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Avian Respiratory System

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An understanding of the avian respiratory system is essential to develop a health monitoring plan for your poultry flock. Knowledge of avian anatomy and what the parts normally look like will help you to recognize when something is wrong and to take the necessary actions to correct the problem.

The respiratory system is involved in the absorption of **oxygen** (O_2), release of **carbon dioxide** (CO_2), release of heat (temperature regulation), detoxification of certain chemicals, rapid adjustments of acid-base balance, and vocalization. While the function of the avian respiratory system is comparable to that of mammals, they are quite different anatomically.

Birds don't breathe the same way mammals do. Like mammals, birds have two symmetrical lungs that are connected to a **trachea** (windpipe), but here the similarity ends. Mammalian lungs contain many **bronchi** (tubes), which lead to small sacs called alveoli. Because alveoli have only one opening, air can flow into and out of them, but it cannot flow through them to the outside of a lung. In comparison, the avian lung has **parabronchi**, which are continuous tubes allowing air to pass through the lung in one direction. They are laced with blood capillaries and it is here that gas exchange occurs. The avian respiratory system is described as non-tidal. The mammalian respiratory system, in contrast, is tidal in that air comes in and then goes out like the tide.

The avian respiratory tract (Figure 1) starts with the **glottis**. The glottis closes when feed is passing down the throat so that the feed does not enter the lungs.

The **trachea** is made up of cartilaginous rings that prevent its collapse from the negative pressure caused by inspiration of air.

The **syrinx** is the voice box. The bird's "voice" is produced by air pressure on a sound valve and modified by muscle tension. It is not possible to remove the syrinx to prevent roosters from crowing. They can be devoiced by changing the muscles by the syrinx but this is a complicated surgery.

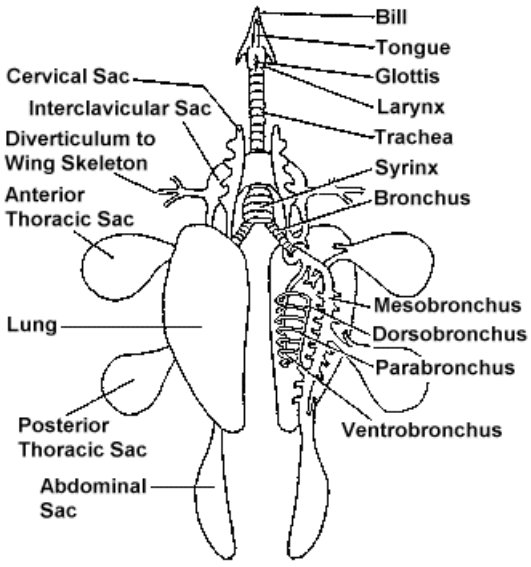

Figure 1. Avian respiratory system.
Source: Michigan State University.

Both male and female chickens are able to crow. The reason hens do not normally crow is because they do not feel like it due to the effects of the female hormone and the absence of sufficient levels of the male hormone. When the ovaries become diseased and the level of female hormones decrease, many hens will start to show male characteristics, including crowing.

The trachea divides into two smaller tubes called bronchi. There is a considerable narrowing in the diameter of the tube at this division. In some respiratory diseases **tracheal plugs** are often formed and they physically block the respiratory tract at the junction of the bronchi and thus suffocating the chicken. Excessive dust in the air is also believed to result in the formation of caseous tracheal plugs and adversely affects the health of the chickens.

Chicken **lungs** are relatively small and do not expand. Instead, they are firmly attached to the ribs. Birds have an **incomplete diaphragm** and the arrangements of the chest musculature and the sternum do not lend themselves to expansion in the same way that the chest of

mammals does. Consequently they can't inflate and deflate lungs in the same way as mammals do. Instead, birds pass air through the lungs by means of **air sacs**. The air sacs are balloon-like structures at the 'ends' of the airway system. In the chicken there are nine such sacs: an unpaired one in the cervical region; two interclavicular air sacs, two abdominal air sacs, two anterior thoracic air sacs and two posterior thoracic air sacs.

The key to the avian respiratory system is that distention and compression of the air sacs, not the lungs, moves air in and out. At any given moment air may be flowing into and out of the lung and being parked in the air sacs. The lungs are stiff and fixed, not at all like the distensible lungs of mammals. The air sacs act as bellows to suck air in and blow it out and also to hold part of the total volume. The air sacs fill a large proportion of the chest and abdominal cavity of birds, and also connect to the air spaces in the bones.

Since birds do not have a diaphragm, they depend on the movement of the sternum (keel) and rib cage in order to breathe. Holding a bird too tight will restrict movement of the rib cage and suffocate the bird. This often happens when young children hold baby chicks too tight.

Another important feature of the avian respiratory system is also part of the skeletal system. The bones of birds are lighter in weight than those of their mammalian counterparts. Some of the bones are hollow and actually act as part of the avian respiratory system. They are called **pneumatic bones** and include the skull, humerus, clavicle, keel (sternum), pelvic girdle, and the lumbar and sacral vertebrae. A broken pneumatic bone can make it difficult for birds to breathe.

With each breath, the bird's respiratory tract is exposed to the inside environment of a poultry house. Poor environments normally do not cause disease directly but they do reduce birds' defenses, making them more susceptible to infection from existing viruses and pathogens.

The air of poultry houses can contain **aerosol particles** or dust originating from the floor litter, feed, dried manure, and the skin and feathers of the birds. These aerosol particles can have a range of adverse effects on poultry. They act as an irritant to the respiratory system and coughing is a physiological response designed to remove them. Excessive coughing lowers the bird's resistance to disease. Aerosol particles can collect inside meat birds and can increase carcass condemnation at the processing plant.

Gases are generated from decomposing poultry waste; emissions from the birds; and from improperly maintained or installed equipment, such as gas burners. Harmful gases most often found in poultry housing are ammonia (NH_3) and carbon dioxide (CO_2). Research has shown that as little as 10 ppm ammonia will cause excessive mucus production and damage to the cilia. Research has also revealed that ammonia levels of 10-40 ppm reduce the clearance of *E. coli* from air sacs, lungs, and trachea in birds.

The avian respiratory tract is normally equipped with defense mechanisms to prevent or limit infection by airborne disease agents; to remove inhaled particles; and to keep the airways clean. Poultry health is affected by the function of three defensive elements: the cilia; the mucus secretions; and the presence of scavenging cells which consume bacteria.

Cilia are tiny hair-like structures in the trachea. Cilia are responsible for propelling the entrapped particles for disposal. **Mucus** is produced in the trachea. Mucus secretion and movement of cilia are well developed in chickens. The consistency of the mucus produced is important for the efficiency of the ciliary activity. Cilia cannot function when the mucus is too thick.

Scavenging cells in the lungs actively scavenge inhaled particles and bacteria that gain entrance to the lower respiratory tract. These cells consume bacteria and kill them, thus preventing their further spread.

It is the integrated function of cilia, mucus and scavenging cells that keeps chicken airways free of disease-producing organisms. The impairment of even one of these components permits an accumulation of disease agents in the respiratory tract and may result in disease.

The typical respiration rate of chickens is about 30 breaths per minute. The rate is higher in the light period (average of 35.6 breaths per minute) than in the dark period (average of 23.1 breaths per minute). The respiration rate increases dramatically during hot weather as panting (defined as greater than 150 breaths per minute) plays an important role in dissipating in the excess heat.

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