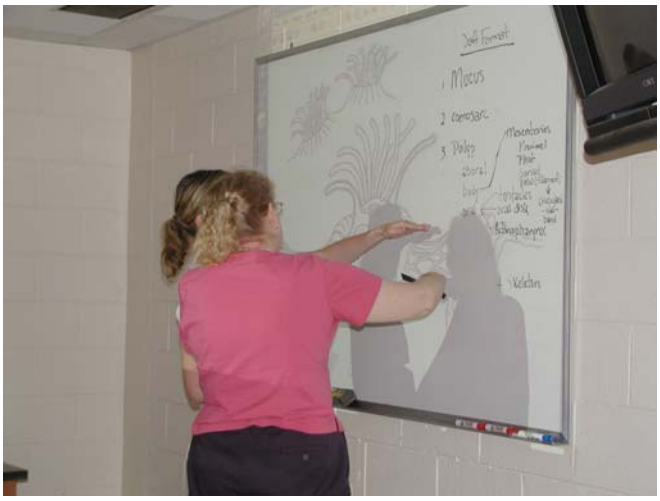
GLOSSARY of CORAL ANATOMY and HISTOPATHOLOGY TERMS

BACKGROUND



Esther Peters points out specialized anatomical structures to workshop participants.

In the Introduction to the *Glossary of Biochemistry and Molecular Biology*, Glick (2006) states that "In the sciences, an essential aspect of recognizing, recalling and communicating something, be it a substance, relationship or method, is the naming of it. To create names for new concepts, methods or items, we invent new words, often using the roots of a Classical language (apoptosis, glycocalyx, isosbestic), and we recruit familiar words and invest them with new meanings (chaperone, kringle, library)." In either case, dictionaries and glossaries have become more important than ever in helping scientists understand what they are studying and to communicate new discoveries in rapidly evolving fields. Workshop participants realized early in the session that being able to communicate across coral biology, pathology, and histology might require reconsideration of pertinent terms and their definitions to make them applicable to coral histopathology and understandable to wider audiences.

The definitions for the terms in this glossary have been derived from diverse sources, which are cited below and in the references at the end of this section. During and following the workshop, participants discussed the utility of terms currently used to describe the microscopic anatomy and pathology as it pertains to hexacorals and octocorals (= corals) and suggested including a glossary in the report to assist in explaining the histopathological findings from the coral sections reviewed by the participants. Most of the anthozoan anatomical terms were developed from dissections and histological studies used to distinguish taxa. Polyp features have been largely based on studies of sea anemones and octocorals, and primarily skeletal features have been used to distinguish taxa among scleractinians. Histological examinations of corals have expanded to include the study of diseases only since the late 1970s. The participants agreed that most descriptors commonly used in the evaluation of vertebrate disease processes could be adapted to the study of coral diseases; however, some new terms might be needed to facilitate interpreting the histological observations being made of coral specimens and making morphological diagnoses.

Some terms were confusing to veterinary and comparative histopathologists and some anatomical terms did not appear to adequately distinguish regions that consist of similar cell types but have different functions and might show different reactions when diseased. For example, "column wall" fits the cylindrical body of an anemone polyp, but should this be used for the colonial polyps embedded in mesoglea or skeleton? Is there a term that could be used to specifically identify the location of lesions in the part of the polyp in contact only with the skeleton or only with the seawater? Are other modifiers needed with "epidermis" and "calicoblastic epidermis"? Participants debated using the term "integument" to identify the unit of the three layers of cells and mesoglea forming the polyp, with modifiers of "paralithic" or "paramaric" to mean "beside the stone (skeleton)" or "beside the sea." The term "calicoblastic layer" has been used to mean the unit composed of calicoblastic epidermis-mesoglea-gastrodermis, but "layer" means only a single thickness of cells or of a homogeneous substance. Participants proposed writing a white paper to justify the rationale for an internationally recognized terminology for coral histopathology in consultation with experts in the scientific nomenclature of coral anatomy and histology.

Workshop participants discuss pros and cons of terminology; T. Work, C. Woodley, and L. Sileo.

During preparation of the workshop report, proposed and confusingly defined terms were presented to four outside experts in anthozoan and coral anatomy and histology: Stephen Cairns, National Museum of Natural History, Smithsonian Institution; Daphne Fautin, University of Kansas; Walter Goldberg, Florida International University; and Jaroslaw Stolarski, Intytut Paleobiologii PAN. The experts had diverse opinions as to the appropriateness and need for these terms, but all urged caution in developing new terms. Dr. Stolarski noted that separating human bones into those that are completely inside the body and those that extrude as limbs might be "useful for casualty ward but awkward for perfectly homologous structures."

But we are talking about the "casualty ward" for corals here and finding pathological changes in just the epidermis in contact with seawater rather than the epidermis that aids in skeletal deposition mean differences in organism function and prognosis for the animal, much as a broken ulna versus a broken pelvis do in humans. After more consideration, thought, and much research in publications, glossaries, and dictionaries, one new term is presented in this proposed glossary ("calicodermis," marked with an "*" below). Other terms that have been in long use for anthozoans were found to be appropriate for the corals.

The terms that generated the most discussion were "ectoderm," "endoderm," "epidermis," and "gastrodermis." Workshop participants were familiar with the use of the first two terms in developmental biology to refer to the outer and inner layers of cells that form during development of an embryo from the blastula into the gastrula. The cnidarian literature presented references to "ectoderm" and "epidermis" as the outer layer of cells of a polyp and "endoderm" or "entoderm" and "gastrodermis" as the inner layer of cells of a polyp. Libbie Hyman assigned the term "epidermis" to the outer adult cnidarian epithelium and proposed the term "gastrodermis" for the inner adult cnidarian epithelium, noting that "ectoderm" and "endoderm" were embryological terms ((Hyman 1940), her first volume in *The Invertebrates* series). Fautin and Mariscal (1991) used "epidermis" and "gastrodermis" in their chapter on Anthozoa in Volume 2 of the *Microscopic Anatomy of Invertebrates* series. Because of this and usage of "epidermis" and "gastrodermis" in other recent anthozoan published works, including the *Illustrated Trilingual Glossary of Morphological and Anatomical Terms Applied to Octocorallia* (Bayer et al. 1983), the workshop participants included these four terms in the glossary, noting their application to the embryological or adult epithelial layers.

In her review of the draft glossary, Dr. Fautin stated that "ectoderm" and "endoderm" refer to the embryological development of the inner and outer layers of cells only in triploblastic animals. She noted that the editor of Volume 2, Jane Westfall, had insisted that Fautin and Mariscal use the terms "epidermis" and "gastrodermis" despite their protests that "ectoderm" and "endoderm" were originally assigned to identify the outer and inner epithelia of adult cnidarians and were later appropriated for embryonic cell layers in the context of ontogenetic recapitulation of the adult layers of Cnidaria. She further reported that Hyman, in her final volume VI (1967), wrote "In a project of such magnitude some errors of fact and judgment are inevitable. It was a mistake on my part to replace the terms ectoderm and entoderm on the grounds that they are embryological terms. They were in fact created by Allman for the two body layers of coelenterates [cnidarians]. I advise that gastrodermis be dropped and regret having introduced it." In conclusion, she stated that Westfall now regrets having enforced its use (D. Fautin, pers. comm.).

The workshop participants discussed these arguments. Although some sources use "ectoderm" or "ectodermis" to refer to the outer cell layer and "endoderm" or "endodermis" to refer to the inner cell layer in adult Cnidaria, these epithelia change in composition and function as the animal grows. The simple endoderm and ectoderm established during gastrulation are not the same as fully differentiated adult tissues in any eumetazoan, whether it is diploblastic or triploblastic. In the Cnidaria, the cells within each layer differentiate first into ciliated supporting cells, and then other cell types differentiate (e.g., mucocytes or nematocytes) or other functions are expressed (e.g., cells of the outer polyp layer develop microvilli for nutrient uptake or secrete an organic matrix for calcification; stem cells form amoebocytes or germ cells as needed for defense or reproduction; cells lining the gastrovascular cavity develop the ability to maintain zooxanthellae without harming them). Thus, the adult epithelia are not the same as the layers in the gastrula.

After much debate among participants and reviewers, "epidermis" and "gastrodermis" were included in the glossary as the terms for the adult epithelia that are derived from the embryonic ectoderm and endoderm, respectively. "Calicodermis" is the ectoderm that assists in building the calcified exoskeleton of scleractinians after the planula settles on the substratum. This term was proposed to shorten the currently used "calicoblastic epidermis" and to correct the misunderstanding that cells here are "calicoblasts" because they do not secrete the crystals of aragonite. Instead, the organic matrix, secreted by these cells, aids in the deposition of the crystals within the space between the cells and the skeleton.

As noted by one of the participants, most terms and descriptors of microscopic anatomy and pathological processes in human and veterinary medicine have evolved over the past centuries through a process of proposal, use, modification, incorporation into the published literature, and general acceptance. The vocabulary and nomenclature for coral histopathology will evolve similarly in time.

The glossary below presents our best compilation of terms found in the literature to date. Sources of the definitions are cited; however, most definitions have been clarified to better explain their pertinence to usage in coral studies. Not all anthozoan anatomical terms are included here as we have focused on those terms that should be most commonly needed for light microscopic histopathological examinations of these organisms, not those that are additionally needed for taxonomic or ultrastructural descriptions. The literature cited should be consulted as needed for other coral anatomical terms, particularly for specific taxa, as well as for terms to describe pathological changes, as necessary. Note also that new discoveries in coral anatomy and histology probably remain, as recently found by Goldberg (2002a; 2002b) for *Mycetophyllia reesi*, and might lead to adoption of new terms in this field.

GLOSSARY

(Terms highlighted in blue are linked back to their definition in this glossary)

Aboral – region of polyp directly opposed to, away from, or remote from the mouth; the terms Basal or Proximal can also be used to describe this region. (Dorland 2006)

Acrosphere – globular tip of scleractinian tentacle, containing numerous nematocytes. (Fautin 2005)

Actinopharynx (**preferred term; synonyms – stomodaeum**, **pharynx**) – invagination of the epidermis to form a short muscular tubular passageway between the mouth and gastric cavity in a polyp, mostly lined with flagellated supporting cells. (Fautin 2005; Peters 2001)

Acute – exposure to a pathogen or a health effect that is brief, intense, short-term, or severe. The terms acute and subacute as they refer to pathology in coral are not currently precise enough to apply to cellular/microscopic changes and these terms as they are used

in the current document will refer only to colony-level (gross) observations. (Stedman 1995)

Amoebocyte – a cell possessing pleomorphic form and high elasticity, the principal cellular defense element of Cnidaria and typically found in the mesoglea. Granular amoebocytes contain small, dense, acidophilic granules in the cytoplasm, may secrete collagen fibers or sclerites, phagocytize and digest particulate matter, or differentiate into other cell types. (Fautin and Mariscal 1991)

Amphophilic – having an affinity both for acid and basic dyes. (Pharma 2006)

Anthocodia (plural Anthocodiae) – the distal part of an octocorallian polyp, bearing the mouth and tentacles. (Bayer et al. 1983)

Anthostele (= Calyx) – the rigid part of polyps seen in some species of octocorals, often stiffened by sclerites, and into which the anthocodia may be withdrawn. (Bayer et al. 1983)

***Antipathin* –** a material composed of proteins and chitin that forms the axis in an antipatharian (black coral). (Goldberg 1976)

Apical– opposite of basal, situated near the apex or tip of a structure, as in the apical portion of a cell. (Stedman 1995)

Apoptosis (a form of programmed cell death) – a morphologic pattern of cell death formation of cytoplasmic blebs, and fragmentation of the cell into membrane-bound affecting single cells, marked by shrinkage of the cell, condensation of chromatin, apoptotic bodies that are phagocytosed by other cells. (Dorland 2006; Stedman 1995)

Aragonite – mineral variation of calcium carbonate ($CaCO_3$) with a crystal structure different from the other two forms of $CaCO_3$, vaterite and calcite. It is formed mainly by marine organisms (e.g., coral) that use it to make their shells and skeletons. (Coris 2006)

Atrophy – diminution of tissues, organs, or entire body, as from death and reabsorption of cells, diminished cellular proliferation, decreased cellular volume, malnutrition, or lessened function. (Stedman 1995)

Attenuated – thinned or weakened, cause unknown. (Stedman 1995)

Autolysis – lysis, enzymatic digestion, of cells by the enzymes present within them. (Stedman 1995)

Axial Polyp – the longest polyp of a group of polyps, which produces secondary (daughter) polyps by lateral budding from its body wall. (Bayer et al. 1983)

Axial Sheath – that part of the colonial coenenchyme immediately surrounding the axis in the octocoral taxa Gorgonacea and Pennatulacea, containing the longitudinal canals and characterized by sclerites commonly different in form from those of the overlying coenenchyme. (Bayer et al. 1983)

Axis – inner supporting structure of Gorgonacea and Pennatulacea. It is usually composed of collagen (see Gorgonin); however, the antipatharian (black coral) axis consists of different proteins and chitin (see Antipathin). The axis can be mineralized in some groups, usually by magnesium calcite (as in sclerites), but in some, the mineral in the axis is aragonite and amorphous hydroxyapatite also occurs in some axial skeletons. (Bayer et al. 1983; Bayer and Macintyre 2001; Goldberg 1976; Holl et al. 1992)

Axis Cortex – layer around the central chord or core of the axis, deposited by an axis epithelium. (Bayer et al. 1983)

Axis Epithelium – layer of cells derived from ectoderm consisting of two types of cells: corticocytes (cells that produce the axis) and desmocytes (cells that attach the octocoral tissues to the axis). (Bayer et al. 1983)

Basal - situated near the base of a structure in relation to a specific reference point, opposite of apical. (Stedman 1995)

Basal Plate – aragonite structure built by the polyp at the bottom or base of the skeletal cup (corallite) enclosing a scleractinian polyp. (Stachowitsch 1992)

Basophilic – denoting components of cells having an affinity for basic dyes under specific pH conditions. Basophilic compounds (e.g., nucleic acids) stain blue with hematoxylin in the 'hematoxylin and eosin' (H&E) staining procedure. (Pharma 2006)

Body Wall – the three layers of tissues (epidermis, mesoglea, gastrodermis) that form the surfaces of the polyp, enclosing the gastrovascular cavity and, in colonial corals, the gastrovascular canals. (Bayer et al. 1983; Goldberg 2002b)

> **Surface Body Wall** – in contact with seawater, covering the coenenchyme, tentacles, oral disk, peristome, and polyp neck zone and anthostele (octocoral) or column (hexacoral).
>
> **Basal Body Wall** – the calicodermis*, mesoglea, and gastrodermis that covers the exoskeleton of the scleractinian coral, surrounding the gastrovascular cavity and canals.
>
> **Actinopharynx Body Wall** – the specialized (heavily ciliated or flagellated) epidermis, mesoglea, and gastrodermis that forms the actinopharynx.

Calice – the upper open or oral surface of the corallite. (Peters 1984)

Calicoblast – primary cell type of the calicodermis* that secretes the organic matrix involved in calcification and formation of the skeleton in the scleractinians. (Puverel et al. 2005)

Calicodermis* (= Calicoblastic Epithelium) – the thin but complex layer of ectodermally derived cells around a scleractinian polyp whose primary function is building the exoskeleton. In a colonial coral, as new polyps are formed, the calicodermis continues as the cell layer immediately adjacent to the skeleton of the interconnecting gastrovascular canals in imperforate corals and completely surrounds the gastrovascular canals embedded in the exoskeleton in perforate corals. Most of the cells are modified to secrete an organic matrix that may have a crucial role in the formation of aragonite crystals to form the exoskeleton. These cells, currently referred to as calicoblasts, do not form aragonite intracellularly. Other cells in the calicodermis are modified to attach the tissue to the exoskeleton (see Desmocyte). This epithelium can also contain mucocytes, pigment cells, or amoebocytes, but usually lacks cnidocytes. (Goldberg 2002b; Goldberg 2001a; Peters 1984, Coral Histopathology Workshop 2005)

Calyx (plural Calyces) – see **Anthostele**

Central Chord or Core – the central part of the axis, made of gorgonin alone, or gorgonin permeated with calcareous matter, sometimes hollow and cross-chambered, not always present. (Bayer et al. 1983)

Chromophore Cell – amoeboid cell containing cytoplasmic pigment granules in the scleractinian genus *Porites*. The granules appear yellow to tan when stained with hematoxylin and eosin using incandescent light microscopy and are bright green in unstained polyp sections when using a filter for green fluorescent protein with epifluorescence microscopy. (Duerden 1902; Smith 2004)

Chronic – long-term exposure to a pathogen or a prolonged health effect. The term chronic as it refers to pathology in coral is not currently precise enough to apply to cellular/microscopic changes and this term as used in the current document will refer only to colony-level (gross) observations. (Stedman 1995, Coral Histopathology Workshop 2005)

Cilium (plural Cilia) – one of the motile extensions of the surface of an epithelial cell containing nine longitudinal double microtubules made of structural proteins arranged in a ring around a central pair. (Stedman 1995)

Cinclide – small opening or "soft spot" in the body wall through which mesenterial filaments can be extruded. (Fautin and Mariscal 1991)

Cnida (plural Cnidae) – a collagenous capsule that develops in a cnidocyte and contains a tubule or thread that everts when triggered. There are three types of cnidae: nematocysts, spirocysts, or ptychocysts. Cnidae are non-self-replicating organelles

secreted by the Golgi apparatus, and are the most complex secretory products in the animal kingdom. (Hessinger and Lenhoff 1989; Mariscal 1984)

Cnidocyst – cnida. (Mariscal 1984)

Cnidocyte – epithelial cell that can produce a cnida in the Cnidarians, see also Nematocyst and Spirocyst. (Mariscal 1984)

Cnidoglandular Band (or Lobe) – the distal thickened rim or free margin along a mesentery. It consists of the median band or tract of a mesenterial filament containing nematocytes, ciliated columnar or collar cells, mucocytes, and granular gland (zymogen) cells, may have two lateral lobes distal to the median lobe, consisting mainly of nutritive/absorptive cells. (Fautin and Mariscal 1991; Goldberg 2002b; Hyman 1940)

Coccidian – a single-celled organism belonging to the protistan Phylum Apicomplexa, characterized by merogony and a life cycle comprising both sexual and asexual stages, parasitic in epithelial cells of invertebrates and vertebrates. (Upton and Peters 1986)

Coenenchyme – the tissues between and continuous with the polyps in a colonial anthozoan, consisting of the surface body wall and gastrovascular canals found either on the surface of or penetrating the skeleton (in hexacorals) or consisting of the surface body wall, gastrovascular canals, and solenia penetrating through the thick mesoglea stiffened with sclerites (in octocorals). The edge zone of the coenenchyme is that portion extending outside the peripheral polyps at the edge of a colony or outside the theca in a solitary coral. (Bayer et al. 1983; Stachowitsch 1992)

Coenosteum – skeleton deposited outside and between the corallite walls of the polyps of a colonial scleractinian. (Peters 1984; Stachowitsch 1992)

Collar Cell – specialized cell found in the epithelia of the mesenterial filament and actinopharynx. Requires transmission electron microscopy to distinguish its characteristic feature, a cilium with shallow rootlet surrounded by fibril-linked microvilli, with small fibrous or lysosome-like apical inclusions. (Goldberg 2002b)

Column – the body wall of an anemone, the cylindrical surface of a polyp. In a scleractinian, that portion of the polyp that can extend outside the calice. (Fautin 2005; Peters 1984)

Columella – column-shaped skeletal projection of the central basal plate or modified inner septal edges, may be solid or not. (Peters 1984; Stachowitsch 1992)

Corallite – the skeleton deposited by an individual polyp within a colony. (Peters 1984, Acropora Biological Review Team)

Corallum – the entire skeletal structure formed by either a solitary (single corallite) or colonial (group of corallites) coral. (Peters 1984)

Corticocyte – cell that produces gorgonin and forms the axis in a gorgonian. (Tidball 1982)

Costa – the extension of the septa outside the calice onto the coenosteum. (Peters 1984)

Degeneration – a nonspecific term applied to retrogressive but sometimes reversible pathological change in cells or tissues, resulting in impairment or destruction of functions; deterioration; preferably the specific changes observed should be fully described. (Dorland 2006; Stedman 1995)

Desmocyte – anchoring cell of the calicodermis* (scleractinian) or axis epithelium (gorgonian), characterized by unique apical and basal modifications for attachment to skeletal surfaces and mesoglea respectively. (Chapman 1974; Goldberg 2001b; Muscatine et al. 1997)

Diagnosis – the determination of the nature of a disease. (Stedman 1995)

> **Field Diagnosis** – made from the study of the macroscopic changes of a coral disease observed in the field.
>
> **Laboratory Diagnosis** – made by a chemical, virological, parasitological, microbiological, or immunological study of secretions, discharges, or tissues.
>
> **Morphologic Diagnosis** – made from an anatomical or histological study of the lesions present.
>
> **Etiologic Diagnosis** – the determination of the cause of the disease.
>
> **Differential Diagnosis** – a systematic comparison and contrasting of similar disease signs and findings to determine which of two or more diseases is considered to be most likely present in the organism, although one or more other diseases are considered less likely to be present but possible. (See also Pathognomonic) A differential diagnosis is also made to distinguish between closely related species in taxonomy.

Disassociation (or Dissociation) – a separation of relationships, as in the separation of epithelial cells because of damage to the intercellular junctions. (Stedman 1995)

Disease – any deviation from, or interruption of, the normal structure or function of any body part, organ, or system that is manifested by a characteristic set of signs and whose etiology, pathology, and prognosis may be known or unknown (Dorland 2006); any impairment that interferes with or modifies the performance of normal function, including responses to environmental factors such as nutrition, toxicants, and climate; infectious agents; inherent or congenital defects, or combinations of these factors. (Wobeser 1981)

Distal – that part of a structure situated away from the center of or point of origin, the extremity or distant part of a limb or organ, e.g., distal tentacle. For a polyp, the distal part is the oral end of the entire polyp. (Fautin 2005; Stedman 1995)

Ectoderm – the outer layer of pluripotential cells in the embryo, after establishment of the primary germ layers during the gastrula stage of development. (Hyman 1940; Martindale et al. 2004; Stedman 1995 discussed the diploblastic versus triploblastic nature of cnidarians)

Endocoel – the region of the gastrovascular cavity between two mesenteries belonging to the same pair; in the endocoel of nondirective mesenteries, the longitudinal retractor muscles on the mesogleal pleats of the two mesenteries protrude into the cavity; in the endocoel of directive mesenteries, the longitudinal retractor muscles on the mesogleal pleats are on the side of the mesenteries so they do not protrude into the cavity. (Fautin 2005)

Endoderm (or Entoderm) – the inner layer of pluripotent cells in the embryo, after establishment of the primary germ layers during the gastrula stage of development. (Hyman 1940; Martindale et al. 2004; Stedman 1995 discussed the diploblastic versus triploblastic nature of cnidarians)

Endolithic – growing within a rock or any other hard inorganic substratum, e.g., coral skeleton. (Coris 2006)

Eosinophilic – cell or tissue elements staining readily with eosin dyes, appear pink to red when using a hematoxylin and eosin staining procedure; sometimes referred to as "acidophilic." (Pharma 2006)

Epidermis – external epithelium of coral polyps and coenenchyme derived from the ectoderm, may be composed of columnar supporting cells (with apical specializations such as microvilli, cilia, or flagella), ciliated sensory cells, mucocytes, epitheliomuscular cells, cnidocytes, pigment cells, neurons, amoebocytes. The epidermis can be reduced in octocorals (supporting cells, sensory cells, cnidocytes, scleroblasts, mucocytes, amoebocytes) and may secrete a covering on basal parts of octocoral colonies. (Fautin and Mariscal 1991; Hyman 1940)

Epitheliomuscular Cell – cnidarian cell in which the cell body is columnar and the nucleus is situated in the basal portion of the cell. It is joined to other epithelial cells in the epidermis or gastrodermis and has elongated basal cytoplasmic extensions containing actin and myosin filaments, known as muscle fibrils or myonemes. The extensions are perpendicular to the cell body and attach to the surface of the mesoglea, facilitating polyp movement and contraction. The apical surface of the cell may have a flagellum. (Fautin and Mariscal 1991)

Epithelium – layer of cells covering both ectodermally and endodermally derived tissues of the polyp body and canals, bound together by various junctions and cementing substances to provide strength and mediate the exchange of metabolic and messenger molecules, and bound to and supported by basement membrane or basal lamina. (Dorland 2006; Stedman 1995)

Euchromatic (= Orthochromatic) – denoting any tissue or cell that stains the color of the dye used, i.e., the same color as the dye solution with which it is stained. (Pharma 2006)

Exocoel – the region of the gastrovascular cavity between two mesenteries belonging to different pairs. Except for the exocoels flanking the directive mesenteries, retractor muscles do not protrude into an exocoel. (Fautin 2005)

Filament – see **Mesenterial Filament**

Flagellum (plural **Flagella)** – single, elongate motile structure consisting of nine pairs of microtubules around two single central proteinaceous microtubules extending from the apical surface of an epithelial cell or tail of spermatozoan. (Stedman 1995)

Full Thickness (= Transmural) – a lesion, wound, or process that involves all layers of a tissue: epidermis or calicodermis*, mesoglea, and gastrodermis. (Coral Histopathology Workshop 2005)

Fusiform – spindle-shaped, tapering at both ends, as in a fusiform cell. (Stedman 1995)

Gastric Cavity – see **Gastrovascular Cavity**

Gastrodermal Canal – see **Gastrovascular Canal**

Gastrodermis – the inner epithelium of a coral polyp derived from the embryonic endoderm, lining the gastrovascular cavity and polyp-connecting canals. Some cells in this epithelium are phagocytic to digest food particles, absorb nutrients, and release waste products; zooxanthellae often reside within membrane-bound vacuoles in these cells. The gastrodermis may also contain ciliated or flagellated supporting cells, cnidocytes, amoebocytes, sensory cells, mucocytes, and pigment cells. (Fautin and Mariscal 1991; Goldberg 2002a; Hyman 1940; Peters 1984)

Gastrovascular Canal – a system of tubes lined with gastrodermis that connect the gastrovascular cavities of colonial coral polyps. The canals extend along the surface of the coenosteum in all colonial scleractinians; in some species additional canals extend from the gastrovascular cavities to penetrate through the coenosteum between polyps, forming a porous or perforated skeleton. In the octocorals, the gastrovascular canals are embedded in the mesoglea and connect to thinner canals called solenia. (Bayer et al. 1983; Peters 1984)

Gastrovascular Cavity – the interior space of a coral polyp, also referred to as the coelenteron in anthozoans, the saclike cavity within a polyp connected to the mouth by the actinopharynx. (Bayer et al. 1983; Fautin and Mariscal 1991)

Germ Cell – oocyte or spermatocyte; cell originating in the gastrodermis of a mesentery that migrates into the mesoglea and develops into either an oocyte or spermatocyte. (Fautin and Mariscal 1991)

Giemsa – a stain that contains both basic and acidic dyes and will therefore differentiate acidic and basic granules in granulocytes. It is also often used to stain tissue sections suspected to contain protozoan parasites. (Pharma 2006)

GMS – Grocott-Gomori's Methenamine Silver Stain, a modification of Gomori's methenamine-silver staining procedure for fungi in which sections are pretreated with chromic acid before addition of the methenamine-silver solution and then counterstained with light green to demonstrate black-brown fungi against a pale green background. (Pharma 2006; Stedman 1995)

Gonad – gametogenic region of a mesentery in a polyp. (Fautin and Mariscal 1991)

Gorgonin – a fibrous, collagenous protein that provides skeletal support for sea fans and other members of the octocoral order Gorgonacea. (Coris 2006; Hyman 1940)

Granular Gland Cell (= Zymogen Cell) – secretory epithelial cell containing acidophilic granules (e.g., lysosomes) that are released into the gastrovascular cavity for extracellular digestion of prey. (Fautin and Mariscal 1991; Hyman 1940)

Holdfast – the portion of an octocoral colony attaching it to or in the substrate. (Bayer et al. 1983)

Hyalin – a translucent, homogenous, structureless, eosinophilic, albuminoid substance occurring in tissue degeneration. (Pharma 2006; Stedman 1995)

Hyalination – process of deposition of a cellular amorphous homogeneous substance which stains bright red with hematoxylin and eosin. (Stedman 1995)

Hyaline – having the properties of hyalin. (Stedman 1995)

Hydropic – excess of water or watery fluid. (Stedman 1995)

Hyperplasia – an increase in the number of normal cells in normal arrangement in a tissue or organ, increasing its size. (Dorland 2006; Stedman 1995)

Hyphae – the fine, branching tubes which make up the body (or mycelium) of a multicellular fungus. (Pharma 2006)

Imperforate coral – corals which have solid skeletons with no connections between the polyps. (Coris 2006)

Infection – invasion and multiplication of parasitic organisms within the body. (Stedman 1995)

Inflammation – a fundamental pathological process aimed at destroying, diluting, and walling off the injurious agent. The process generally consists of a dynamic complex of cytological and chemical reactions that occur in affected tissues in response to an injury or abnormal stimulation caused by a physical, chemical, or biologic agent, including the local reactions and resulting morphologic changes, the destruction or removal of injurious material, and the responses that lead to repair or healing. (Dorland 2006; Sparks 1985; Stedman 1995)

Karyolysis – swelling of the nucleus of a cell and gradual loss of its chromatin, indicated by paling of the basophilic reaction in hematoxylin and eosin staining. (Dorland 2006; Stedman 1995)

Karyorrhexis – rupture of the nucleus of a cell and the chromatin disintegrates into small pieces, which are extruded from the cell. (Dorland 2006)

Lesion – a wound or injury, or any pathologic change in the tissues. (Stedman 1995)

> **Lesion Distribution** – distinguished on the basis of number of that particular type of lesion (focal: single, localized area; multifocal: relating to, arising from, or occurring in more than one place; diffuse: spread about, not restricted; systemic: spread throughout the entire organism).
>
> **Lesion Severity** – semiquantitative, subjective ranking of the degree of damage or extent of pathological change seen in tissues or an organism (ranging from minimal: smallest amount or lowest limit; mild; moderate; marked; to severe: intensely or extremely bad, very poor condition, or greatest in degree or extent).

Loculus (plural **Loculi)** – calcified area or fiber-filled space within an axis (the axial skeleton of a gorgonian) or a space within the gastrovascular cavity between septa (interseptal loculus). (Bayer et al. 1983; Fautin 2005)

Lysis – dissolution or destruction of cells or structures. Lyse means to break up, disintegrate, or to effect lysis. (Stedman 1995)

Lysosome – a cytoplasmic membrane-bound vesicle containing a variety of glycoprotein hydrolytic enzymes (lysozymes) active at an acid pH, for digesting exogenous material such as bacteria or worn-out organelles of the cell. (Stedman 1995)

Margin – a boundary, edge, or border, as of a surface or structure. In anthozoans, also where the polyp column meets the oral disk. (Fautin 2005; Stedman 1995)

Melanin – high molecular weight polymer of indole quinone produced by animals, this pigment can be black, brown, yellow, red, or violet. It is produced by gorgonian cells (corticocytes) to encapsulate infectious agents. (Petes et al. 2003; Pharma 2006)

Melanized – characterized by deposition of melanin. (Stedman 1995)

Mesenterial Filament – a convoluted, elongated or ribbonlike extension of the free inner edge of the mesentery, composed of cells which aid in capture and digestion of food. These filaments, which appear as white loops with translucent mesentery, may also help to protect the coral from substrate competitors and invaders by protrusion through the mouth or through temporary openings in the tissue. The free edge is the cnidoglandular band, which may or may not be flanked by lateral ciliated tracts or lobes depending on the species and location along the edge. In octocorals, the filaments of the two mesenteries opposite the siphonoglyph are very long and heavily flagellated, whereas the remaining six are shorter and glandular. (Bayer et al. 1983; Goldberg 2002b; Peters 1984)

> **Digestive Filament** – specialized ciliated, thin, grossly translucent, unequally bilobed, stalk-like contractile structure with spatulate distal end found in the scleractinian coral *Mycetophyllia reesi*. One lobe contains cnidae, mucocytes, collar cells, and granular cells and it protrudes through the polyp mouth during feeding (this species lacks tentacles). It is histologically distinct from mesenterial filaments and is housed in mesenterial ducts, radially arranged specially modified tubular mesenteries connecting to the actinopharynx. (Goldberg 2002b)

Mesentery – internal longitudinal partition of tissue providing structural support and increasing surface area, which is important in nutrition and fertility of anthozoans. A mesentery develops by infolding of the mesoglea and its lining gastrodermis from the body wall of the polyp. Multiple mesenteries are arranged radially within the gastrovascular cavity of the polyp (between the septa in scleractinian corals) and are attached to the oral disk. (Fautin 2005)

> **Directive Mesentery** – one of a pair of mesenteries attached to the actinopharynx in which the mesogleal pleats of the longitudinal retractor muscles face away from each other, toward the exocoel.
>
> **Nondirective Mesentery** – one of a pair of mesenteries attached to the actinopharynx in which the mesogleal pleats of the longitudinal retractor muscles face each other, toward the endocoel.
>
> **Complete Mesentery** – extends from the body wall to attach to the actinopharynx.
>
> **Incomplete Mesentery** – the free inner edge does not reach the actinopharynx.

Mesoglea – the connective tissue of coral and all cnidarians consisting of collagenous fibers embedded in a gelatinous material or ground substance of highly hydrated protein and neutral polysaccharide polymers and containing amoebocytes and other cells. The proportion of matrix to fiber and cells in this layer varies with the species and its condition. (Fautin and Mariscal 1991; Peters 1984)

Mesogleal pleat – sheets of myonemes known as longitudinal retractor muscles are anchored into mesoglea and pleated accordion-fashion so that the mesoglea is sandwiched between two monolayers of epithelia within the middle portion of a mesentery. (Fautin and Mariscal 1991; Peters 1984)

Mucocyte – modified columnar epithelial cell with basal nucleus containing basophilic granules or spumous inclusions, also referred to as a mucous secretory cell or mucosecretory cell. The cell synthesizes and secretes mucus through an apical pore to aid in feeding, protection, and sediment removal. (Peters 1984)

Mucus – protective secretion of mucocytes consisting of a polysaccharide-protein-lipid complex; it traps particles non-selectively, removes sediment, lubricates the passage of food within the actinopharynx (ciliary-mucus feeding) and helps digest it, provides protection against desiccation, and presents a barrier against environmental stresses, including salinity and temperature changes and exposure to UV radiation. Mucus may also be involved in self-recognition and the immune response of cnidarians. Some of the properties of mucus can be distinguished in histology by using a staining procedure involving alcian blue, periodic acid, and Schiff's reagent (AB/PAS). (Brown and Bythell 2005; Carson 1997; Fautin and Mariscal 1991; Goldberg 2002a)

Mycosis – any disease caused by a fungus. (Pharma 2006)

Myoneme – contractile portion of epitheliomuscular cell or muscle fibril (myofibril) contained within the plasma membrane that anchors it to the mesoglea. It is attached by a long peduncle or process to the nuclear-containing portion of the cell. Myonemes may be diffuse or clustered into longitudinal and circular contracting sheets of muscle. (Fautin and Mariscal 1991)

Necrosis – cell death characterized by irreversible damage, the earliest of which is mitochondrial. Changes visible with light microscopy are nuclear (pyknosis, karyolysis, or karyorrhexis) and generally accompanied by cytoplasmic hyper-eosinophilia, shrinkage, or fragmentation. After such changes, the outlines of individual cells are indistinct and affected cells may become merged, sometimes forming a focus of coarsely granular, amorphous, or hyaline material. (Stedman 1995)

Necrotic – pertaining to or affected by necrosis. (Stedman 1995)

Nematocyst – a type of cnida, secreted by the Golgi apparatus, produced exclusively by a cnidocyte or nematocyte of the Cnidaria. It consists of a double-walled capsule and an elongated hollow, sometimes externally spiny tubule that evaginates on mechanical or

chemical stimulation to entangle or deliver toxin to prey or repel attackers. About 30 types of nematocysts have been defined, based on morphology of the capsule and tubule. (Fautin and Mariscal 1991; Goldberg 2002b; Hessinger and Lenhoff 1989; Peters 1984)

Nematocyte – cell that produces a nematocyst. (Mariscal 1984)

Nematode – member of the Nematoda, a class of unsegmented helminthes with fundamental bilateral symmetry and secondary triradiate symmetry of the oral and esophageal structures. Many species are parasites. (Pharma 2006)

Neoplasia – the pathological process that results in the formation and growth of a neoplasm. (Stedman 1995)

Neoplasm – an abnormal tissue that grows by cellular proliferation more rapidly than normal and continues to grow after the stimuli that initiated the new growth cease. A neoplasm is often characterized by partial or complete lack of structural organization and functional coordination with the normal tissue, usually forming a distinct mass. (Stedman 1995)

Neuron – multifunctional (combined characteristics of sensory, motor, inter- and neurosecretory neurons), morphological and functional unit of the nerve net consisting of the nerve cell body and processes, axon and dendrite(s) (sometimes these processes are referred to as neurites), communicating through electrical conduction or secretion of neuropeptides. (Fautin and Mariscal 1991; Grimmelikhuijzen and Westfall 1995)

Nodule – a small node, a circumscribed mass of tissue, or knob-like or knotty swelling of tissue. (Stedman 1995)

Nonseptate – not divided internally by partitions. (Stedman 1995)

Oocyte – female sex cell or gamete, immature ovum. (Stedman 1995)

Oral – describing the region of a coral polyp near or toward the mouth; the terms Apical and Distal can also be used to describe this region. (Fautin 2005)

Oral Disk – the part of the polyp through the center of which the mouth opens, including peristomal tissue and tentacles. (Peters 1984)

Ovum – the mature female germ cell (egg; female gamete). (Coris 2006)

Parasite – an organism that lives on (ectoparasite) or in (endoparasite) another organism and derives its nourishment from that host organism. (Stedman 1995)

Pathogen – any virus, microorganism, or other substance causing disease. (Stedman 1995)

Pathognomonic – typical characteristic signs, findings, or pattern of abnormalities specific for a given disease and not found in any other condition. Few disease signs and findings are characteristic for a single disease (see also Differential Diagnosis). (Stedman 1995)

Perforate coral – coral that has a porous skeleton with gastrovascular canals that connect the gastrovascular cavities of the polyps along the surface and through the skeleton. (Coris 2006)

Peristome – the portion of the oral disk surrounding the mouth and inside the ring of tentacles; may be elevated. (Peters 1984)

Pigment cell – basally located epithelial cell that produces pigmented granules (e.g., green fluorescent protein-like pigments, animal coloration pigment). The genus *Porites* contains specialized pigment granule-producing amoeboid cells called chromophore cells. Note that phagocytes can contain lipofucsin pigment granules obtained from necrotic cells. (Duerden 1902; Peters 1984)

Phagocyte – a cell capable of ingesting bacteria, foreign particles, and other cells, present on the lobes of the mesenterial filaments and elsewhere in corals. (Hyman 1940; Peters 1984; Stedman 1995)

Pharynx – see Actinopharynx

Pinnule – one of the lateral processes along the tentacle of an octocoral. (Bayer et al. 1983)

Planula (plural Planulae) – the ciliated planktonic larval stage of the coral, developing from the zygote, occasionally noted in histological sections. The planula undergoes metamorphosis upon settlement on a suitable substrate. Some species of corals produce free-swimming planulae and other species brood planulae within the gastric cavity for variable periods of time. (Peters 1984)

Pleomorphic – polymorphic, occurring in more than one morphologic form. (Stedman 1995)

Polyp – the basic structural unit of an anthozoan, consisting of a sac-like cylindrical body, a basal (aboral) disk that may be modified to produce a calcium carbonate or gorgonin exoskeleton or attach the polyp to the substrate, and an oral disk bearing mouth and tentacles. (Peters 1984)

Proximal – that part of a structure nearest to the point of origin on an organism, as in a part of a limb or organ, e.g., proximal portion of tentacle. For a polyp the proximal part is its base that is attached to a surface or in mesoglea or skeleton. (Fautin 2005; Stedman 1995)

Ptychocyst – a type of cnida used in tube construction by burying anemones (Ceriantharia). These anemones build a tube into which they can contract for protection almost entirely from the everted flattened, sticky tubules of the ptychocysts that trap sand grains to form the tube. (Hyman 1940)

Pyknosis – a condensation or reduction in size of the cell or its nucleus. Nuclear pyknosis is contraction of the nucleus to a deep staining irregular or round mass, a stage of necrosis or sign of cell death. (Pharma 2006; Stedman 1995)

Pyknotic – characterized by pyknosis. (Stedman 1995)

Pyrenoid – a small proteinaceous body found within the cytoplasm of zooxanthellae (and other phytoflagellates) and closely associated with the chloroplasts. It contains the enzyme ribulose-1,5-bisphosphate carboxylase/oxygenase (RubisCO), which adds carbon dioxide to the sugar ribulose-1,5-bisphosphate as it synthesizes and deposits polysaccharides. The pyrenoid is visible in fixed, stained sections of zooxanthellae as a small round refringent body surrounded by a pale staining starch sheath. (Dorland 2006; Leggat et al. 1999)

Pyriform – pear-shaped. (Pharma 2006)

Regeneration – reproduction or reconstitution of a lost or injured part or an entire organism. (Stedman 1995)

Sclerite – minute magnesium-calcite element in octocoral mesoglea or axis. (Bayer et al. 1983; Goldberg 1976)

Scleroblast – cell within the mesoglea of octocorals that produces a sclerite. The sclerite may be formed intracellularly in some octocorals or by a combination of intra- and extracellular calcification. (Bayer et al. 1983)

Section – a thin slice of tissue, cells, macroorganisms, or any material for examination under the microscope. (Stedman 1995)

> **Cross** – sliced at right angles (or transverse) to the longitudinal axis of the organism. A cross-section of a polyp is one sliced at right angles to the longitudinal axis running in the oral to aboral direction. A cross-section of a coral colony branch is one sliced at right angles to the longitudinal axis extending from the axial polyp to the base of the branch.
>
> **Sagittal** – sliced along or parallel to the longitudinal axis of the polyp or branch (see Cross for explanation of axes).
>
> **Oblique** – a diagonal cross section that is neither parallel to the longitudinal axis nor at right angles to this axis (see Cross for explanation of axes).

Septum (plural Septa) – one of the vertical calcareous plates or partitions radiating from the corallite wall toward the central axis within the calice that provide support to the mesenteries. (Peters 1984)

> **Primary** – full plates/partitions that separate two sets of mesenterial pairs.
>
> **Secondary** – partial plates/partitions that separate mesenteries within a mesenterial pair.

Signalment – identification of the organism whose health is being examined, by describing distinguishing peculiar, appropriate, or characteristic physical marks or signs (e.g., species name, age or stage in development, size, coloration, gross lesions) and collection site and date collected. The basic signalment is aided by including collection site information, the specific samples collected from the specimen for investigation, and other observations on the history of the specimen's condition, to the extent known. (CDHC Workshop: Coral Histopathology II, this document page 20)

Siphonoglyph – the strongly ciliated groove extending down the side of the actinopharynx to direct water into the gastrovascular cavity. Scleractinian polyps lack siphonoglyphs; a polyp of an octocoral, cerianthid, and zoanthid has one siphonoglyph; an antipatharian polyp has two siphonoglyphs; although an actinarian and corallimorpharian polyp usually has two siphonoglyphs, it may have none, one, three, or more of them. (Bayer et al. 1983; Fautin 2005; Hyman 1940)

Skeleton – the structurally supporting matrix of aragonite crystals formed by a scleractinian on the outside of the polyp, technically an exoskeleton, or the structural support for an octocoral. (Bayer et al. 1983; Stachowitsch 1992)

Solenium (plural **Solenia)** – in octocorals, a small canal lined with gastrodermis, penetrating the coenenchyme, forming a network, and fusing with the larger gastrovascular canals to interconnect the gastrovascular cavities of the polyps. (Bayer et al. 1983)

Spermary – gonad producing male gametes within the mesoglea of a mesentery. It may appear as an unattached cyst-like structure within the gastrovascular cavity of a sectioned octocoral polyp, but the mesentery producing it is attached to the underside of the oral disk. (Bayer et al. 1983; Fautin and Mariscal 1991)

Spermatocyte, Spermatozoan – male gamete or sex cell that contains the genetic information to be transmitted by the male. (Stedman 1995)

Spirocyst – single-walled capsule which contains a tightly coiled tubule bearing microtubules that form a web of fine, adhesive microfibrillae when discharged for prey capture or attachment, produced by a spirocyte. (Goldberg and Taylor 1996; Mariscal 1984; Peters 1984)

Spirocyte – a cell lacking a sensory cilium that produces the spirocyst and occurs only in anthozoans. (Fautin and Mariscal 1991)

Stem Cell – any precursor cell, a cell whose daughter cells may differentiate into other cell types. The term "interstitial cell" or "I-cell" has been used in the literature to refer to undifferentiated cnidarian (particularly Hydrozoa) cells lying between epithelial cells or migrating through the mesoglea that differentiate into the germ cells, nematocytes, and other cell types as needed. The term is rarely used in discussions of Anthozoa. More recent resources did not include this term, and "interstitial cell" has other specific meanings in vertebrate histology. "Stem cell" has universal meaning in all organisms. (Fautin and Mariscal 1991; Hyman 1940; Stedman 1995; Thomas and Edwards 1991)

Stomodeum – mouth and actinopharynx as it begins developing in the coral embryo and planula, is also often applied to the actinopharynx of the adult. (Hyman 1940; Stedman 1995)

Supporting cell – columnar cell of the epidermis or gastrodermis with central nucleus, may have apical specializations of microvilli, cilia, or flagella. (Goldberg 2002a)

Tentacle – hollow, contractile extension of the polyp's oral disk distal to the mesenteries, typically cylindrical, commonly tapering to a point but in some species terminating in a spherical acrosphere, and rarely branched. In octocorals, each tentacle has two diametrically arrayed rows of short pinnules. The tentacle's internal cavity is continuous with the gastrovascular space, continuous with that of the main body. In most species, it is studded with nematocysts and/or spirocysts, either scattered or arrayed in batteries. Tentacles are typically used in food capture, defense, and sediment removal; in some species, some tentacles are specialized to take up dissolved organic matter from seawater. (Acropora Biological Review Team 2005; Peters 1984; Stachowitsch 1992)

Theca – wall of the skeletal cup (corallite) surrounding the scleractinian polyp. (Stachowitsch 1992)

Tinctorial – relating to coloring or staining. (Pharma 2006)

Tissue – a collection of similar cells and the intercellular substances surrounding them united in the performance of a particular function. Cnidaria possess all four of the basic tissues: (1) epithelium, (2) connective, (3) muscle, and (4) nerve. (Dorland 2006; Hyman 1940; Stedman 1995)

Transmural – **see Full Thickness**

Vacuole – a tiny fluid-filled cavity or a membrane-bound vesicle formed in the protoplasm of a cell. (Dorland 2006; Stedman 1995)

Vacuolated – having vacuoles. (Stedman 1995)

Vacuolization (or **Vacuolation**) – formation or multiplication of vacuoles. (Stedman 1995)

Zooxanthellae – dinoflagellates (unicellular photosynthetic organisms) that live within the gastrodermal cells of some scleractinians, octocorals, sea anemones and other animals (not cnidarians), which give corals a characteristic brown coloration. Zooxanthellae provide energy in the form of photosynthate, use animal wastes (nitrogenous ones and carbon dioxide) and, in calcifying organisms, enhance calcification. (Peters 1984)

Zymogen – Proenzyme, precursor of an enzyme requiring a change in the molecule to make it active. (Stedman 1995)

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