Avian lumbosacral spinal cord specializations
1. **Lumbosacral expansion** of gray and white matter of the cord in the spinal levels that serve the hindlimbs.

- Present in all limbed tetrapods, and in some fishes with sensitive fins.

- Cord expands and contracts gradually, over many segments.

- Even though the cord does not fill the diameter of the neural canal, the swellings adjacent to the limbs are reflected in increased neural canal diameter at those levels (Giffin 1990).

---

**Fig. 3.** Topography of the spinal cord of the ostrich. The transverse sections are all made on the same scale of enlargement and their proper levels are indicated on the drawing.
2. The **glycogen body**: a mass of specialized, glycogen-rich glial cells that occurs only in birds.

- Occupies a trough, the *sinus rhomboidalis*, that separates the dorsal halves of the spinal cord.
2. The **glycogen body**: a mass of specialized, glycogen-rich glial cells that occurs only in birds.

- Occupies a trough, the *sinus rhomboidalis*, that separates the dorsal halves of the spinal cord.

---

*pigeon, from Huber 1936: fig 3*
2. The **glycogen body**: a mass of specialized, glycogen-rich glial cells that occurs only in birds.

- Occupies a trough, the *sinus rhomboidalis*, that separates the dorsal halves of the spinal cord.

- Varies widely in size among taxa, from barely noticeable (e.g., ostriches) to larger in cross-section than the spinal cord itself (e.g., chickens, pigeons).

- Serially, it expands and contracts rapidly, over just a few segments.

- If the glycogen body is large, the neural canal will be noticeably expanded to accommodate it.
3. **Lumbosacral canals**: transverse, fluid-filled meningeal tubes that arch dorsally over the spinal cord.

**Fig. 12** Casts of the vertebral canal of three different avian species. Note differences in the heights of the lumbosacral canals. *Asterisks* indicate location of the glycogen body. *r* rostral, *c* caudal
3. **Lumbosacral canals**: transverse, fluid-filled meningeal tubes that arch dorsally over the spinal cord.

- Present in most (all?) birds, Larger and earlier-developing in weak fliers and flightless taxa.

---

**Fig. 11** Comparison of the vertebral canal of a pigeon and of a chicken at the time of hatching. Note large fluid spaces in the chicken. *Scale bars*, pigeon 1 mm, chicken 2 mm
3. **Lumbosacral canals:**
transverse, fluid-filled meningeal tubes that arch dorsally over the spinal cord.

- Present in most (all?) birds,
Larger and earlier-developing in weak fliers and flightless taxa.

- These canals occupy expansions of the neural canal at former intervertebral joints in the synsacrum.

Necker 2005: fig 3
3. **Lumbosacral canals**: transverse, fluid-filled meningeal tubes that arch dorsally over the spinal cord.

- Present in most (all?) birds, Larger and earlier-developing in weak fliers and flightless taxa.

- These canals occupy expansions of the neural canal at former intervertebral joints in the synsacrum.

Necker 2005: fig 3
3. **Lumbosacral canals**: transverse, fluid-filled meningeal tubes that arch dorsally over the spinal cord.

- Present in most (all?) birds, Larger and earlier-developing in weak fliers and flightless taxa.

- These canals occupy expansions of the neural canal at former intervertebral joints in the synsacrum.

- Many lines of evidence point to function as semicircular-canal analogues for maintaining equilibrium.

---

Fig. 6 Scheme of the possible function of the lumbosacral canals (*bottom*) as compared to the function of the semicircular canals (*top*). Movements of the head result in an inertia-driven bending of the cupula (C) which excites the sensory hair cells whose stereocilia reach into the cupula. Similarly, during rotations of the body inertia of the fluid in the lumbosacral canals and near the accessory lobes (*AL*) is thought to mechanically distort the lobes, which then results in a mechanical stimulation and excitation of the finger-like processes of the lobe neurons.
4. **Accessory lobes (of Lachi):**
small, segmental lobes that project from the lateral aspect of the spinal cord near the roots

- Present all along the cord, enlarged in the lumbosacral region

- Made up of neurons and glycogen cells

*Fig. 1* a Transverse section of the lumbosacral vertebral column of a one-week-old pigeon at the level of the glycogen body.  
b Accessory lobe with neurons (arrow) and glycogen cells (arrowhead).  
AL accessory lobe, GB glycogen body, ML medial ligament, LL lateral (dentate) ligament, TL transverse ligament,  
VC vertebral canal, VH ventral horn.  
*Scale bars* 2 mm in a, 200 μm in b

*Necker 2005: fig 1*
4. Accessory lobes (of Lachi):
small, segmental lobes that project from the lateral aspect of the spinal cord near the roots

- Present all along the cord, enlarged in the lumbosacral region

- Made up of neurons and glycogen cells

- Associated with the lumbosacral canals

- Possibly function as lumbosacral canal receptors, to aid in maintaining equilibrium

- No known osteological traces

Fig. 4 a Transverse section of the vertebral column of a one-day-old chicken showing wide fluid spaces surrounding the accessory lobes (solid arrow); open arrows indicate the dorsolateral lumbosacral canals limited medially by meningeal membranes. b Transverse section of the vertebral canal of the common swift (Apus apus) showing an accessory lobe (arrow) with a laterally running arachnoidal trabecle (arrowheads) and the surrounding cerebrospinal fluid spaces. Dashed box in inset indicates section of the photomicrograph. I dentate ligament, P paragriseal cells. Scale bars, 1 mm in a,
5. **Ventral eminences**: segmental bumps on the ventral surface of the spinal cord.

- Caused by increased cross-sectional area of ventral horn (motor neurons) adjacent to ventral roots of spinal nerves.

- Ventral roots emerge from the ventral eminences.

- Only lumbosacral specialization that projects ventrally instead of dorsally or laterally.

- Osteological correlates: these bumps fill cup-shaped vacuities in the floor of the neural canal in the sacral region.

*Streeter 1904: fig 2*
<table>
<thead>
<tr>
<th>Type</th>
<th>Made of</th>
<th>Occurs in</th>
<th>Segmental or continuous</th>
<th>Anatomical direction</th>
<th>Osteological correlate?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lumbosacral enlargement</td>
<td>White and gray matter</td>
<td>Limbed tetrapods</td>
<td>Continuous, many segments</td>
<td>All directions (radially)</td>
<td>Neural canal expansion</td>
</tr>
<tr>
<td>Glycogen body</td>
<td>Glycogen cells (glia)</td>
<td>Birds</td>
<td>Continuous, few segments</td>
<td>Dorsal</td>
<td>Neural canal expansion</td>
</tr>
<tr>
<td>Lumbosacral canals</td>
<td>Meninges</td>
<td>Birds</td>
<td>Segmental</td>
<td>Dorsolateral</td>
<td>Neural canal expansion</td>
</tr>
<tr>
<td>Accessory lobes of Lachi</td>
<td>Neurons and glycogen cells</td>
<td>Birds</td>
<td>Segmental</td>
<td>Lateral</td>
<td>(none)</td>
</tr>
<tr>
<td>Ventral eminences</td>
<td>White and gray matter</td>
<td>Ostriches, other birds?</td>
<td>Segmental</td>
<td>Ventral</td>
<td>Neural canal expansion</td>
</tr>
</tbody>
</table>