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HISTOLOGICAL CHANGES IN THE STRUCTURE OF *RANA TIGERINA* INTESTINE DURING SPONTANEOUS AND THYROID HORMONE INDUCED METAMORPHOSIS

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ABSTRACT

The intestine, which is present in both the premetamorphic tadpoles and postmetamorphic frogs, is drastically remodeled during metamorphosis. There is a general shortening of the digestive tract which is accompanied by the epithelial changes. At cellular level the major change involves the replacement of larval epithelium by the adult epithelium. Simultaneously the muscle and connective tissue layers also increased in thickness during the course of metamorphosis. These changes tend to occur during the later stages of metamorphosis, broadly classified as metamorphic climax. It was observed that in both spontaneous and thyroid hormone induced metamorphosis, the intestine exhibit the same sequence of structural transitions.

Key Words: Intestine, Metamorphosis, Larval Epithelium, Adult Epithelium

INTRODUCTION

Metamorphosis in the Indian bull frog, *Rana tigerina*, is associated with those changes that prepare an aquatic tadpole for a terrestrial life as an adult frog. Thus, during the course of metamorphosis, the feeding habits of frog change from herbivorous tadpoles to carnivorous adult frogs. To adapt to the new feeding habits, the intestine undergoes significant histomorphological alterations.

One of the most striking internal reorganizations during metamorphosis take place in the structures associated with feeding and digestion. As the feeding habits of the tadpole change from microphagus to macrophagus, it is accompanied by remodeling of the alimentary canal, in particular the intestine (Su *et al.*, 1997; Shi and Ishizuya-Oka, 1996). As the metamorphosis progresses, the relatively simpler intestine is transformed into a much more complex organization. It is well established that thyroid hormone (TH) plays a critical role in precipitating metamorphosis (Gilbert and Frieden, 1981; Gilbert *et al.*, 1996) however research in understanding the functional mechanisms continues (Kawahara *et al.*, 1991; Das *et al.*, 2002). The present study was carried to evaluate the histological changes in the intestine of *Rana tigerina*.

MATERIALS AND METHODS

Freshly spawned fertilized eggs of *Rana tigerina* were collected from in and around Kolhapur district. The collected samples were allowed to hatch and were raised in the laboratory. Tadpoles of comparable sizes were segregated to study natural metamorphosis. To study TH induced metamorphosis, tadpoles were raised in water containing 100 nM 3, 5, 3'-triiodothyronine. Transverse sections of intestines of spontaneous as well as TH induced metamorphosing tadpoles were studied using hematoxylin and eosin.

RESULTS AND DISCUSSION

Results

During the course of metamorphosis, there is a drastic change in the feeding habits as the herbivorous tadpole is transformed to carnivorous frog. The functional changes associated with change in feeding habits are reflected in significant histomorphological alterations and remodeling of the intestine. The tadpole intestine was observed to be much longer but simpler than the adult intestine. It essentially showed no or very little circular folds or villi and consisted of a single layer of primary epithelium with

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very little connective tissue or muscle (Figure 1). As metamorphosis progresses many intestinal folds were observed which appear circularly and line the intestinal lumen.

The transformation of tadpole intestine to frog intestine involves the removal larval epithelium followed by the development of the adult epithelium. This remodeling of the intestine creates a shorter but substantially more sophisticated epithelium with numerous microvilli and brush borders. Thus the luminal surface area is substantially increased. It was observed that the histological changes include differentiation of the adult epithelium as well as the increase in the thickness of muscle and connective tissue layers (Figure 2). It was observed that the intestine can be induced to undergo precocious remodeling by treating pre-metamorphic tadpoles with TH. The changes induced by TH treatment include degeneration of the larval epithelium and the development of the adult epithelium with microvilli and brush borders. Simultaneously, the muscle becomes considerably thicker during the metamorphosis (Figure 2).

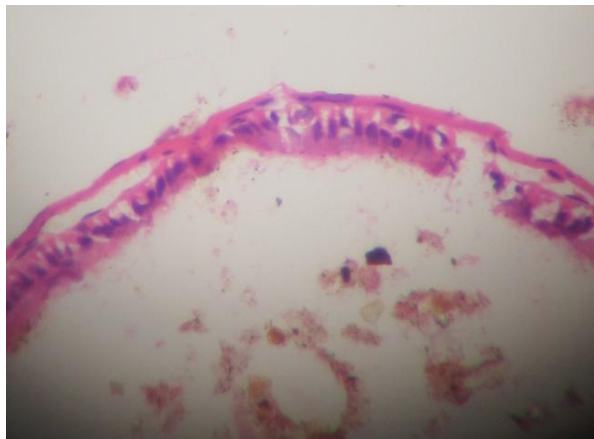


Figure 1: Simpler structure of the tadpole intestine with a single layer of columnar epithelium during spontaneous metamorphosis

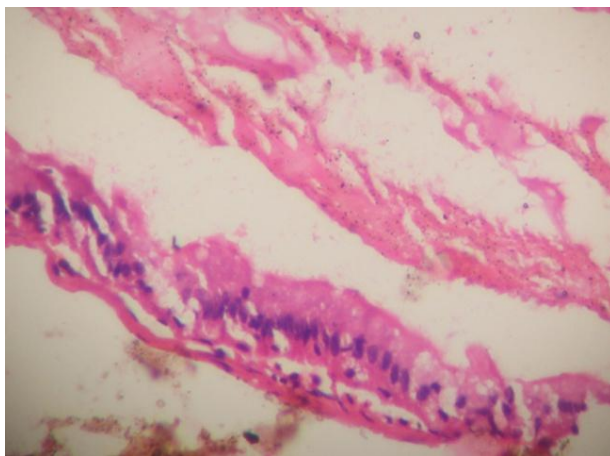


Figure 2: Tadpole intestine during spontaneous metamorphosis showing thickening of basal lamina and connective tissue

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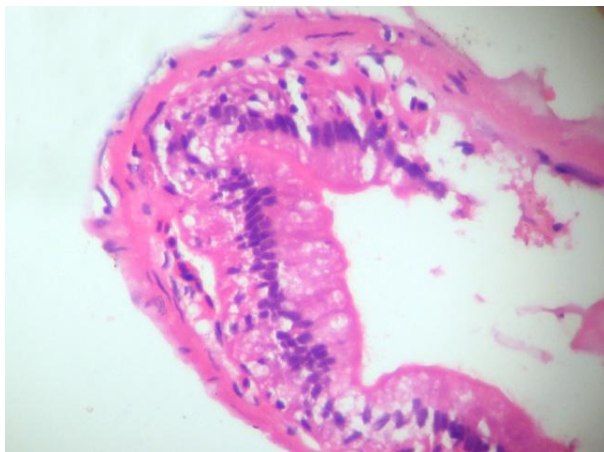


Figure 3: Tadpole intestine during TH induced metamorphosis showing thickening of basal lamina and connective tissue

Discussion

The much longer and simpler tadpole intestine is remodeled considerably during metamorphosis. The tadpole intestine which consists of primary epithelium with very little connective tissue or muscle is transformed during metamorphic climax into the adult intestine with increased luminal surface area and considerable longitudinal and circular muscle cell layers and connective tissue. The increased luminal surface area in turn increases the effectiveness and efficiency of absorption in the intestine, reducing the need for the proportional length found in the tadpole intestine. These anatomical changes occur in the intestine because of the regulation of several cellular processes which include programmed cell death, cell proliferation and cell differentiation (Wyllie *et al.*, 1980; Yoshizato, 1989). It was also observed that treating pre-metamorphic tadpoles with exogenous TH results in precocious metamorphosis with similar changes in the intestine.

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