

# Veterinary Bioscience: Digestive System



## LECTURE 26 DEVELOPMENT OF THE MOUTH AND GASTROINTESTINAL TRACT IN THE EMBRYO

### LECTURER

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### INTENDED LEARNING OUTCOMES

At the end of this lecture, you should be able to:

- Explain the developmental anatomy in the embryo of the mouth and associated structures, including the tongue in order to elaborate on the origin of anatomical structures in adult animals and common malformations.
- Describe the derivatives of the primitive gut tube (fore-, mid-, hindgut) in order to explain the relations between organs in adult animals.
- Discuss the developmental anatomy of the oesophagus, stomach and intestines in order to elaborate on their orientation in adult animals.

### KEY WORDS

Embryology, coelom, gut tube, foregut, midgut, hindgut, mouth, palate, tongue, cloaca, gastrointestinal development.

### LECTURE OVERVIEW

#### **Early formation of the gut tube**

Formation of the primitive gut is initiated by the establishment of the endodermal layer of the blastocyst. With folding of the body wall into a cylindrical shape, the primitive gut within the embryo is formed into a tube with three parts: foregut, midgut, hindgut and the part of the primitive gut that remains outside the embryonic body wall, the yolk sac.

**Derivatives of the fore-gut** include part of the mouth, the pharynx; the oesophagus, the stomach, the liver and the pancreas, the thyroid, the parathyroid and the thymus glands, the trachea and the lungs.

**Derivatives of the mid-gut** include the major part of the small intestine.

***Derivatives of the hind-gut*** include the large intestine and the cloaca.

### **Development of the mouth**

The Stomodaeum is a midline depression on the ventral surface of the head that is created by the cranial and lateral body folding. It subsequently enlarges into a definitive oro-nasal cavity. The oral plate (or pharyngeal membrane) is formed by the fusion of the ectoderm of the stomodaeum and the endoderm of the fore-gut. The oral plate subsequently breaks down and the cranial opening of the digestive tube is established.

After head folding, fleshy mesenchymal swellings, the branchial arches, develop on either side of the developing oro-nasal cavity. The derivatives of the branchial arches contribute to formation of the head and neck. For example, the first branchial arch divides into the left and right maxillary processes and mandibular processes which elongate to form the jaws and mouth.

### **Development of the palate**

At an early stage of development the oral and nasal cavities are confluent, but palate development subsequently separates the oral and nasal cavities. The palate derives from three parts:

1. Left palatine process
2. Right palatine process
3. Medial palatine process (= inter-maxillary process)

These three processes fuse together to separate the oral and nasal cavities. This hard palate extends caudally as the soft palate that separates the rostral pharynx into the nasopharynx (dorsal) and oropharynx (ventral).

Early in development, the most cranial part of the fore-gut becomes very broad and flattens dorso-ventrally. This expanded fore-gut gives rise to a series of pouches - pharyngeal pouches - which extend laterally. These pharyngeal pouches provide numerous contributions to various organs and tissues, many of which are not associated with the digestive system. These include the eustachian tubes (auditory tube, the fossae of the tonsils and covering epithelium and cells of the parathyroid, thymus and thyroid glands.

### **Development of the tongue**

The tongue arises as a protrusion from the floor of the pharynx into the primitive mouth. Tongue formation begins as 4 distinct mesenchymal swellings:

- A median tongue swelling;
- Two distal tongue swellings;
- A proximal tongue swelling.

The median and distal tongue swellings will form the body of the tongue, while the proximal tongue swelling will form the root of the tongue. The epithelium covering the surface of the tongue is completely renewed every 7-10 days.

### **Formation of the oesophagus**

The fore-gut narrows to form the oesophagus and elongation of the oesophagus occurs during growth of the cervical and thoracic regions of the body. The epithelial lining of the oesophagus and any associated mucosal glands develop from the endoderm of the primitive fore-gut. The connective tissue and muscle layer of the oesophagus are derived from accumulating mesenchymal cells partially derived from the splanchnic mesoderm of the primitive gut.

## Formation of the stomach

The stomach arises as a spindle-shaped swelling of the fore-gut located in midline. A dorsal mesentery (the dorsal mesogastrium) develops on the dorsal surface and the ventral mesentery (the ventral mesogastrium) develops on the ventral surface. It has a cranial opening - the cardia and a caudal opening - the pylorus. The developing stomach moves caudally and shifts away from the midline. Thus, the stomach rotates towards the left pulling with it the dorsal mesentery and leading to the formation of the greater omentum. There is species-specific differential enlargement and reshaping of the stomach, e.g. the ruminant stomach.

## Formation of the small and large intestines

Initially, the primitive gut is straight with dorsal and ventral mesenteries. Later the ventral mesentery breaks down. The gut grows faster than the body so a hairpin-shaped loop is formed. The remnant of the yolk sac (the yolk-stalk) is at the tip of the loop. Rapid development of the liver forces the loop of gut into the umbilical stalk - this is physiological herniation. Later the intestines return to the abdomen and move into their final position. Further changes involve rotation of the loop and extensive coiling of the cranial arm of the loop to form the duodenum, jejunum and most of the ileum.

The gut loop from the yolk-stalk to the proctodaeum contributes to the terminal part of the ileum, caecum, colon, rectum and anal canal. The caecum becomes established as a definite pouch-like diverticulum of the digestive tube caudal to the yolk stalk. Species-specific changes occur in the developing caecum and colon to account for the specific layouts discussed in anatomy.

## Cloaca and proctodaeum

The caudal portion of the primitive gut expands to form the blind cavity of the cloaca. The invagination of ectoderm beneath the tail forms the proctodaeum. This boundary between the endoderm and the ectoderm forms the cloacal membrane, which degenerates resulting in the anal opening.

## FURTHER READING

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