrine glands. Unlike exocrine glands (see chapter 5), endocrine glands have no ducts, but release their secretions directly into the blood system, which carries them throughout the body. However, hormones only affect the specific target organs that recognize them. For example, although it is carried to virtually every cell in the body, follicle stimulating hormone (FSH), released from the anterior pituitary gland, only acts on the follicle cells of the ovaries causing them to develop.

A nerve impulse travels rapidly and produces an almost instantaneous response but one that lasts only briefly. In contrast, hormones act more slowly and their effects may be long lasting. Target cells respond to minute quantities of hormones and the concentration in the blood is always extremely low. However, target cells are sensitive to subtle changes in hormone concentration and the endocrine system regulates processes by changing the rate of hormone secretion.

The main endocrine glands in the body are the pituitary, pineal, thyroid, parathyroid, and adrenal glands, the pancreas, ovaries and testes. Their positions in the body are shown in diagram 16.1.

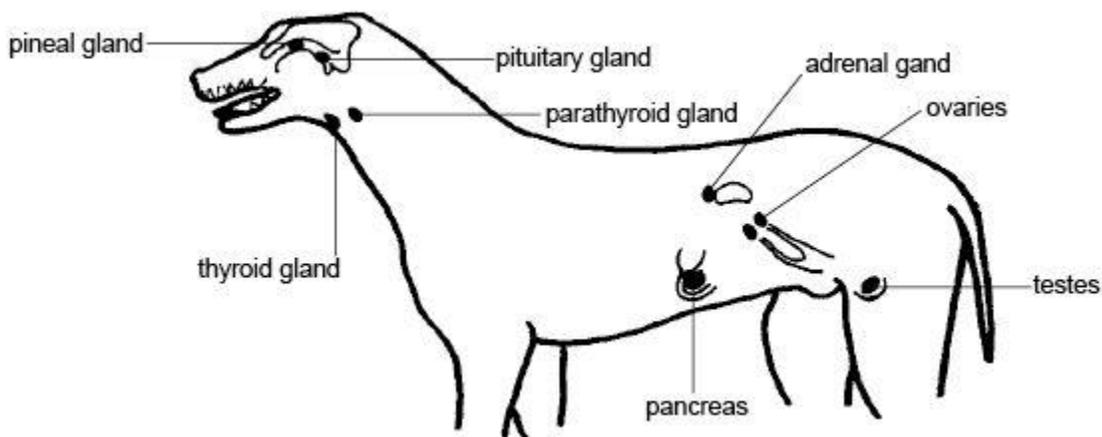


Diagram 16.1 - The main endocrine organs of the body

The Pituitary Gland And Hypothalamus[[edit](#)]

The pituitary gland is a pea-sized structure that is attached by a stalk to the underside of the cerebrum of the brain (see diagram 16.2). It is often called the “master” endocrine gland because it controls many of the other endocrine glands in the body. However, we now know that the pituitary gland is itself controlled by the hypothalamus. This small but vital region of the brain lies just above the pituitary and provides the link between the nervous and endocrine systems. It controls the autonomic nervous system, produces a range of hormones and regulates the secretion of many others from the pituitary gland (see Chapter 7 for more information on the hypothalamus).

The pituitary gland is divided into two parts with different functions - the anterior and posterior pituitary (see diagram 16.3).

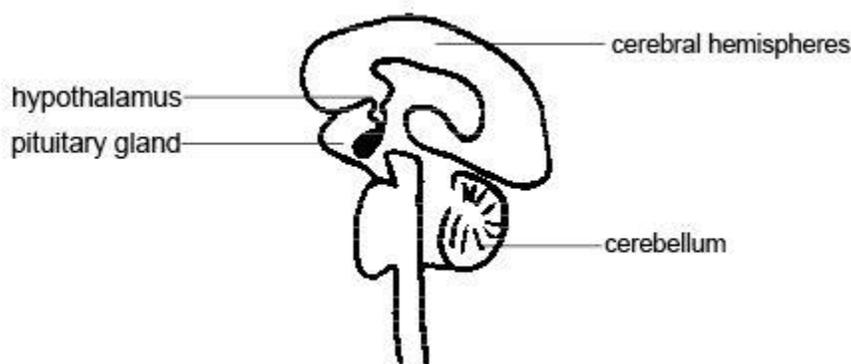


Diagram 16.2 - The position of the pituitary gland and hypothalamus

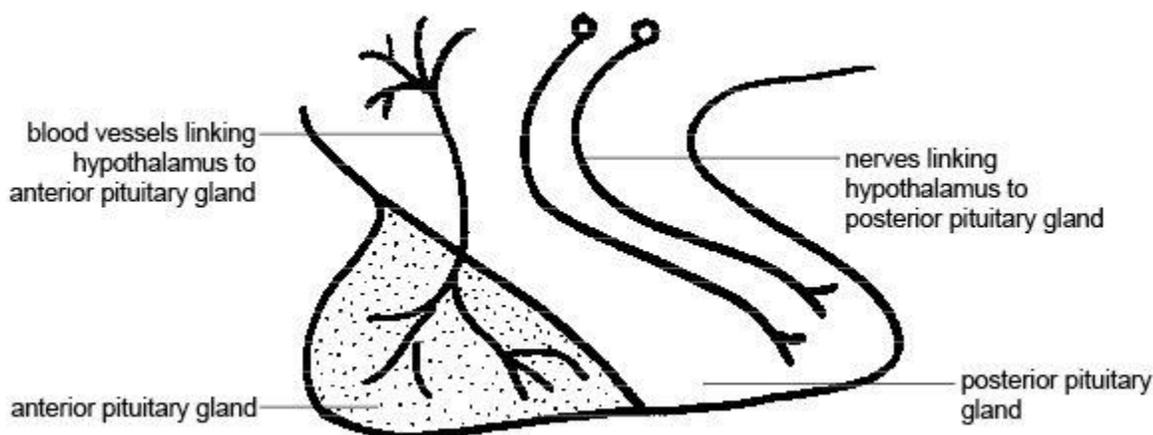


Diagram 16.3 - The anterior and posterior pituitary

The anterior pituitary gland secretes hormones that regulate a wide range of activities in the body. These include:

1. Growth hormone that stimulates body growth.
2. Prolactin that initiates milk production.

3. Follicle stimulating hormone (FSH) that stimulates the development of the follicles of the ovaries. These then secrete oestrogen (see chapter 6).
4. melanocyte stimulating hormone (MSH) that causes darkening of skin by producing melanin
5. lutenizing hormone (LH) that stimulates ovulation and production of progesterone and testosterone

The posterior pituitary gland

1. Antidiuretic Hormone (ADH), regulates water loss and increases blood pressure
2. Oxytocin, milk "let down"

The Pineal Gland[\[edit\]](#)

The pineal gland is found deep within the brain (see diagram 16.4). It is sometimes known as the 'third eye' as it responds to light and day length. It produces the hormone melatonin, which influences the development of sexual maturity and the seasonality of breeding and hibernation. Bright light inhibits melatonin secretion. Low level of melatonin in bright light makes one feel good and this increases fertility. High level of melatonin in dim light makes an animal tired and depressed and therefore causes low fertility in animals.

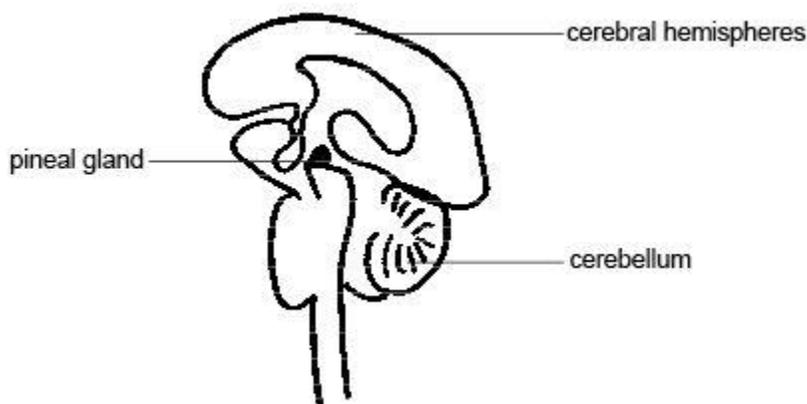


Diagram 16.4 - The pineal gland

The Thyroid Gland[\[edit\]](#)

The thyroid gland is situated in the neck, just in front of the windpipe or trachea (see diagram 16.5). It produces the hormone thyroxine, which influences the rate of growth and development of young animals. In mature animals it increases the rate of chemical reactions in the body.

Thyroxine consists of 60% iodine and too little in the diet can cause goitre, an enlargement of the thyroid gland. Many inland soils in New Zealand contain almost no iodine so goitre can be common in stock when iodine supplements are not given. To add to the problem, chemicals

called goitrogens that occur naturally in plants like kale that belong to the cabbage family, can also cause goitre even when there is adequate iodine available.

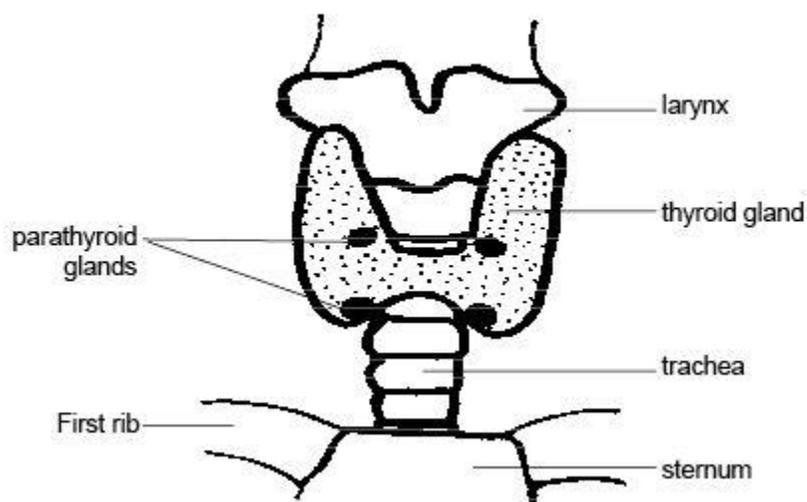


Diagram 16.5 - The thyroid and parathyroid glands

The Parathyroid Glands[\[edit\]](#)

The parathyroid glands are also found in the neck just behind the thyroid glands (see diagram 16.5). They produce the hormone parathormone that regulates the amount of calcium in the blood and influences the excretion of phosphates in the urine.

The Adrenal Gland[\[edit\]](#)

The adrenal glands are situated on the cranial surface of the kidneys (see diagram 16.6). There are two parts to this endocrine gland, an outer cortex and an inner medulla.

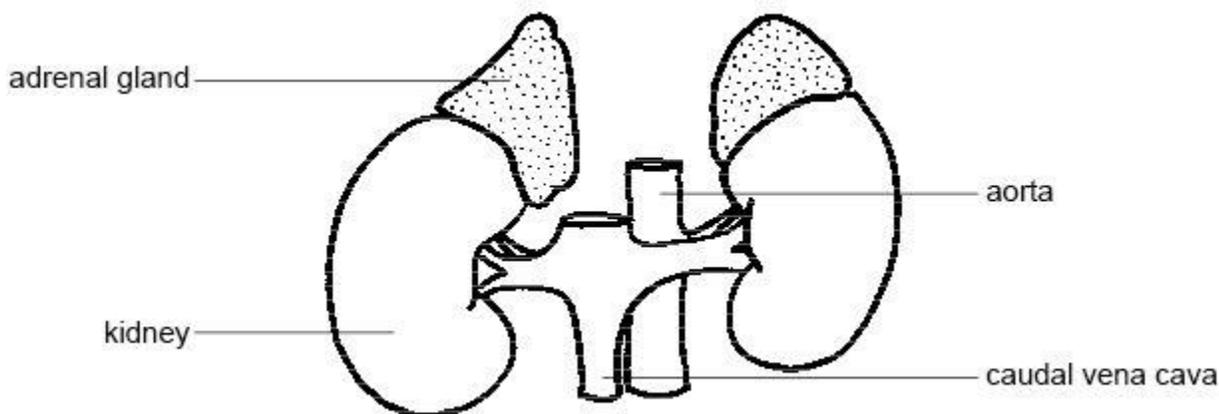


Diagram 16.6 - The adrenal glands

The adrenal cortex produces several hormones. These include:

1. Aldosterone that regulates the concentration of sodium and potassium in the blood by controlling the amounts that are secreted or reabsorbed in the kidney tubules.
2. Cortisone and hydrocortisone (cortisol) that have complex effects on glucose, protein and fat metabolism. In general they increase metabolism. They are also often administered to animals to counteract allergies and for treating arthritic and rheumatic conditions. However, prolonged use should be avoided if possible as they can increase weight and reduce the ability to heal.
3. Male and female sex hormones similar to those secreted by the ovaries and testes.

The hormones secreted by the adrenal cortex also play a part in “general adaptation syndrome” which occurs in situations of prolonged stress.

The adrenal medulla secretes adrenalin (also called epinephrine). Adrenalin is responsible for the so-called flight fight, fright response that prepares the animal for emergencies. Faced with a perilous situation the animal needs to either fight or make a rapid escape. To do either requires instant energy, particularly in the skeletal muscles. Adrenaline increases the amount of blood reaching them by causing their blood vessels to dilate and the heart to beat faster. An increased rate of breathing increases the amount of oxygen in the blood and glucose is released from the liver to provide the fuel for energy production. Sweating increases to keep the muscles cool and the pupils of the eye dilate so the animal has a wide field of view. Functions like digestion and urine production that are not critical to immediate survival slow down as blood vessels to these parts constrict.

Note that the effects of adrenalin are similar to those of the sympathetic nervous system.

The Pancreas[[edit](#)]

In most animals the pancreas is an oblong, pinkish organ that lies in the first bend of the small intestine (see diagram 16.7). In rodents and rabbits, however, it is spread thinly through the mesentery and is sometimes difficult to see.

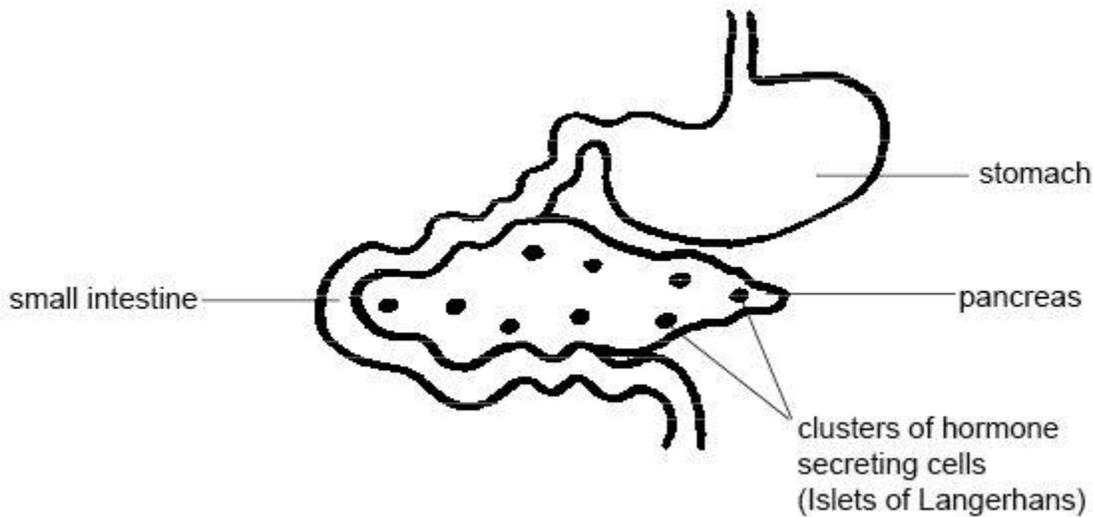


Diagram 16.7 - The pancreas

Most of the pancreas acts as an exocrine gland producing digestive enzymes that are secreted into the small intestine. The endocrine part of the organ consists of small clusters of cells (called Islets of Langerhans) that secrete the hormone insulin. This hormone regulates the amount of glucose in the blood by increasing the rate at which glucose is converted to glycogen in the liver and the movement of glucose from the blood into cells.

In diabetes mellitus the pancreas produces insufficient insulin and glucose levels in the blood can increase to a dangerous level. A major symptom of this condition is glucose in the urine.

The Ovaries[[edit](#)]

The ovaries, located in the lower abdomen, produce two important sex hormones.

1. The follicle cells, under the influence of FSH (see the pituitary gland above), produce oestrogen, which stimulates the development of female sexual characteristics - the mammary glands, generally smaller build of female animals etc. It also stimulates the thickening of the lining of the uterus in preparation for pregnancy (see chapter 13).
2. Progesterone is produced by the corpus luteum, the endocrine gland that develops in the empty follicle following ovulation (see chapter 13). It promotes the further preparation of the uterine lining for pregnancy and prevents the uterus contracting until the baby is born.

The Testes[[edit](#)]

Cells around the sperm producing ducts of the testis produce the hormone testosterone. This stimulates the development of the male reproductive system and the male sexual characteristics - generally larger body of male animals, mane in lions, tusks in boars, etc

Summary[[edit](#)]

- Hormones are chemicals that are released into the blood by endocrine glands i.e. Glands with no ducts. Hormones act on specific target organs that recognize them.
- The main endocrine glands in the body are the hypothalamus, pituitary, pineal, thyroid, parathyroid and adrenal glands, the pancreas, ovaries and testes.
- The hypothalamus is situated under the cerebrum of the brain. It produces or controls many of the hormones released by the pituitary gland lying adjacent to it.
- The pituitary gland is divided into two parts: the anterior pituitary and the posterior pituitary.
- The anterior pituitary produces:
 - Growth hormone that stimulates body growth
 - Prolactin that initiates milk production
 - Follicle stimulating hormone (FSH) that stimulates the development of ova
 - Luteinising hormone (LH) that stimulates the development of the corpus luteum
 - Plus several other hormones
- The posterior pituitary releases:
 - Antidiuretic hormone (ADH) that regulates water loss and raises blood pressure
 - Oxytocin that stimulates milk “let down”.
- The pineal gland in the brain produces melatonin that influences sexual development and breeding cycles.
- The thyroid gland located in the neck, produces thyroxine, which influences the rate of growth and development of young animals. Thyroxine consists of 60% iodine. Lack of iodine leads to goitre.
- The parathyroid glands situated adjacent to the thyroid glands in the neck produce parathormone that regulates blood calcium levels and the excretion of phosphates.
- The adrenal gland located adjacent to the kidneys is divided into the outer cortex and the inner medulla.
- The adrenal cortex produces:
 - Aldosterone that regulates the blood concentration of sodium and potassium
 - Cortisone and hydrocortisone that affect glucose, protein and fat metabolism
 - Male and female sex hormones
- The adrenal medulla produces adrenalin responsible for the flight, fright, fight response that prepares animals for emergencies.
- The pancreas that lies in the first bend of the small intestine produces insulin that regulates blood glucose levels.
- The ovaries are located in the lower abdomen produce 2 important sex hormones:

- The follicle cells of the developing ova produce oestrogen, which controls the development of the mammary glands and prepares the uterus for pregnancy.
 - The corpus luteum that develops in the empty follicle after ovulation produces progesterone. This hormone further prepares the uterus for pregnancy and maintains the pregnancy.
- The testes produce testosterone that stimulates the development of the male reproductive system and sexual characteristics.

Homeostasis and Feedback Control[[edit](#)]

Animals can only survive if the environment within their bodies and their cells is kept constant and independent of the changing conditions in the external environment. As mentioned in module 1.6, the process by which this stability is maintained is called homeostasis. The body achieves this stability by constantly monitoring the internal conditions and if they deviate from the norm initiating processes that bring them back to it. This mechanism is called feedback control. For example, to maintain a constant body temperature the hypothalamus monitors the blood temperature and initiates processes that increase or decrease heat production by the body and loss from the skin so the optimum temperature is always maintained. The processes involved in the control of body temperature, water balance, blood loss and acid/base balance are summarized below.

https://en.wikibooks.org/wiki/Anatomy_and_Physiology_of_Animals/Endocrine_System

Tada... You're A&P is complete!