

Ultrastructure of Cestode Epithelia: Phylogenetic, Functional, and Developmental Aspects Across the Neodermata

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The Neodermata constitutes a monophyletic clade within the phylum Platyhelminthes. Neodermatans, including Cestoda, Monogenea, and Trematoda, are characterized by possessing an outer layer known as a neodermis. This unique neodermis is constituted as a dynamic living tegument that is syncytial, consisting of a uniform anucleated vesiculated distal cytoplasm supported by nucleated cytons that are withdrawn into the underlying musculoparenchymal region. The precursors of the tegumental, and in some the protonephridial, neodermis appears in an extremely simplified form in the hexacanth larval stage. After metamorphosis into the metacestode juvenile stage, followed by maturation into the adult stage, metacestodes and adult cestodes share a common structural plan of tegumental and excretory epithelia consistent with the neodermatan plan. In both of these post-larval stages, the apical edge of the tegument's distal cytoplasm is elaborated into complex microtriches of various forms that have been extensively studied and reported on in the literature. Recent reports have also described extracellular vesicles in various forms that occur among the microtriches, and microvesicular bodies in the outermost region of the distal cytoplasm. The exact nature of extracellular vesicles with similar appearance in the excretory epithelia of both metacestodes and adults has not been fully explored. Unlike

tegumental and excretory epithelia that are rather uniform across diverse taxa, the uterine epithelia are quite diverse in structure. This diversity appears to be associated primarily with functional variation in the contribution of the uterus to eggs and egg-enclosing structures in various taxa that have been studied. However, more research is needed to explore phylogenetic trends in all of these neodermatan epithelia types.

Thus it is proposed here that the following areas should receive attention in the future from ultrastructural biologists:

- 1) detailed comparison of potential extracellular vesicles and multivesicular bodies across consecutive cestode developmental stages and along the adult strobila;
- 2) the developmental and functional nature of projections and vesicles elaborated by excretory epithelia;
- 3) the developmental and functional nature of projections and vesicles elaborated by diverse reproductive epithelia;
- 4) the developmental and structural relationships between excretory, tegumental, and reproductive epithelia, including cell junctions that separate these syncytia from each other;
- 5) details of the neoplastic interactions between tegumental and excretory epithelia during malignant transformation of some metacestodes;

- 6) the relationships, including proteomics and surfaceomics, between extracellular vesicles and multivesicular bodies in diverse excretory/secretory products;
- 7) comparison of these features across all neodermatan taxa, including diverse Cestoda, Trematoda, and Monogenea.