The Aquarium Vet

E-quarist Course®

Welcome to The Aquarium Vet E-quarist course®.

In this document you will find the Contents page as well as a few pages from each of the Penguin Modules to give you an insight into the course.

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The initial course consisted of ten modules with a focus on fish and aquatic invertebrates. From 2018 onwards, modules on Penguins, Sea Turtles and Chelonians, Amphibians and Alligators / Crocodiles will be available. The current modules available are:

Module 1. Fish Anatomy and Physiology

Module 2. Disease Concepts and Diagnostics in Fish

Module 3. Water Chemistry and Quality

Module 4. Aquatic Life Support Systems

Module 5. Fish Diseases and Treatments

Module 6. Nutrition and Reproduction

Module 7. Elasmobranchs

Module 8. Invertebrates I – Cephalopods and Crustaceans

Module 9. Invertebrates II – Sea Jellies and Echinoderms

Module 10. Invertebrates III – Coral Husbandry

Module 21. Penguins I

Module 22. Penguins II

Module 23. Penguins III - under development and should be available early in 2022.

Module 31. Chelonians I – under development and should be available early in 2022.

The Aquarium Vet

E-quarist™ Course

Module Twenty One

Penguins I

Contents

2. Anatomy and Physiology

As mentioned previously, birds have the following characteristics:

- warm-blooded
- feathered
- winged
- bipedal
- egg-laying

Birds are capable of maintaining a stable internal body temperature, independent of the external environment, just like mammals. This is called **homeothermy** or **endothermy**, and commonly referred to as "warm-blooded". Thermoregulation (particularly in cold climates) will be discussed later in this chapter under the appropriate anatomy sections.

Most birds maintain their body temperature at 40°C (104°F), which is 3 - 4°C (5.4 – 7.2°F) higher than mammals. In diurnal birds their daytime temperature may be a little higher during the day, with the reverse for nocturnal birds.

Penguin temperatures are usually a little lower with their body temperature being between 37 and 39 °C (98.6 to 102.2 °F). In a study using wild King penguins (*Aptenodytes patagonicus*), the birds had lower body temperatures (down as low as 36.5 °C or 97.7 °F) when at lower environmental temperatures (-30 °C or -22 °F) (Froget *et. al* 2002).

Birds as a group have the highest metabolic rates of all vertebrates.

2.1 External Anatomy

Skin

The skin of birds is mostly unseen due to the feathers (discussed below), even though as with most animals it is the largest organ in the body. However, there are some bare areas on the bill, parts of the face and feet depending on the bird.

The skin functions to keep out pathogens, by providing a barrier to entry, as well as retaining body fluid and contributing to homeostasis. The skin is also a large sensory organ.

The skin of birds has the same layers as many other animals with an outer layer called the **epidermis** and the inner layer, the **dermis**. Invaginations of the skin form feather follicles but

unlike mammals there are no glands (sweat or sebaceous) associated with these follicles. As such birds cannot sweat or perspire.

Most bird skin is quite thin being only three to five cells thick, but is thicker over the bare parts of the face and legs. This is much thinner than the skin of mammals. The epidermis consists of two layers:

- Stratum corneum
- Stratum germinativium

The outer stratum corneum consists of layers of flattened (squamous) keratinized cells (called keratinocytes), which are combined with lipids almost in a bricks and mortar arrangement (lipids are the mortar) providing an impermeable barrier.

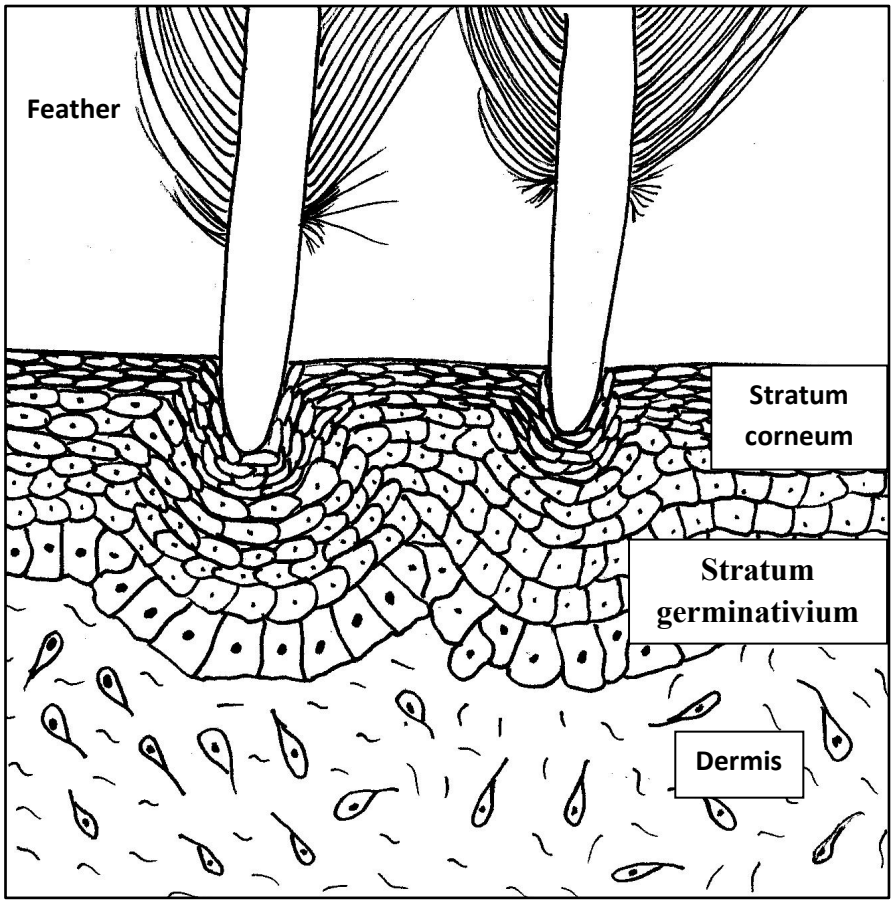

Figure 15 - Diagram showing the various skin layers.

The stratum germinativium is the layer where the keratinocytes originate. As they multiply they migrate upwards, lose their nucleus, become keratinized and form the stratum corneum. It is in this layer that the lipids mentioned in the previous paragraph are produced. These lipids are hydrophobic and contribute to waterproofing in combination with the secretion of the

uropygial gland (see later in this section). They also assist by keeping the feather keratin from becoming brittle and possess some antibacterial and antifungal properties.

The dermis layer is thicker than the epidermis. It contains fat deposits, nerves and nerve endings, blood vessels, lymphatics and smooth muscle. The smooth muscle controls feather movement. The base of the feather follicles are in the dermis layer, often closely associated with sensory nerve endings.

The sub-cutaneous tissue (mainly collagen and fat) lies below the dermis separated by a thin layer of elastic fibers.

Temperate penguins (genus *Sphensicus*) have bare skin between the face and eyes. This helps with evaporative cooling and increasing heat loss in warmer climates.

Penguins have a thick layer of fat below the skin which assists with insulation (analogous to blubber in marine mammals). Sadly in the period from the 1860's to the 1890's there was commercial penguin harvesting in the Falkland Islands and on Macquarie Island with the production of many gallons of penguin oil. See Figure 16.

Figure 16 - Necropsy of a Gentoo penguin (*Pygoscelis papua*) showing the fat layer under the skin (arrow).

Feathers

Feathers are the main characteristic that differentiates birds from all other animals. Feathers are composed of a unique form of keratin only present in birds. Keratin is a fibrous structural protein that composes human hair and fingernails. In birds keratin is also present in scales that may cover the feet and lower legs.

Feathers make up 4 to 12 % of the birds bodyweight, depending on the species. There are two main types of feathers:

- Vaned feathers
- Down feathers

Vaned feathers are the outer layer of feathers, the typical quilled feather. The stiff central shaft is called the rachis. Flat, blade-like vanes are present on either side of the rachis. The vanes are composed of a series of barbs, extending obliquely from the rachis. Each barb in turn has finer branches called barbules. The barbules are held together by barbicels (small hooks that run the length of the barbule and hook together to form a smooth surface. See Figures 17 and 18 below and over the page.

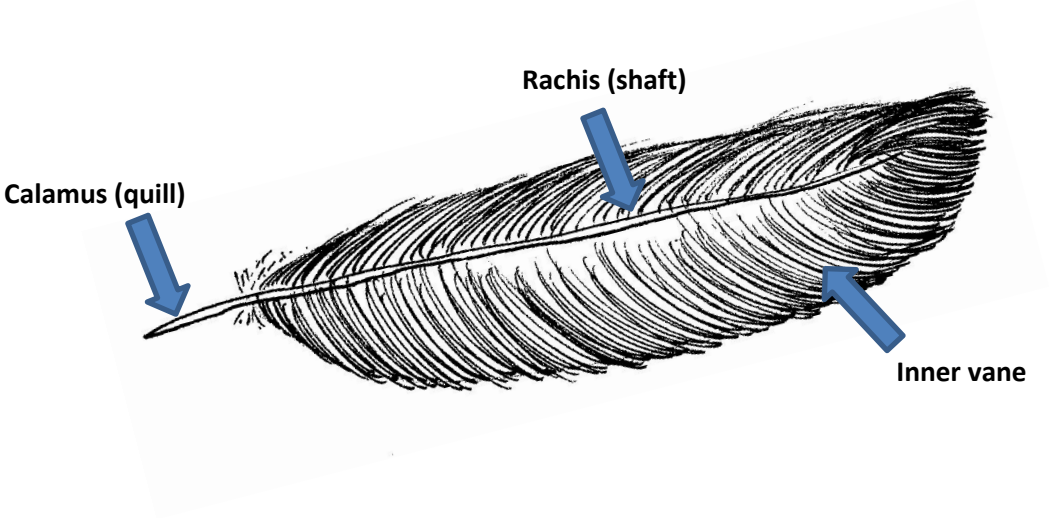

Figure 17 - Diagram of a vaned feather.

In growing feathers, the central core or pulp (inside the quill) consists of vascular (blood vessels) connective tissue. This pulp regresses as the feather grows and is completely absent in mature feathers.

Vaned feathers are of various types. The smaller feathers which cover the body are called **contour feathers**. Flying birds possess two rows of long flight feathers, called **remiges**, being primary and secondary remiges. Above and below the remiges, are rows of **covert feathers**. Tail feathers are called **retrices** and similarly are associated with covert feathers.

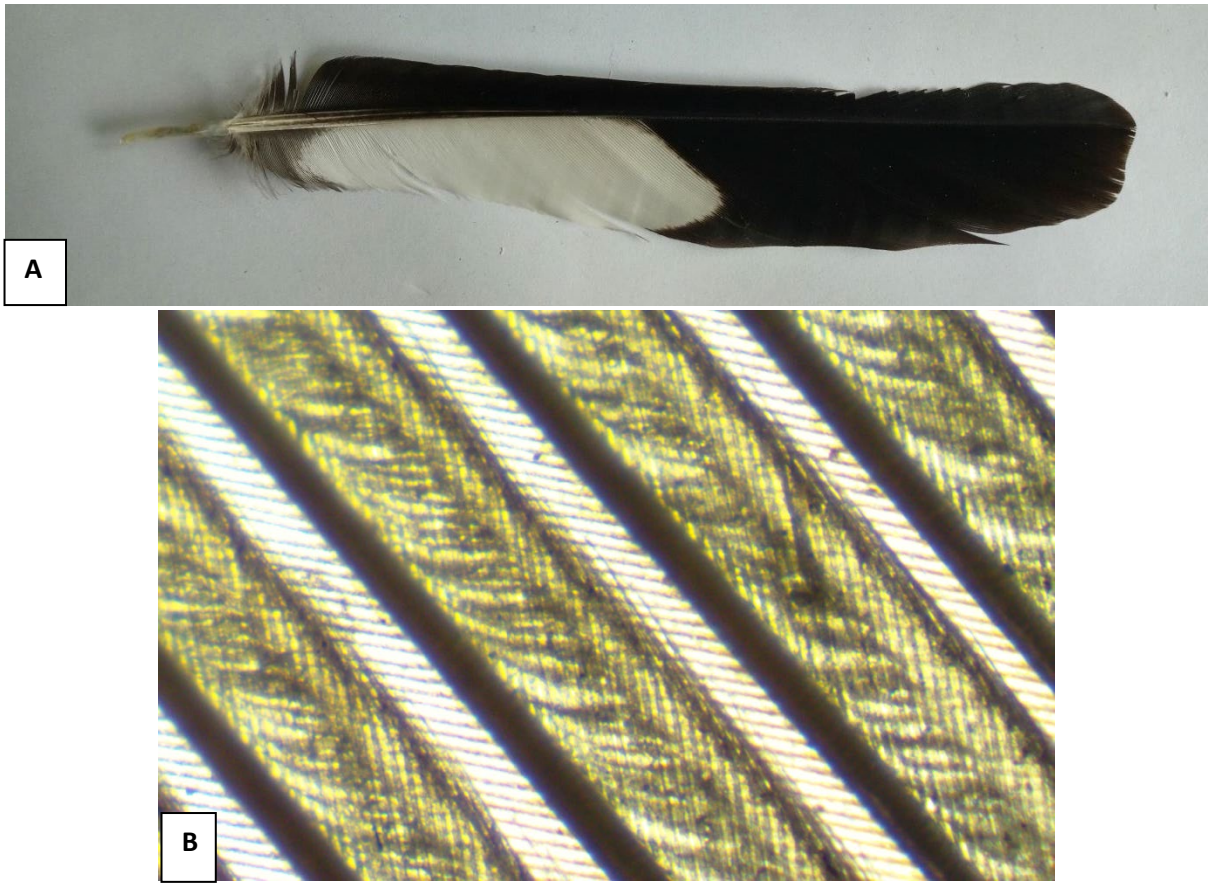

Figure 18 - A = Australian Magpie (*Cracticus tibicen*) feather; B = same feather x 40.

Penguins do not possess long fight feathers. However, they do possess long and bristle like tail feathers (retrices). See Figure 19 over the page.

Down feathers form a layer next to the skin and provide warmth. They lack a rachis. The barbules do not possess barbicels. Hence they are not smooth like vaned feathers, but rather are fluffy. This allows them to fill with air pockets, which assists with maintaining body temperature. In cold weather, birds will "fluff up" increasing the volume occupied by the feathers, which conserves heat by acting as insulation.

Figure 19 - Tail feathers (retrices) on a king penguin (*Aptenodytes patagonicus*).

In the Antarctic, Emperor penguins (*Aptenodytes forsteri*) and King penguins (*Aptenodytes patagonicus*) huddle together to conserve body heat. Chicks will do the same in the formation of crèches in some species.

Down feathers are very well developed in aquatic birds. Many penguin species have evolved to survive sub-zero Antarctic winters. A large component of this is the fluffy layer of down feathers. The original eiderdown for bedding was harvested from the nests of eider ducks in Scandinavian countries and archeological digs indicate that the Vikings possessed eiderdown on their voyages.

The overlapping feathers of penguins create a surface practically impenetrable to wind or water. The down feathers trap air, which provides about 80% of the thermal insulation for penguins. This air dissipates during diving and a stream of bubbles is often seen when they dive.

Heat loss also occurs via the bill and any bare facial areas. Birds tuck their head into or under their wing to maintain body heat.

Natal down refers to the feathers on baby birds. These down feathers arise from the same feather follicles that the contour feathers will develop from at **fledging**. Down feathers in adults arise from a separate group of feather follicles specifically for down feathers.

Figure 20 - King penguins (*Aptenodytes patagonicus*) at SEA LIFE Melbourne Aquarium. On the right is a chick displaying natal down.

The colour of skin and feathers is usually produced by three pigments:

- **Melanin** – produced by melanocyte cells in the epidermis
- **Carotenoids** (carotenes and xanthophylls) – synthesized by plants and taken up in the diet
- **Porphyrins** – red and green pigments synthesized in the bird cells

The crests of Macaroni penguins (*Eudyptes chrysolophus*) and other Eudyptes members fluoresce under a UV light a yellow-green colour. Investigation has revealed a new class of pigments called **pterins**, dissimilar to the carotenoid and melanin pigments which form most bird plumage. In Snares penguins (*Eudyptes robustus*), there has been a documented correlation between the intensity of this yellow pigment and body condition (heavier and healthier birds).

Feathers are held in the feather follicle by feather muscles, keratin bridges between the feather and follicular epidermis, as well the opposing concave and convex surfaces of the feather shaft and feather follicle.

The Aquarium Vet

E-quarist™ Course

Module Twenty Two

Penguins II

Contents

4.3 Chick Rearing

Altricial chicks are incapable of feeding themselves or moving around. The term comes from the Latin word *alere* meaning to rear or to nourish. These chicks are either born with no feathers or a fine down. They are born with their eyes closed and need to be fed by their parents. Penguins produce altricial chicks that need rearing by the parents.

It is essential to closely monitor the parents to see that they are feeding the chick(s) successfully. See Figure 95 over the page. CCTV in many cases can assist with monitoring parental feeding, as the footage can be fast forwarded as required and then closely examine the feeding in real time. As always good record keeping is important so that these observations are shared with the penguin caring team.

First feeding should be observed within 12 hours of hatching and should occur 5 to 10 times per day. Penguin chicks have a very rapid growth rate and can consume up to 50% of their bodyweight each day. As such it is very important to feed the parent birds *ad libitum*. It is also advisable to reduce and even stop the level of vitamin supplement given to the parents, so that the chick(s) cannot get an overdose of the fat-soluble vitamins (A, D, E and K).

The parents of chicks should have their food especially prepared. This means removing all fish spines (fins) and squid pens from the food as sadly, chick deaths have occurred from spines causing an oesophageal obstruction and choking as well as gut perforation with secondary peritonitis. Similarly, if feeding aquaculture-reared fish, it may be worth gutting these to remove any stones, wood, and uneaten fish pellets.

It is important to remember that rearing chick(s) places great nutritional demands on the parents. As such, these should be fed *ad libitum* and may consume two to four times their normal amount of food. This is especially the case when there are two chicks and they are growing quickly.

Monitoring the parent's weight and body condition is also essential during chick rearing, to ensure they do not lose too much weight during this period, requiring an increased feeding rate.

Figure 95 - King penguin (*Aptenodytes patagonicus*) feeding its chick. Such chick feeding observations are very important and must be recorded along with the time of the feed. Photo courtesy of SEA LIFE Melbourne Aquarium.

Chick Handling

For most penguins to examine a chick, one or both parents will need to be restrained. See Figure 96 over the page. Full PPE (especially safety glasses / goggles) should be worn during this procedure as parents can be very protective when chicks are being examined.

Whenever handling chicks always use two hands (one on top and one under) to ensure the chick is fully supported, to protect it from other birds, and it will also decrease any risk of dropping the chick. Always have all equipment necessary (weighing, tube feeding etc.) ready to minimize the time that the chick is handled and away from the parents. This will decrease the parents stress level, as well as minimize any temperature drop that the chick may experience.

Where possible do all tasks (e.g. weighing, tube feeding etc.) in the exhibit as close to the parents as possible. This reduces both parent and chick stress level and eliminates the risk of slipping and dropping the chick, if leaving the display and moving to off-display area.

Chick Weighing

Regular weighing of chicks will ensure they are gaining weight at an acceptable rate. Over time, with good record keeping, each facility can develop its own normal growth rate charts for the species under their care. Failure to gain weight can indicate the necessity to intervene with supplementary feeding, usually via a tube (covered in the next section).

Weighing chicks will vary with the species from daily to a minimum of three times a week. Generally, this is easiest done in the display rather than transporting the chick to back of house. The weighing should be done at about the same time each day for consistency. First thing in the morning is ideal as this allows the remainder of the day to take any action if required. The weighing process will always be easier with three people. The first to restrain / hold back the parent(s), the second to handle and weigh the chick and the third as recorder and assistant. See Figure 96, 97 and 98.

Figure 96 - Keeper holding a king penguin (*Aptenodytes patagonicus*) while the chick has been removed for weighing. Photo courtesy of SEA LIFE Melbourne Aquarium.

Chicks should ideally be weighed within a few hours of hatching to obtain an initial birth weight. If the chick hatches overnight, then weighing first thing the next morning is fine. In the first 24 to 48 hours there may be no weight gain or even a small loss of up to 10% until regular feeding is established. On the second or third day (at the latest), the chick should start to gain weight and after that gain about 10% of their bodyweight each day. As a general guide, chicks that are being successfully reared by their parents will have doubled their birth weight by between days 5 and 7.

When there are two chicks, it is very important to ensure that they are both gaining weight at about the same rate. Sometimes, the second chick hatched is smaller and so does not gain as much weight as the first. In this case, fostering or supplemental feeding may be needed, for one or even both chicks.

During the weighing process, it is important to also assess the chick's health. The chick should appear strong, react to being handled and be able to hold its head up. If it displays none of these, then it may be ill and dehydrated. To assess hydration, lightly pinch the skin at the back

of the neck. If after doing this, the skin remains in a pinched position, then the chick is likely dehydrated and will need veterinary attention and fluid therapy.

Figure 97 - Weighing a king penguin (*Aptenodytes patagonicus*) chick. A second larger chick can be seen in the background. Photo courtesy of SEA LIFE Melbourne Aquarium.