Vet eBooks
VET-EBOOKS.COM

FREE · NO SIGN-UP

ANATOMY · AVIAN · ILLUSTRATED GUIDE

AVIAN ANATOMY

Avian Anatomy: How Bird Bodies Differ (PDF)

How bird bodies differ — the skeleton, air sacs and one-way lungs, crop, proventriculus and gizzard, the cloaca and the single ovary, with labelled atlas plates. Companion to the article at vet-ebooks.com.

Contents

The 17 sections of this guide, in order.

IN SHORT

Avian anatomy is not mammalian anatomy with feathers — almost every system is rebuilt around flight and egg-laying. Birds have a **rigid lung** ventilated by **air sacs** that pump air one way and even fill the bones; a skeleton that is **fused, lightened and pneumatic**; no teeth but a **two-part stomach** ending in the muscular **gizzard**; no urinary bladder and no urea, but **uric acid** voided through a **cloaca**; and usually only a **single left ovary**. This guide walks each system with labelled atlas plates and a free illustrated PDF.

KEY POINTS

1. The bird lung is **rigid and does not inflate**. Eight thin-walled **air sacs** act as bellows, driving air **one way** through the gas-exchanging **parabronchi** — a far more efficient system than the mammalian tidal lung. There is **no diaphragm**.
2. Many bones are **pneumatic**: air-sac diverticula fill the humerus, sternum, vertebrae, pelvis and skull. Lighter — but it links the skeleton to the airway.
3. The trunk is **fused into a rigid box** (notarium, synsacrum, pygostyle) while the **neck is exceptionally long and mobile**, because the head must do the work of hands.
4. There are **no teeth**. Food is stored in the **crop**, mixed with acid and pepsinogen in the **proventriculus**, and then both ground and chemically digested in the **gizzard** — which is where most proteolysis actually occurs.
5. Birds are **uricotelic** and have **no urinary bladder**; urine, faeces and gametes all leave through the **cloaca**.
6. In most species only the **left ovary and oviduct** develop — a weight saving that shapes the whole reproductive tract.

About the images

The plates are reproduced for educational reference from *A Colour Atlas of Avian Anatomy* (McLelland J, Wolfe Publishing). Most show the domestic chicken, so this doubles as a working guide to **chicken anatomy**, with the duck, pigeon and canary used where they show a feature better. Each figure is credited beneath it; copyright remains with the original author and publisher.

This illustrated guide to **avian anatomy** works through the whole bird — the **bird skeleton**, the air sacs and one-way lungs, the crop, proventriculus and gizzard, the cloaca, and the single ovary — and shows at each step exactly **how bird bodies differ from mammals**. It is written for veterinary students and clinicians moving into avian practice, and it covers **avian anatomy and physiology** side by side, because in a bird the two are inseparable — the shape of the lung *is* the explanation of how it works. There are labelled atlas plates throughout and a free PDF. If you are comparing across species, it pairs with our Dog Anatomy and Cat Anatomy guides.

01 Bird vs mammal: the differences at a glance

Almost every difference in **avian anatomy** traces back to two demands: **flight** (be light, be rigid, deliver oxygen at extraordinary rates) and **laying a large, calcified egg**. Before the detail, here is the whole comparison in one place — it is the single most useful thing to have in your head when you first open a bird.

FEATURE	BIRD	MAMMAL
Lungs	**Rigid**, fixed to the ribs, do not inflate; gas exchange in **parabronchi** with **one-way** airflow	Elastic, expand and recoil; blind-ending alveoli with **tidal** (in-and-out) airflow
Air sacs	**Present** — eight thin-walled bellows in the chicken that ventilate the lungs and invade the bones	Absent
Diaphragm	**Absent** — breathing is driven by the sternum and ribs	Present; the main inspiratory muscle
Bones	Many are **pneumatic** (air-filled and connected to the air sacs); extensive **fusion**	Marrow-filled; far fewer fusions
Teeth	**None** — a keratin beak (rhamphotheca); food is ground in the gizzard	Present, differentiated
Stomach	**Two parts**: glandular proventriculus + muscular ventriculus (gizzard)	One stomach, glandular
Crop	Present in most species — an oesophageal storage pouch	Absent
Bladder	**Absent** — no bladder, no renal pelvis and no urethra; urine drains to the cloaca	Present
Nitrogen waste	**Uric acid** — the white paste on a dropping	Urea, in liquid urine
Ovaries	Usually the **left only**; the right regresses in the embryo	Paired and functional
Red blood cells	**Nucleated** and oval	Anucleate and biconcave
Excretory / genital exit	A single **cloaca**	Separate openings

Two clinical consequences follow immediately. First, birds are **extremely good at hiding illness**, so subtle changes in weight over the keel or in droppings matter enormously. Second, several of these differences are **anaesthetic (anesthetic) and surgical traps** — the pneumatic bones, the absent diaphragm and the air sacs all change how you handle, ventilate and inject a bird.

02 The bird skeleton: light, fused and rigid

Set a bird skeleton beside a mammal's and the same bones are there — but the proportions and the joins are transformed. The skeleton is **lighter** (thin cortices, high calcium phosphate, air-filled cavities), the **trunk is fused into a rigid box**, and the limbs are simplified by fusion and loss of individual bones. The neck, in contrast, is long and extraordinarily mobile. If you want the mammalian baseline in the same plate-by-plate format, our horse anatomy guide to bones and landmarks is the closest comparison.

Fig 1 — The complete avian skeleton (chicken). Note the deep **keel** on the sternum, the compact fused trunk, the long flexible neck, and the wing skeleton held in its folded Z-shape. Compared with a mammal the skeleton is lighter, with more fusion and fewer separate bones.

Image — McLelland J. A Colour Atlas of Avian Anatomy , Wolfe — plate 68, skeleton of an adult chicken. Reproduced for educational reference.

ADAPTATION	WHAT IT IS	WHY IT MATTERS
Pneumatic bones	Air-sac diverticula invade the medullary cavity of the humerus, sternum, vertebrae, ribs, pelvis and skull	Lighter skeleton — but a fracture opens a route into the respiratory system, so osteomyelitis and air-sacculitis can spread either way
Fusion of the trunk	The **notarium** (fused cranial thoracic vertebrae, with or without the last cervical — authors differ) and the **synsacrum** (fused thoracic, lumbar, sacral and caudal vertebrae, itself fused to the ilium)	A rigid box that resists the forces of flight and of landing on two legs
Pygostyle	The last caudal vertebrae fused into a plate	Anchors the tail feathers that steer and brake
Long mobile neck	Many more than a mammal — about 14–16 in the chicken, ~17 in the duck, ~12 in the pigeon — with saddle-shaped joints; the atlas meets a **single** occipital condyle	The head does the work our hands do — preening, feeding, nest building
Keel (carina)	A deep midline plate on the sternum	The origin of the huge flight muscles. Flat in flightless *ratites*; deep in strong fliers — and the standard site for **body-condition scoring**
Furcula	The fused clavicles — the wishbone	Acts as a spring between the shoulder joints during the wingbeat
Uncinate processes	Caudally directed hooks on the ribs, overlapping the rib behind	Brace the rib cage against collapse when the flight muscles pull

The **trunk skeleton** below shows the fusions working together. The vertebral column between the neck and the tail is almost immobile; the ribs carry backward-pointing **uncinate processes** that lock each rib to the next; and the whole cage transmits the pull of the flight muscles without collapsing.

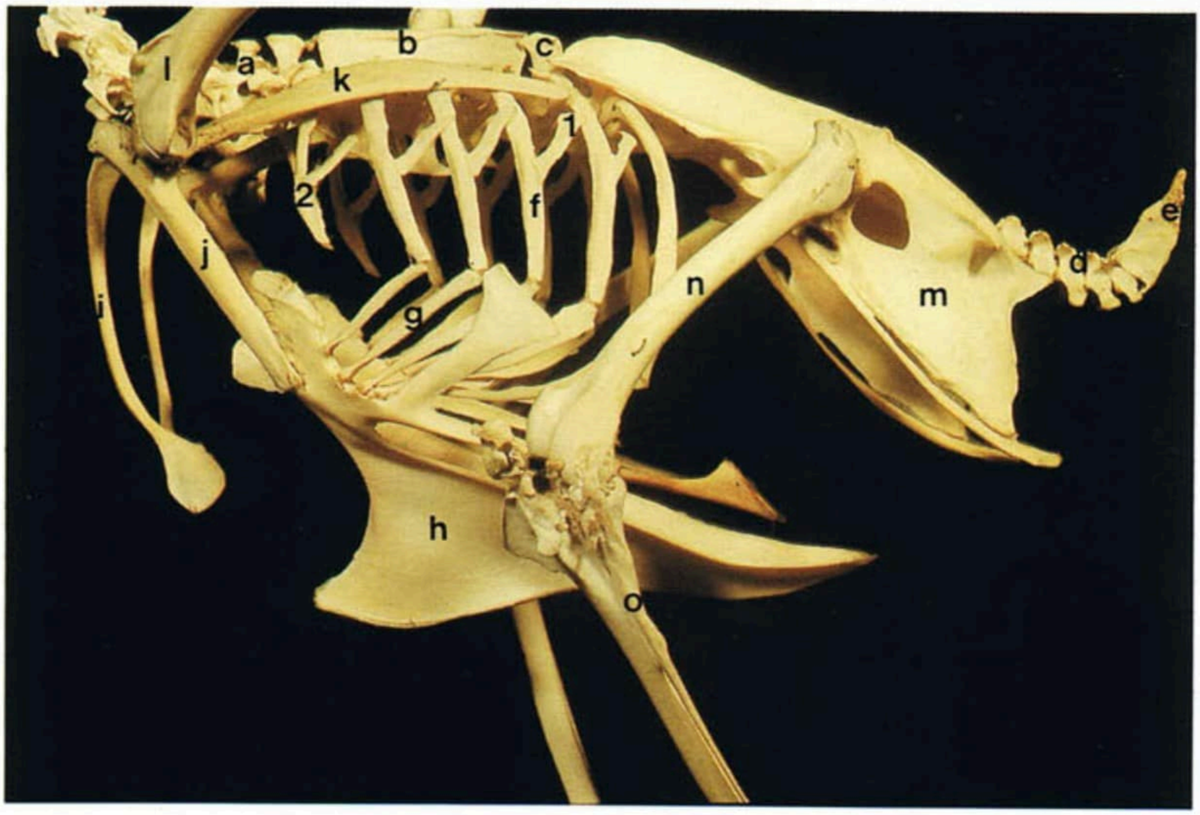

Fig 2 — The trunk skeleton, lateral view. The rigid core of the bird: fused vertebrae, ribs braced by **uncinate processes**, the synsacrum fused to the pelvis behind, and the sternum with its keel below. This is the frame that the wings pull against.

Image — McLelland J. A Colour Atlas of Avian Anatomy , Wolfe — plate 80, trunk skeleton of an adult chicken. Reproduced for educational reference.

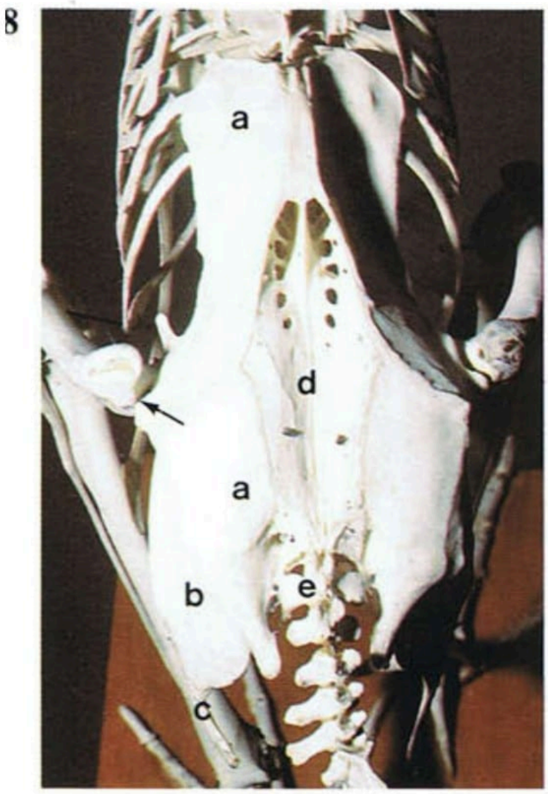

Fig 3 — The synsacrum and pelvis, dorsal view. (a) ilium, (b) ischium, (c) pubis, (d) synsacrum, (e) free caudal vertebrae. The synsacrum — fused thoracic, lumbar, sacral and caudal vertebrae — is itself fused to the ilium. The pubic bones do **not** meet ventrally, leaving the pelvis open so an egg can pass.

Image — McLelland J. A Colour Atlas of Avian Anatomy , Wolfe — plate 78, synsacrum and pelvis of an adult chicken. Reproduced for educational reference.

03 The flight frame: keel, furcula and thoracic girdle

The power of flight is delivered through three bones you will palpate or radiograph constantly. The **sternum** carries a deep midline **keel (carina)** from which the great pectoral muscles arise — the *pectoralis* pulling the wing down and, cleverly, the *supracoracoideus* running through a pulley at the shoulder to pull it *up*. Birds that do not fly (the **ratites** — ostrich, emu, rhea) have a flat, raft-like sternum with no keel.

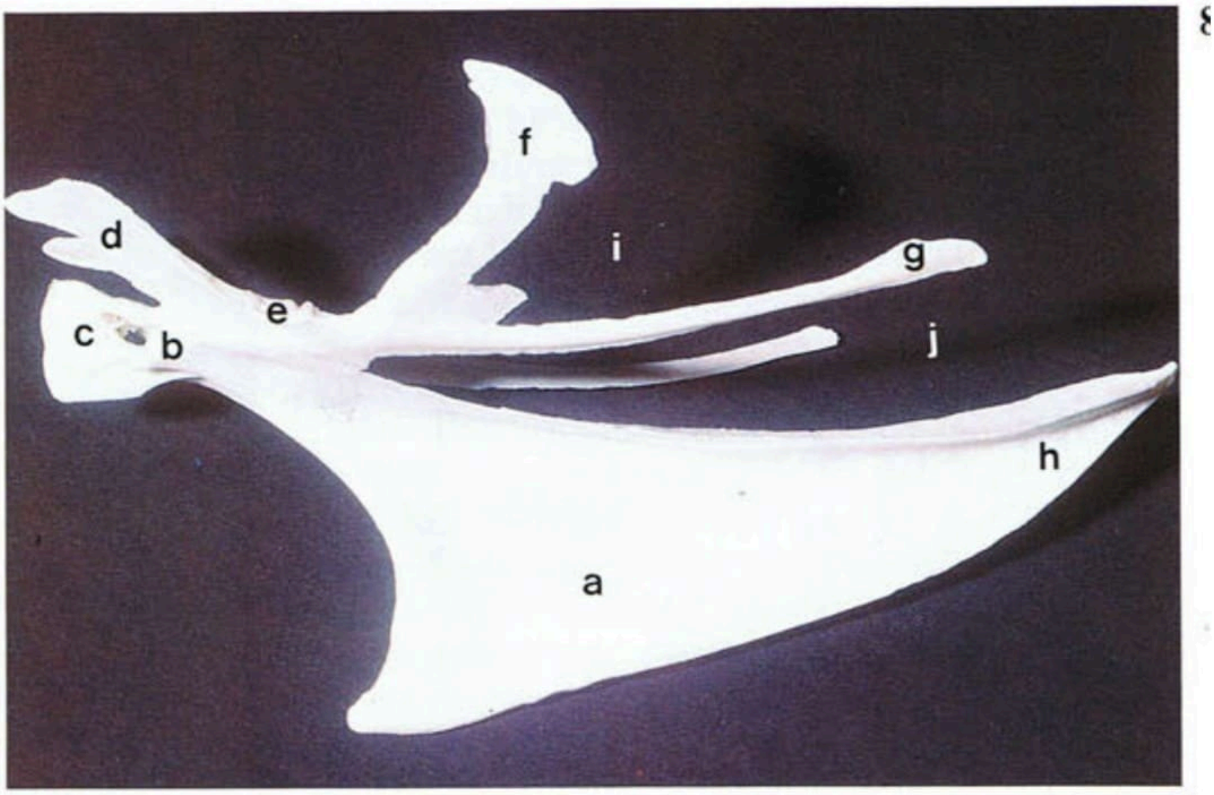

Fig 4 — The sternum and its keel, left lateral view. (a) the **keel or carina** — the deep plate that anchors the flight muscles; (b–e) articular facets and processes for the coracoid and ribs; (f) thoracic process; (g–j) the caudolateral processes, median trabecula and the notches between them, closed in life by membrane.

Image — McLelland J. A Colour Atlas of Avian Anatomy , Wolfe — plate 81, sternum of an adult chicken. Reproduced for educational reference.

The **thoracic girdle** is a rigid triangle of three bones on each side: the strut-like **coracoid** bracing the shoulder against the sternum, the blade-like **scapula** lying along the ribs, and the **clavicles**, which fuse ventrally into the **furcula** — the wishbone. The furcula behaves like a spring, flexing and recoiling with each wingbeat to hold the shoulders the right distance apart.

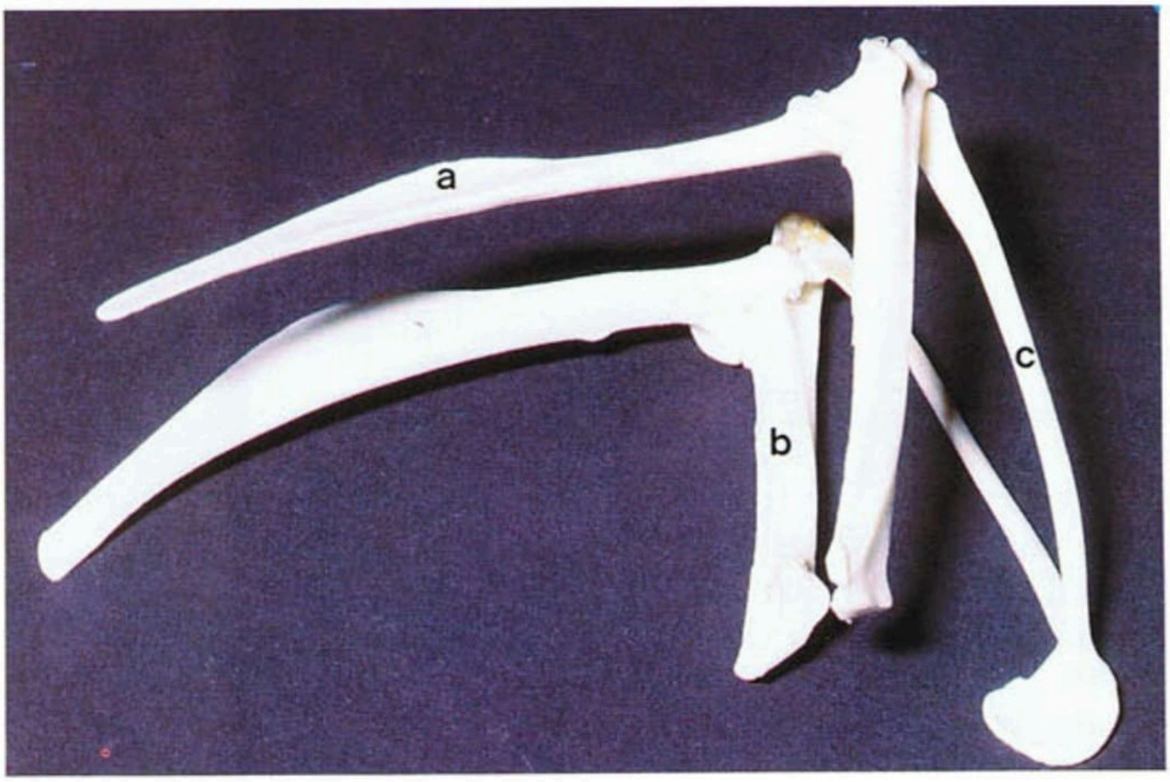

Fig 5 — The thoracic girdle: scapula, coracoid and furcula. (a) scapula, (b) coracoid, (c) clavicle. The coracoid is the strong strut that holds the shoulder away from the sternum during the downstroke; the paired clavicles fuse ventrally to form the **furcula (wishbone)**, which acts as a spring between the shoulder joints.

Image — McLelland J. A Colour Atlas of Avian Anatomy , Wolfe — plate 82, right and left thoracic girdles of an adult chicken. Reproduced for educational reference.

04 The wing and leg skeleton: the bones you name on a radiograph

Distal to the shoulder the wing repeats the mammalian pattern and then simplifies it. **Humerus, radius and ulna** are all recognisable — but note that in a bird the **ulna is the larger of the two** forearm bones and carries the secondary flight feathers, the reverse of what you expect from a mammal. Beyond the carpus most of the hand is fused into a single **carpometacarpus**, only two free carpal bones remain, and the digits are reduced to three. The first digit carries the **alula** — a small tuft of stiff feathers on the leading edge that works like a wing slat, keeping airflow attached at low speed.

The leg is fused in the same way, but from both ends. The **femur** is short and held close to the body; the **tibiotarsus** is the long bone below the knee (tibia fused with the proximal tarsal bones), with a slender **fibula** splinted alongside; and the visible "lower leg" of a standing bird is the **tarsometatarsus**, the distal tarsals fused to the metatarsals. What looks like a backwards knee is therefore the **ankle — the intertarsal joint**. Most birds have four toes with the first, the **hallux**, directed backwards; parrots and woodpeckers are **zygodactyl**, with digits 2 and 3 forward and 1 and 4 back.

These are the names on every avian radiograph report — and two of them are bones you will actually use. The **ulna** and the **tibiotarsus** are the standard intra-osseous catheter sites, precisely because neither is pneumatic.

05 The skull, beak and the S-shaped neck

The avian skull is light, thin-walled and dominated by **huge orbits** separated by a paper-thin interorbital septum — vision is the bird's leading sense. There are **no teeth**: the jaws are sheathed in keratin as the **beak**. Sutures disappear soon after hatching, so the braincase reads as a single vaulted shell.

The striking functional difference is **cranial kinesis**. Where a mammal can only drop its lower jaw, a bird can also **raise the upper jaw**, hinging it on the braincase at a flexible zone in the nasal and premaxillary bones and driving it through the quadrate, pterygoid and palatine bones. This widens the gape and lets the beak work as a precision tool.

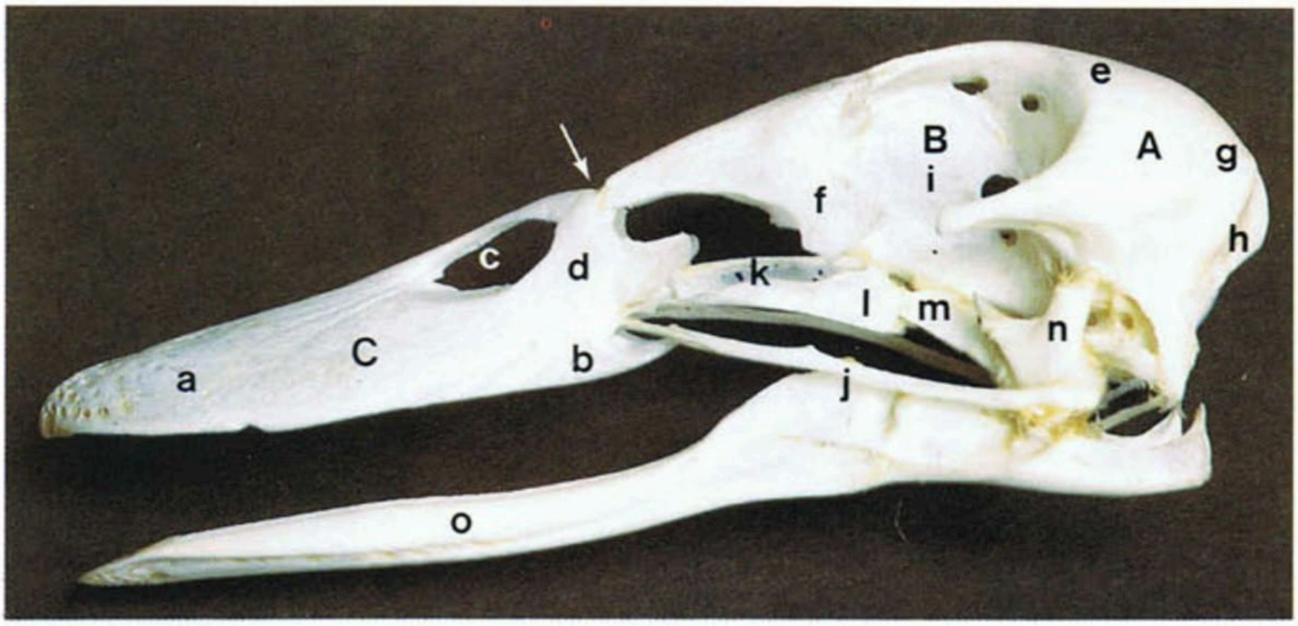

Fig 6 — The avian skull, lateral view (duck). (A) the vaulted braincase, (B) the very large orbit, (C) the beak-shaped face. The arrow marks the flexible **craniofacial hinge** where the upper jaw is raised in cranial kinesis; (l) palatine, (m) pterygoid and (n) quadrate are the pivots that drive it; (o) mandible.

Image — McLelland J. A Colour Atlas of Avian Anatomy , Wolfe — plate 69, skull of an adult duck. Reproduced for educational reference.

Behind the skull the **cervical column** is long, S-shaped and unusually mobile: the chicken has about **14–16 cervical vertebrae** (sources differ, because where the neck ends and the thorax begins is itself debated; the duck has around 17 and the pigeon 12), their joints are saddle-shaped, and the small ring-like **atlas articulates with a single occipital condyle**. That combination gives a range of head movement no mammal approaches — necessary, because the beak and neck must do the work that our forelimbs do.

Fig 7 — The S-shaped cervical column. The long, mobile neck of the chicken. The arrow marks the small ring-shaped **atlas**, which meets a **single** occipital condyle — unlike the two condyles of a mammal — making the atlanto-occipital joint exceptionally mobile.

Image — McLelland J. A Colour Atlas of Avian Anatomy , Wolfe — plate 76, the S-shaped cervical region of an adult chicken. Reproduced for educational reference.

The eye: the largest organ in a bird's head

Those orbits are full. The avian eye is enormous relative to the skull — in many owls and raptors the two eyeballs together outweigh the brain — and it is braced by a ring of small overlapping bones set in the sclera, the **scleral ossicles**. The retina has **no blood vessels of its own**; it is nourished instead by the **pecten**, a heavily pigmented, pleated, richly vascular fan that projects into the vitreous from the optic disc.

Two consequences catch clinicians out. The iris is controlled by **striated, not smooth, muscle**, so topical atropine will not reliably dilate a bird's pupil and the bird can constrict it voluntarily. And because the optic nerves decussate almost completely, there is **no consensual pupillary light reflex** — shining a light into one eye tells you nothing about the other.

Hearing and the brain get less attention, but two facts are worth carrying. The ear has **no pinna** and a **single ossicle**, the columella, behind an eardrum reached through an opening hidden under feathers caudoventral to the eye. And the avian brain is **smooth, without gyri**, with very large **optic lobes** — the anatomical restatement of the point that vision, not smell, runs the bird.

06 Pneumatic bones: a skeleton full of air

This is one of the strangest features of **bird anatomy** and one of the most clinically important. Diverticula of the air sacs grow *into* certain bones and replace the marrow with air, so the bone is hollow and braced internally by fine struts. The **humerus, sternum, cervical and thoracic vertebrae, synsacrum, ribs, pelvis and many skull bones** are typically pneumatised, though the pattern varies between species.

It is worth correcting the usual shorthand here. Pneumatic bones are not simply "lighter": avian bone is actually **denser** than mammalian bone, and a bird's skeleton is not a smaller fraction of its body mass than a comparable mammal's. What pneumatisation buys is **stiffness and strength for a given amount of bone** — material redistributed to where flight loads act — plus extra respiratory volume. The weight saving is real, but far smaller than the textbook cliché suggests.

Fig 8 — A pneumatic bone: the proximal humerus. The large opening in the proximal humerus is the **pneumatic foramen**, through which an air-sac diverticulum enters the marrow cavity. The bone is effectively part of the respiratory system.

Image — McLelland J. A Colour Atlas of Avian Anatomy , Wolfe — plate 305, proximal part of the humerus of a chicken. Reproduced for educational reference.

Clinical rule:

never give **intra-osseous fluids into a pneumatic bone** (humerus, femur in some species) — you would be infusing directly into the air sacs. Use the ulna or tibiotarsus. For the same reason a fracture of a pneumatic bone is effectively an open airway, and infection can travel in either direction between bone and air sac.

07 The avian respiratory system: air sacs and one-way breathing

The respiratory system is where birds depart most radically from mammals, and it is worth learning properly because it explains both their athletic performance and their vulnerability to inhaled toxins. Beyond the lungs, the bronchi open into a set of large, thin-walled, almost transparent **air sacs**. The chicken has **eight**: the unpaired **cervical** and unpaired **clavicular** sacs, plus the paired **cranial thoracic**, **caudal thoracic** and **abdominal** sacs. (You will also see the figure *nine* quoted: all the sacs begin as pairs, and some texts count the cervical sac as paired rather than fused. Either way the clavicular sac is genuinely unpaired.)

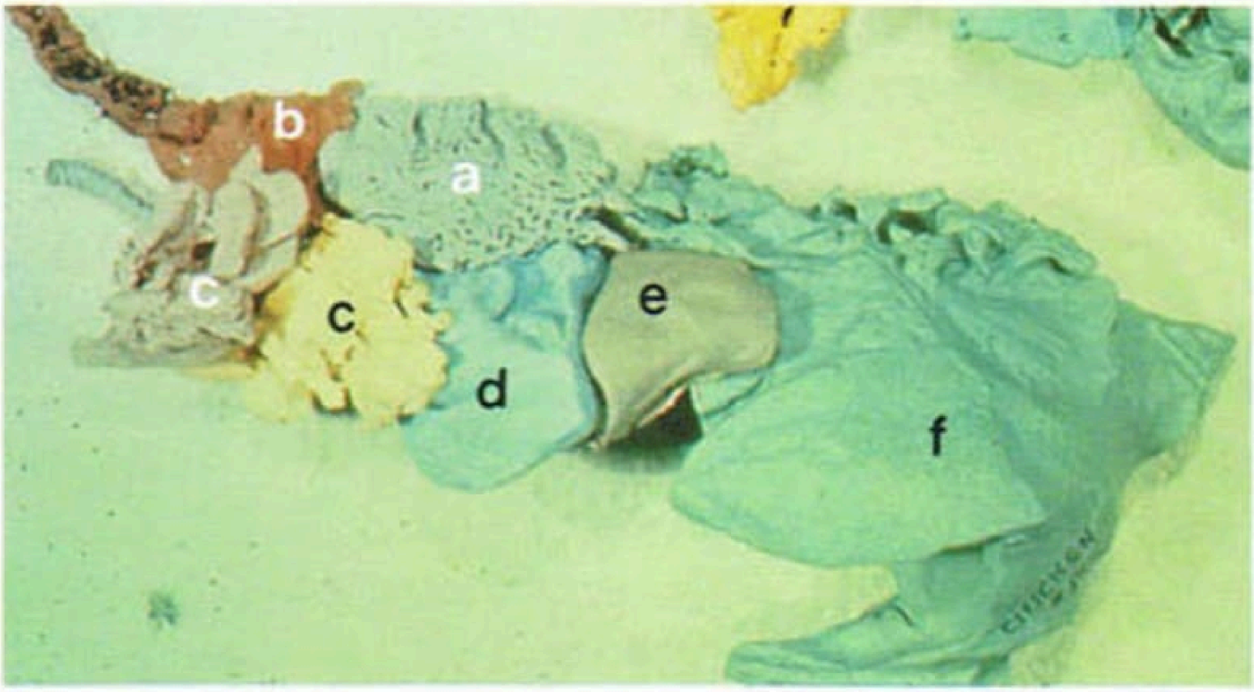

Fig 9 — The air sac system (latex cast). (a) lung, (b) cervical sac, (c) clavicular sac, (d) cranial thoracic sac, (e) caudal thoracic sac, (f) abdominal sac. The sacs are thin-walled bellows that reach throughout the body cavity — and send diverticula into the bones.

Image — McLelland J. A Colour Atlas of Avian Anatomy , Wolfe — plate 288, air sacs of an adult chicken, latex cast. Reproduced for educational reference.

Critically, **the air sacs do not exchange gas**. They are bellows. Because they are poorly vascularised, they are also a place where infection is hard to reach with drugs and where debris settles — hence **air-sacculitis**, a common finding in poultry and pet birds.

Air moves through the system in a **one-way circuit that takes two breaths** to complete:

1. **First inspiration** — air passes down the trachea and primary bronchus, largely bypassing the lung, and fills the **caudal** (posterior) sacs — the caudal thoracic and abdominal sacs.
2. **First expiration** — that air is pushed out of the caudal sacs *forwards into the lung*, through the parabronchi, where gas exchange happens.
3. **Second inspiration** — the air moves on from the lung into the **cranial** (anterior) sacs — cervical, clavicular and cranial thoracic.
4. **Second expiration** — it leaves through the trachea.

The result is that **fresh air flows across the gas-exchange surface during both inspiration and expiration** — unlike the mammalian lung, which fills and empties by the same route and always retains stale air. Flow is one-way through the **paleopulmonic** parabronchi, which make up the bulk of the lung; the smaller **neopulmonic** region (up to about a quarter of lung volume in the chicken) is ventilated back and forth. Combined with a cross-current blood flow, this makes the avian lung remarkably efficient, and is why birds can fly at altitudes that would render a mammal unconscious.

> **Why the canary died first.**
>
> The same efficiency makes birds exquisitely sensitive to **airborne toxins** — carbon monoxide, PTFE (overheated non-stick pans), aerosols and smoke. A modern cage bird in a kitchen is at real risk, and the anatomy is the reason.

08 The rigid lung and the parabronchi

Avian lungs are small, bright pink and **do not expand**. They are moulded into the dorsal ribs — the ribs actually indent them — and are firmly attached, so they change volume very little during breathing. Instead of ending blindly in alveoli, the airways continue through the lung as fine parallel tubes, the **parabronchi**, whose walls are honeycombed with air capillaries interwoven with blood capillaries. Gas exchange happens there, in a continuous flow rather than a tidal one.

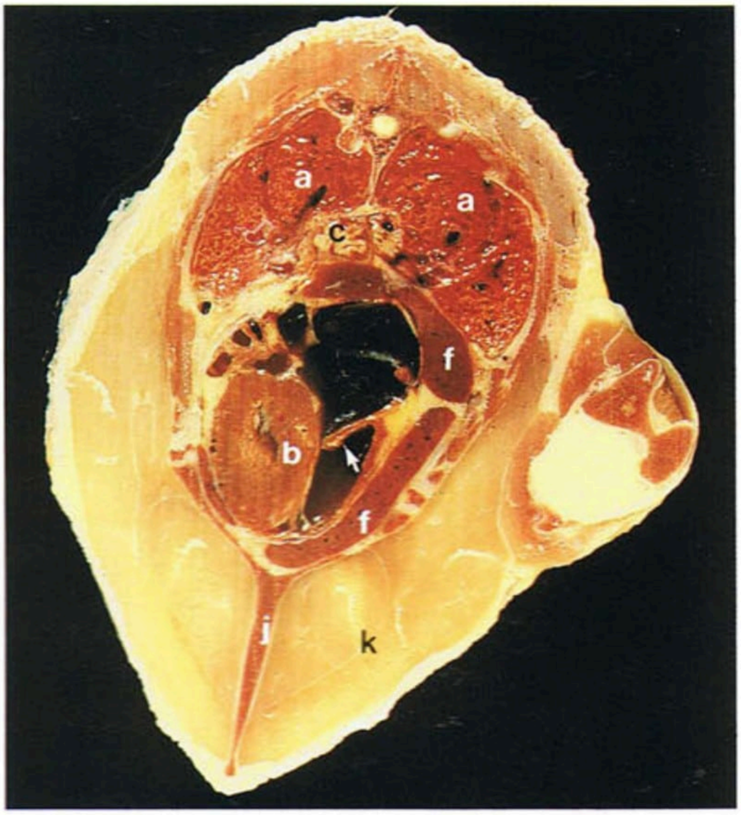

Fig 10 — The lungs in situ, transverse section. (a) the paired lungs, moulded tightly against the dorsal body wall and indented by the ribs; (b) heart; (f) liver; (j) keel of the sternum and (k) the great pectoral muscle mass below. The lungs are **fixed and rigid** — they do not inflate and deflate.

Image — McLelland J. A Colour Atlas of Avian Anatomy , Wolfe — plate 266, transverse section through the thorax of an adult chicken, caudal view. Reproduced for educational reference.

Since there is no diaphragm, ventilation is entirely skeletal: the sternum swings ventrally and the ribs rotate outwards, enlarging the body cavity and drawing air into the sacs. That has a blunt practical consequence — **if you restrain a bird so that its sternum cannot move, it cannot breathe.** Over-tight handling or a heavy hand on the chest is genuinely lethal.

09 The trachea and syrinx: how birds make sound

Above the lungs sits an airway built quite differently from a mammal's. The avian **trachea** is long — in swans, cranes and a few other species it even loops inside the keel before turning back — and it is **wider** than that of a mammal of similar size. The combination gives a large tracheal dead space, which birds offset by breathing more deeply and less often. Crucially, the tracheal rings are **complete cartilage circles**, not the C-shaped rings of a mammal, and they cannot expand.

Birds have a larynx, but it does not make sound. Voice is produced far lower down at the **syrinx** — a chamber of cartilages, muscles and thin tympaniform membranes sitting at the **bifurcation of the trachea into the two primary bronchi**, deep at the thoracic inlet. Because it has two sound sources, one at each bronchus, some songbirds can sing two notes at once. Clinically the location matters more than the trick: a change or loss of voice in a parrot points to the **syrinx**, not the throat, and syringeal aspergillomas sit exactly where they are hardest to see and hardest to reach.

Never use a cuffed endotracheal tube in a bird.

The tracheal rings are complete and rigid, so an inflated cuff has nowhere to expand: it presses straight onto the mucosa, causing pressure necrosis and, days later, a tracheal stricture. Use an **uncuffed** tube of the largest diameter that passes easily. Intubation itself is straightforward — the glottis sits at the base of the tongue and is easy to see.

10 The avian digestive system: no teeth, but a crop

Birds swallow food whole and process it further down. The beak takes it, the **crop** stores and softens it, and the two-part stomach does chemically and then mechanically what teeth would have done. One detail to fix before you ever pass a tube: the avian **oesophagus runs down the right side of the neck**, not the midline, and the crop sits slightly to the right at the thoracic inlet — which is the direction a crop tube must follow.

REGION	WHAT IT DOES	NOTES
Beak	Prehension only — there are no teeth	Continuously growing keratin sheath; overgrowth is a common cage-bird problem
Oesophagus & crop	Storage and softening	The **crop** is a ventral dilation at the thoracic inlet. Well developed in the pigeon (which makes **crop milk**), smaller in the canary, and absent in owls
Proventriculus	The **glandular** stomach — secretes HCl and pepsinogen	Short and spindle-shaped; its deep glands open through raised papillae
Ventriculus (gizzard)	The **muscular** stomach — grinds food against grit	Two thick and two thin muscle masses running between **two tendinous centres**, lined by a hard **koilin cuticle**. Very muscular in seed-eaters; thin-walled and without a cuticle in raptors and fish-eaters
Small intestine	Digestion and absorption	Duodenal loop cradles the pancreas, as in mammals
Caeca	Paired blind sacs where the ileum meets the rectum (the segment older texts call the colon); microbial fermentation	Long and paired in the chicken, ostrich and duck; tiny or absent in the pigeon, canary and most parrots
Colon & cloaca	Short colon into the **cloaca**	The cloaca has three chambers — coprodeum, urodeum and proctodeum — receiving faeces, urine and gametes

Fig 11 — The crop in three species. The oesophagus (a) widening into the **crop** (b, c) at the thoracic inlet. The crop is a simple storage pouch, but its size varies enormously between species — large and lobed in the pigeon, which produces **crop milk** for its young, and much smaller in seed-eating passerines.

Image — McLelland J. A Colour Atlas of Avian Anatomy , Wolfe — plates 117–119, crops of the pigeon, canary and duck. Reproduced for educational reference.

The crop matters clinically out of all proportion to its simplicity: it is where **crop stasis**, sour crop, foreign bodies and hand-rearing burns present, and it is the route for **crop tube feeding** in a sick bird.

11 The two-part stomach: proventriculus and gizzard

The avian stomach is split into a chemical half and a mechanical half. The **proventriculus** is the glandular stomach: a short spindle-shaped chamber whose deep glands secrete hydrochloric acid and pepsinogen through visible raised papillae.

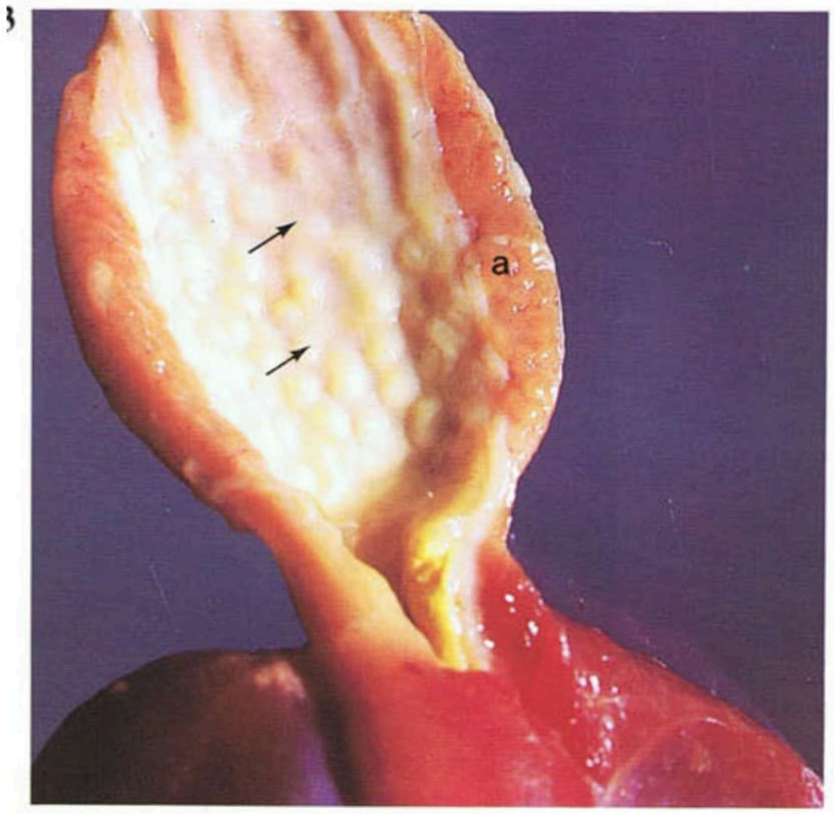

Fig 12 — Inside the proventriculus. The opened glandular stomach. The arrows mark the openings of the deep proventricular glands on their raised papillae; (a) the thick glandular wall. This is where acid and pepsinogen are *added* — but they do most of their work further on: proteolysis happens principally in the **gizzard**, where the pH sits around 1.5–2.5.

Image — McLelland J. A Colour Atlas of Avian Anatomy , Wolfe — plate 123, interior of the proventriculus of an adult chicken. Reproduced for educational reference.

Food then passes into the **ventriculus**, universally called the **gizzard**. This is a powerful muscular mill built from two thick and two thin muscle masses running between the **two pale tendinous centres** in its side walls, and lined by a hard, ridged **koilin cuticle**. Grit held inside acts as the grinding surface. In seed-eating birds it is massive; in raptors and fish-eaters, which swallow soft prey, it is thin-walled and has **no cuticle at all**.

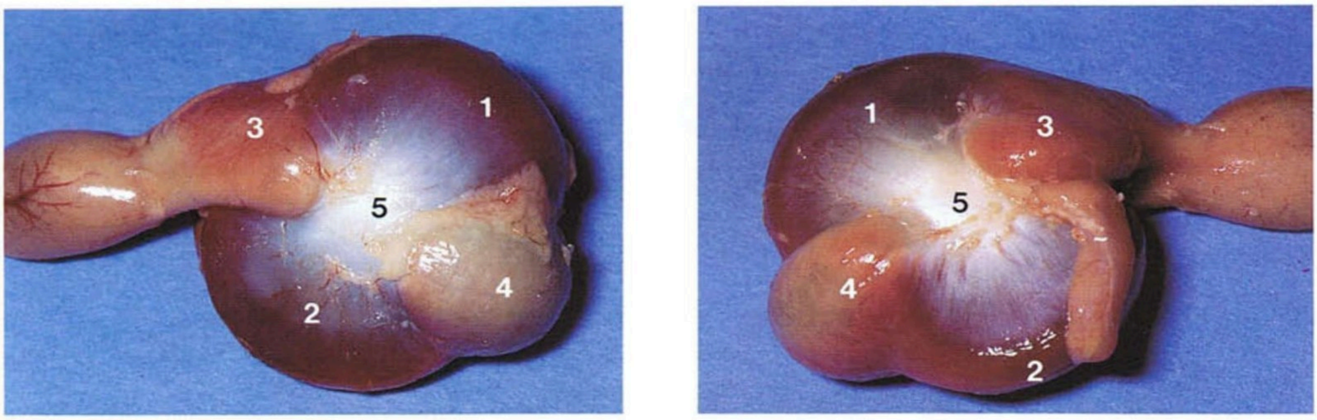

Fig 13 — The gizzard (ventriculus), two views. (1, 2) the two thick muscle masses and (3, 4) the two thin ones, running between (5) the pale **tendinous centres** in the lateral walls. The asymmetric muscle arrangement produces a shearing, grinding action against the koilin lining and the grit held inside.

Image — McLelland J. A Colour Atlas of Avian Anatomy , Wolfe — plates 125–126, gizzard of a chicken. Reproduced for educational reference.

Why this matters:

the gizzard is where **heavy-metal foreign bodies** (lead, zinc) lodge and are slowly ground down and absorbed — which is why a radiograph of a sick parrot or waterfowl is often aimed squarely at the ventriculus.

12 Liver, spleen, caeca and the immune organs

The **liver** is large and bilobed, wrapping around the caudal heart, and is the organ most often enlarged in a sick psittacine. The **spleen** is small and round to oval, sitting near the junction of proventriculus and gizzard on the right. The **pancreas** lies within the duodenal loop, exactly as it does in a mammal.

The paired **caeca** deserve more than a footnote. They are long in the chicken, duck and ostrich, where they ferment fibre (fiber) — on a far smaller scale than the forestomachs in our cattle anatomy guide — and they empty only every few hours. That is why an occasional dark, pasty, strong-smelling **caecal (cecal) dropping** in an otherwise well chicken is normal, and why the caeca are where *Histomonas* and *Eimeria* do their damage. They are tiny or absent in pigeons, canaries and most parrots.

The immune anatomy is genuinely different. Birds have **no encapsulated lymph nodes** — waterfowl are the partial exception — and rely instead on lymphoid aggregates scattered through the gut, spleen and other tissues. The two primary organs are the **thymus**, a chain of small pale lobes running down each side of the neck beside the jugular vein, and the **bursa of Fabricius** in the roof of the cloaca, where B lymphocytes mature. Both regress with age and both are routinely assessed at poultry post-mortem — an unexpectedly small bursa is the classic finding in infectious bursal disease.

13 No bladder: uric acid and the cloaca

Bird kidneys sit deeply recessed into the ventral surface of the synsacrum and pelvis — you cannot lift them out without breaking bone. They perform the same filtration as a mammal's, but the nitrogenous end-product is **uric acid**, not urea. Uric acid is nearly insoluble, so it can be excreted as a paste with very little water — a huge saving in weight and in water, and the reason the white cap on a dropping is *urine*, not faeces.

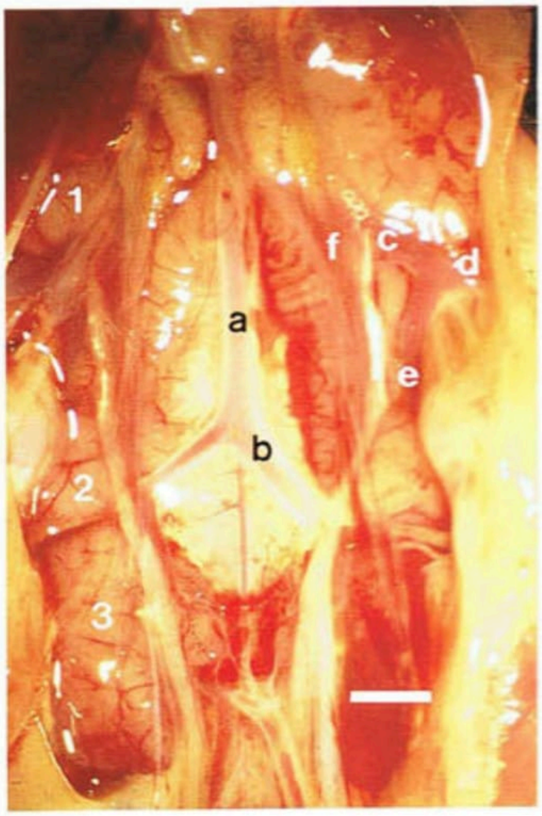

Fig 14 — The kidneys in situ, ventral view. The paired kidneys lie sunk into depressions of the synsacrum and pelvis, each divided into **cranial (1), middle (2) and caudal (3)** divisions. (a) aorta, (b) ischiadic artery, (c) common iliac vein, (d) external iliac vein, (e) caudal renal portal vein, (f) caudal renal vein — the vessels of the **renal portal system** that drains the hindlimbs through the kidney.

Image — McLelland J. A Colour Atlas of Avian Anatomy , Wolfe — plate 188, kidneys of a day-old chicken. Reproduced for educational reference.

There is **no urinary bladder**, no renal pelvis and no urethra. The ureters open into the **urodeum** of the cloaca, and urine is voided together with the faeces. The **cloaca** itself is the common chamber for the digestive, urinary and genital tracts, divided into three: the **coprodeum** (faeces), the **urodeum** (urine and gametes) and the **proctodeum** opening at the vent.

Two further oddities are worth knowing. Birds possess a **renal portal system**: venous blood from the legs can pass through the kidneys before returning to the heart, which is why a drug given in the caudal half of the body may be cleared before it reaches the general circulation — so **prefer the pectoral muscles** for intramuscular injection. And in the roof of the young bird's cloaca sits the **bursa of Fabricius**, the organ in which B lymphocytes mature; it regresses with age, and its size is routinely assessed on poultry post-mortem.

14 One ovary, one oviduct

In the overwhelming majority of birds, only the **left ovary and left oviduct** develop; the right pair regresses in the embryo. The **kiwi** is the consistent exception, and several birds of prey — peregrines especially — commonly keep both ovaries while still losing the right oviduct. The saving in weight is obvious once you appreciate what a laying hen's tract becomes: a hierarchy of yolky follicles, the largest ready to ovulate, drained by an oviduct that can occupy much of the left body cavity.

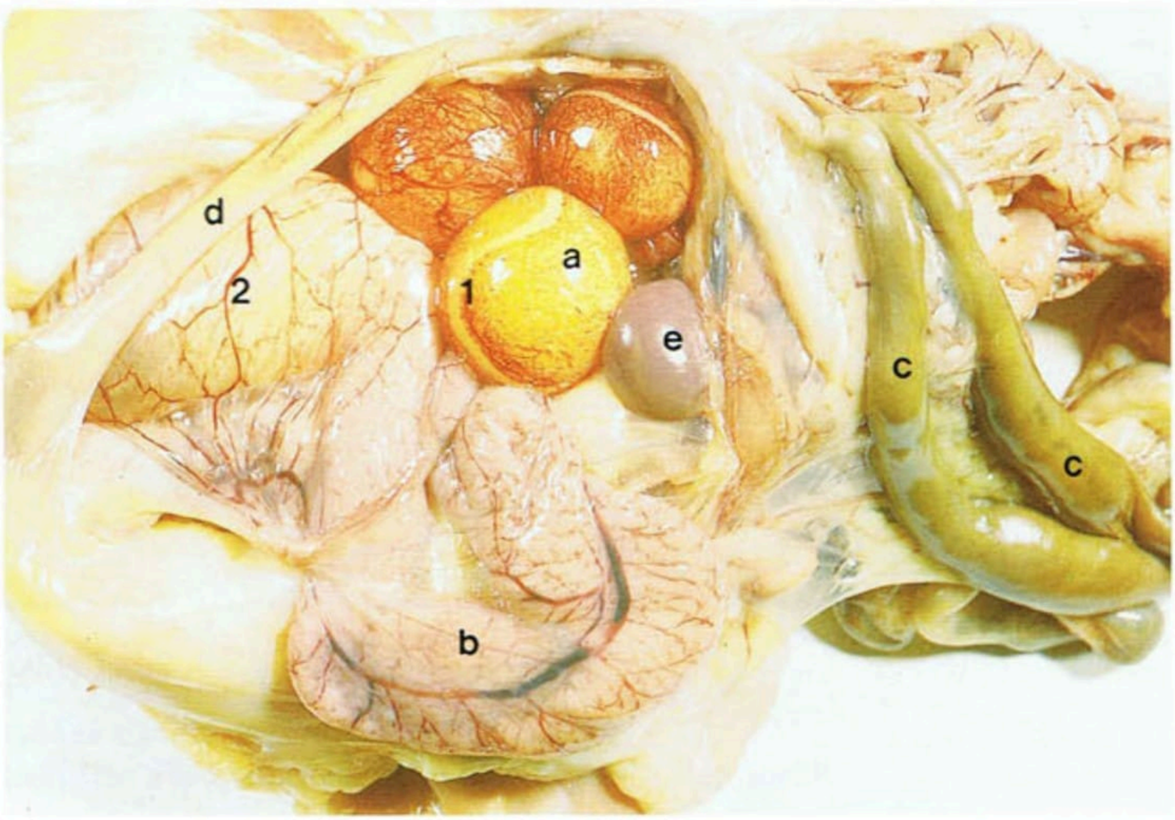

Fig 15 — The ovary and oviduct of a hen in lay. (a) the single **left ovary**, carrying its graded hierarchy of yolk-filled follicles; (b) the coiled **oviduct**; (c) the right and left **caeca**; (d) rectum; (e) spleen. Only the left side develops — the right ovary and oviduct regress before hatching.

Image — McLelland J. A Colour Atlas of Avian Anatomy , Wolfe — plate 161, ovary and oviduct of an in-lay chicken. Reproduced for educational reference.

The oviduct is a production line, and each region adds one component of the egg: the **infundibulum** engulfs the ovulated yolk (and is where fertilisation occurs), the **magnum** adds albumen, the **isthmus** the shell membranes, the **uterus (shell gland)** the calcified shell and pigment, and the **vagina** delivers it to the cloaca. Hens also store sperm in tubules at the utero-vaginal junction, so a single mating can fertilise eggs for up to about two weeks.

The whole journey takes about **24–26 hours**, and the shell gland accounts for most of it: roughly 15 minutes in the infundibulum, about 3 hours in the magnum laying down albumen, 1–2 hours in the isthmus for the shell membranes, and **around 20 hours in the uterus (shell gland)** building the calcified shell. Because the hen ovulates again within about an hour of laying, it is the timetable rather than the ovary that limits her to roughly one egg a day.

Meeting that calcium demand needs a dedicated reserve, and birds have one: **medullary bone**, a labile spicular bone laid down inside the marrow cavities of the long bones under oestrogen, drawn down for each shell and rebuilt between eggs. It is the reason chronic egg laying in a pet cockatiel presents as **pathological fracture or hypocalcaemic seizures** — the hen has quietly mined her own skeleton.

Males have **internal testes** that sit beside the cranial pole of the kidneys and swell dramatically in the breeding season. Most birds have **no protrusible (intromittent) phallus** — mating is a brief *cloacal kiss* — though waterfowl and ratites, which do have one, are the notable exceptions.

One practical consequence of internal testes: **you cannot sex most birds by looking at them.** The majority of psittacines are monomorphic, and the species that are dimorphic are so by plumage or cere colour rather than by anatomy — the budgerigar's cere (blue in the male, brown in the breeding female) and the eclectus parrot's green male and red female are the familiar exceptions. Everything else needs **DNA sexing** from a blood or feather sample, or endoscopy.

15 Feathers, skin and the uropygial gland

Avian skin is **thin, dry, loosely attached and almost glandless**. Birds have **no sweat glands**; they lose heat by panting, by gular fluttering and through the air sacs. The one significant skin gland is the **uropygial (preen) gland** above the tail base, whose oily secretion is spread over the feathers during preening — and it is absent in some species, including many parrots and pigeons. Compare the thick, glandular, follicle-dense skin of a mammal in our dog anatomy guide.

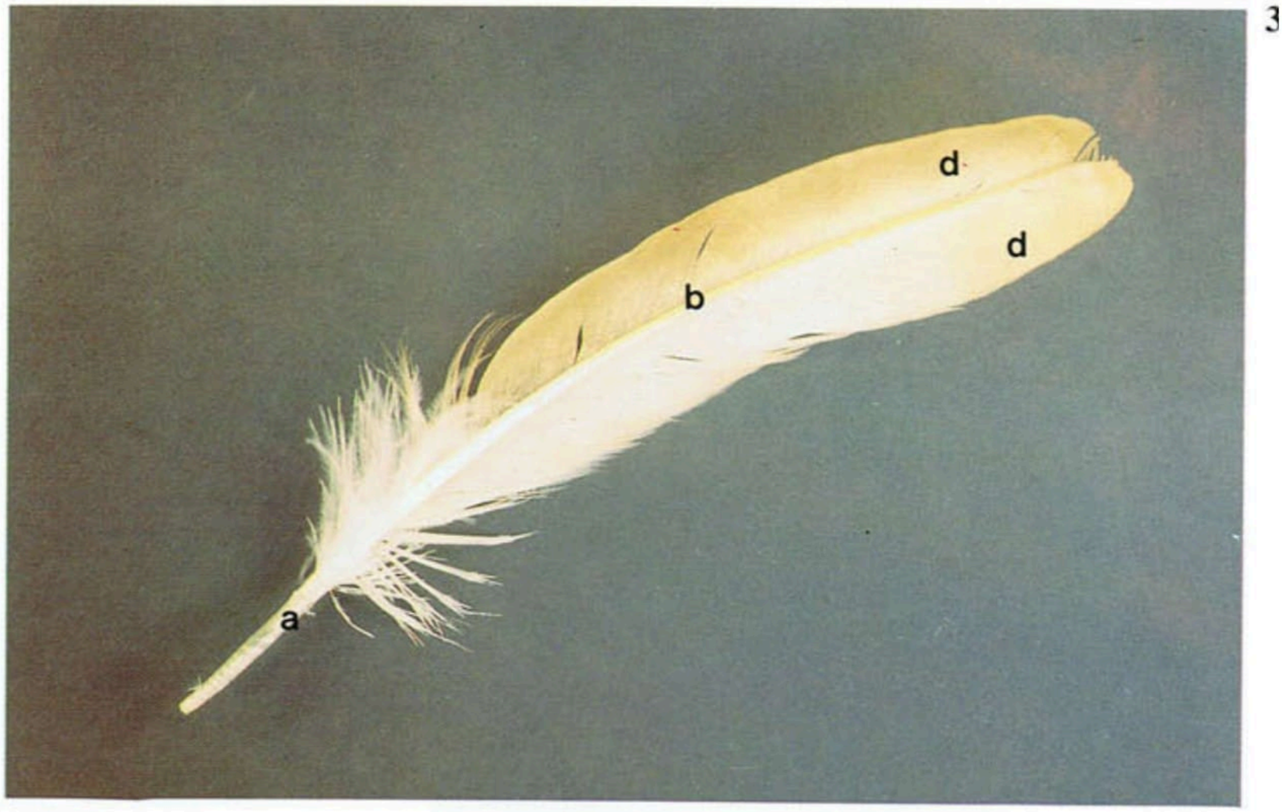

Fig 16 — The structure of a flight feather. (a) the **calamus** or quill, implanted in the follicle; (b) the **rachis**, the solid shaft; (d) the **vane**, formed by rows of barbs zipped together by hooked barbules. Note the asymmetric vanes of a flight feather — the narrow leading edge is what makes it an aerofoil.

Image — McLelland J. A Colour Atlas of Avian Anatomy , Wolfe — plate 30, flight feather of an adult chicken. Reproduced for educational reference.

Feathers are not scattered at random: they grow from defined tracts (**pterylae**) separated by bare areas (**apteria**) — which is exactly why a bird can be plucked in lines, and why surgical approaches follow the apteria. Feathers are also **dead keratin once grown**, so damage is permanent until the next moult, but a **growing (blood) feather has a live blood supply** and will haemorrhage (hemorrhage) significantly if broken. Parrots, cockatoos and cockatiels also carry **powder down** — feathers that disintegrate at the tip into a fine white keratin dust; its sudden absence in a cockatoo is a recognised sign of psittacine beak and feather disease.

16 The heart and the blood

The avian heart is **four-chambered like a mammal's, but proportionally larger and much faster**: relative to body weight it is roughly twice the size of a comparable mammal's, and resting rates run from about 250 beats/min in a chicken to 500–600 in a small parrot and over 1,000 in a hummingbird — far too fast to count with a stethoscope. Two structural differences are worth carrying: the **right atrioventricular valve is a single muscular flap** rather than a membranous tricuspid valve, and the aorta arches to the **right**, not the left.

The blood is different too. Avian **red cells are nucleated and oval**, birds have **thrombocytes** instead of platelets, and **heterophils** stand in for neutrophils. That is why an avian smear cannot be read on mammalian rules, and why most automated analysers cannot count avian blood at all — the nucleated red cells are miscounted as leucocytes (leukocytes).

17 Why avian anatomy matters clinically

Nearly every practical rule in bird medicine is an anatomical fact in disguise:

Handling and anaesthesia

No diaphragm means **sternal movement is breathing** — restrain a bird around the chest and it suffocates. The air sacs also make induction and recovery with inhalant agents very fast, and allow **air-sac cannulation** to bypass a blocked trachea.

Injections and fluids

Give intramuscular injections into the **pectoral muscles** in preference to the legs, because the **renal portal system** may carry drug from the hindlimb through the kidney before it reaches the general circulation. Never place an intra-osseous catheter in a **pneumatic bone**; use the ulna or tibiotarsus.

Assessing the patient

Body condition is scored over the **keel**. The droppings are read in three parts — faeces, white uric acid and clear urine — and a change in any one localises the problem. Because prey species mask disease, a bird that looks obviously sick is usually very sick.

One cavity, not two: the coelom

Because a bird has no diaphragm, it has no separate thoracic and abdominal cavities at all — the viscera sit in a single **coelom**, subdivided only by thin membranes and by the air sacs themselves. Two consequences follow directly. Ventilation depends entirely on movement of the sternum and ribs, so **a hand closed around the chest suffocates the bird** however gently it is holding it: restrain over the shoulders and let the keel move. And anything that occupies coelomic space — a retained egg, an enlarged liver, ascites — compromises breathing far sooner than the equivalent would in a mammal, because there is no diaphragm separating the problem from the lungs.

Two emergencies the anatomy explains

Upper airway obstruction has a way out that mammals do not have. A bird with a syringeal aspergilloma, an inhaled seed or a tracheal stricture is dying of an obstruction that sits above the lungs — but because the respiratory system is a one-way flow-through circuit, an **air sac cannula** placed into the caudal thoracic or abdominal air sac lets the bird ventilate while bypassing the trachea completely. It is a genuinely life-saving procedure, and it exists only because of the air sac anatomy described above.

Egg binding is a coelomic problem, not just a reproductive one. A retained egg in the single left oviduct presses on the kidneys and the ischiatic nerve running past them — which is why a bound hen is often presented for *leg weakness* rather than straining — obstructs the cloaca so that neither urates nor faeces pass, and splints the coelom so the bird cannot breathe properly. All three follow from anatomy the article has already described.

Two more worth naming The **choana** is the slit in the hard palate connecting the nasal cavity to the oropharynx; its margin normally carries sharp papillae, and blunting of them is a classic sign of hypovitaminosis A. And because birds excrete nitrogen as uric acid rather than urea, dehydration or renal failure precipitates urate crystals — in joints as painfully lame **articular gout**, or across the serosal surfaces as visceral gout found at post-mortem.

Radiography and toxins

Look at the **ventriculus** for metal densities in any unwell parrot or waterfowl, and remember that the respiratory efficiency that lets a bird fly over Everest also makes it the first casualty of fumes in a kitchen.

18 Avian anatomy quiz: 15 self-test questions

Cover the answers and work down the list. These are the points most often examined in **avian anatomy** and most often needed in the consult room.

SELF-TEST1. Name the three biggest anatomical differences between a bird and a mammal.**Answer: Air sacs with rigid, one-way lungs** (and no diaphragm); a **two-part stomach** (glandular proventriculus + muscular gizzard) with no teeth; and a **cloaca** with no urinary bladder, excreting uric acid.2. How many air sacs does a chicken have, and do they exchange gas?**Answer: Eight** — unpaired cervical and clavicular, plus paired cranial thoracic, caudal thoracic and abdominal. (Some texts say nine, counting the cervical sac as paired.) They are thin-walled bellows that **ventilate** the lungs — **they do not exchange gas** themselves.3. Why does a bird not need a diaphragm?**Answer:** Because the lungs do not inflate. Ventilation comes from movement of the **sternum and ribs**, which squeezes and fills the air sacs; the rigid lung is simply flushed with air.4. What is a pneumatic bone, and why is it clinically important?**Answer:** A bone whose marrow cavity is invaded by an **air-sac diverticulum** (humerus, sternum, vertebrae, pelvis, skull). A fracture connects the airway to the outside, so infection can pass in either direction — and you must never place intra-osseous fluids in one.5. Which two bones form the bird's flight skeleton signature?**Answer:** The **keel (carina)** of the sternum, which anchors the flight muscles, and the **furcula** (fused clavicles — the wishbone), which springs between the shoulders. Note the clavicles are **reduced or absent in some parrots**.6. What is the difference between the proventriculus and the ventriculus?**Answer:** The **proventriculus** is the **glandular** stomach (acid and pepsinogen); the **ventriculus** or **gizzard** is the **muscular** stomach that grinds food against grit, lined by a hard koilin cuticle.7. Which birds have a well-developed crop, and what does the pigeon do with it? **Answer:** Most grain-eaters — the chicken and especially the pigeon. Both sexes of pigeon produce **crop milk**, a sloughed epithelial secretion fed to the squabs.8. Where is the synsacrum and what is fused into it?**Answer:** In the caudal trunk: fused **thoracic, lumbar, sacral and caudal vertebrae**, itself fused to the **ilium** — giving a rigid pelvis with no pubic symphysis.9. Why do birds have no pubic symphysis? **Answer:** The pubic bones stay separate ventrally so a hen can pass an egg. It also means the avian pelvis is open ventrally, unlike the mammalian ring.10. Which ovary and oviduct are functional in most birds?**Answer:** Only the **left**. The right ovary and oviduct regress during embryonic development (the kiwi consistently, and several raptors commonly, keep both ovaries).11. What is the white part of a bird dropping?**Answer: Uric acid** — birds are uricotelic and have **no urinary bladder**, so urine passes to the cloaca and is voided with the faeces.12. How does avian blood differ from mammalian blood?**Answer:** Avian **red blood cells are nucleated and oval**; birds also have **thrombocytes** rather than platelets, and heterophils in place of neutrophils.13. What is the koilin cuticle?**Answer:** The tough, ridged lining secreted onto the inner surface of the **gizzard**, against which grit grinds the food. Its green-yellow colour is not intrinsic — it comes from bile regurgitated forward from the duodenum.14. Why is the keel used clinically?**Answer:** It is the landmark for **body-condition scoring** — the pectoral muscle mass either side of the keel is palpated, because birds hide illness and weight loss shows here first.15. What is cranial kinesis?**Answer:** The ability to raise the upper jaw on the braincase, at a flexible hinge between the cranium and the nasal/premaxillary bones, increasing the gape. Mammals cannot do this.

19 Avian anatomy — frequently asked questions

How is bird anatomy different from mammal anatomy?

The biggest differences are **rigid lungs ventilated by air sacs with one-way airflow and no diaphragm**; a **lightened, fused and partly air-filled skeleton**; **no teeth** but a crop and a two-part stomach ending in the muscular gizzard; **no urinary bladder**, with uric acid voided through a **cloaca**; and usually a **single left ovary**. See the comparison table above.

How do birds breathe?

Air is drawn by movement of the sternum and ribs into **air sacs**, which act as bellows. It takes **two breath cycles** for one lungful of air to travel caudal sacs → lung → cranial sacs → out, so **fresh air crosses the gas-exchange surface on both inspiration and expiration**, one-way through the paleopulmonic parabronchi that form most of the lung. The lungs themselves do not inflate.

Do birds have a diaphragm?

No. There is no muscular diaphragm dividing the body cavity, and breathing depends entirely on movement of the sternum and ribs — which is why a bird held too tightly around the chest cannot breathe.

Why are bird bones hollow?

Many bird bones are **pneumatic**: diverticula of the air sacs grow into the marrow cavity, leaving an air-filled bone braced by internal struts. It saves weight, but it means the skeleton is continuous with the respiratory system — so fractures and intra-osseous catheters in these bones are dangerous.

What is the difference between the proventriculus and the gizzard?

The **proventriculus** is the **glandular** stomach that adds acid and pepsinogen; the **gizzard (ventriculus)** is the **muscular** stomach that grinds the food against grit, lined by a tough koilin cuticle. Together they replace the work of teeth.

Why do birds only have one ovary?

In nearly all birds only the **left** ovary and oviduct develop, the right regressing in the embryo. It is generally explained as a weight saving for flight — and it avoids carrying two large calcified eggs at once.

What is the white part of bird droppings?

It is **urine**. Birds excrete nitrogen as **uric acid**, a near-insoluble white paste, and having no bladder, renal pelvis or urethra they void it through the cloaca together with the faeces.

Do birds have vocal cords?

No. Birds have a larynx but no vocal cords; sound is made by the **syrinx**, a separate organ at the bottom of the trachea where it divides into the two bronchi. That is why a voice change in a bird is a lower-airway sign, not a throat problem.

Do birds have lymph nodes?

Generally no. Birds lack the encapsulated lymph nodes mammals have (waterfowl are a partial exception) and use scattered lymphoid tissue instead. Their two unique primary organs are the **thymus** in the neck and the **bursa of Fabricius** above the cloaca.

How do you tell if a bird is male or female?

Usually not by anatomy. The testes are internal and most birds have no protrusible phallus, so there is nothing to see externally. Most parrots are monomorphic and need **DNA sexing** from a feather or blood sample; a few species differ in plumage or cere colour.

How does avian anatomy compare with other species we cover?

Birds diverge from mammals far more than mammals diverge from each other. For the mammalian baseline see our Dog Anatomy, Cat Anatomy, Horse Anatomy and Cattle Anatomy visual guides.

> **When to refer**
>
> - **The bird that stops breathing when restrained** — no diaphragm; the sternum must be free to move.
> - **The intra-osseous catheter** — never in a pneumatic bone (humerus); use the ulna or tibiotarsus.
> - **The injection site** — pectoral muscles, because the renal portal system drains the legs.
> - **The sick parrot's radiograph** — metal densities in the ventriculus (lead, zinc).
> - **The thin bird** — body condition is scored over the keel, where loss shows first.
> - **The kitchen fume death** — one-way lungs make birds the most sensitive species to airborne toxins.

Sources

1. McLelland J. *A Colour Atlas of Avian Anatomy*. Wolfe Publishing — source of the labelled plates throughout this guide.
2. König HE, Korbel R, Liebich HG. *Avian Anatomy: Textbook and Colour Atlas*. 2nd ed. 5m Books — systematic and clinical avian anatomy.
3. Dyce KM, Sack WO, Wensing CJG. *Textbook of Veterinary Anatomy*. 5th ed. Elsevier — comparative reference for the mammalian contrasts.
4. WikiVet — Avian Respiratory System — open revision notes on air sacs and lung structure.

Vet eBooks
VET-EBOOKS.COM

MORE FREE STUDY GUIDES · RESOURCES

More free veterinary study guides

This is one of a growing library of free veterinary study guides on vet-ebooks.com — written for practising vets and students, sourced from the standard veterinary texts, and every one free with a downloadable PDF and no sign-up.

3,400+
veterinary books

400+
drug profiles

Study guides
a free PDF with each

All free
no sign-up needed

www.vet-ebooks.com