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Descriptive Veterinary Pathology Course
Armed Forces Institute of Pathology
Washington, D.C. 20306-6000
10-13 June 1997

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MICROSCOPIC DESCRIPTIVE TECHNIQUES

(Modification of 1973 outline by Garrett S. Dill, Jr, DVM, James B. Moe, DVM, PhD, and Ralph Bunte, DVM)

GENERAL

1. There is **NO ONE WAY** to describe a slide. Develop a style that is comfortable and consistent.
2. Be concise. Almost all slides can be described in 7 sentences or less.
3. Describe in an "inverted pyramid" or from big to little. Place the main event first; leave the ancillary changes for last.
4. Write with the reader in mind. If, after reading your description, the reader can give **you** the diagnosis, then you have done a good job.
5. List the tissue first (i.e., kidney). Do not embellish ("We have a triangular section of kidney measuring 2X2X3 centimeters) - this is unnecessary verbiage.
6. Describe organs in a consistent manner. If you can break each organ down into components which you describe for EVERY slide, you will never overlook a major lesion. (For instance, when describing a section of lung, always look at these five components: alveolar space, alveolar septa, airways, vasculature, and pleura. All hollow organs have both a lumen and a wall, which generally has multiple distinct layers.) Make sure to look at each part, even if you don't describe them.
Remember Lumen + Wall.
7. You do not have to describe every cell or every pattern that you see on the slide. This will only serve to confuse the reader. (If most cells have indistinct cell

borders, while some have distinct cell borders, describe the cells as having indistinct cell borders rather than "primarily indistinct, but rarely distinct". Go with the **majority** of the cells.)

8. Don't describe normal, except when interpreting electron micrographs. This simply wastes your time - you're a pathologist, not an anatomist. Also avoid any negative comments, (i.e., "There is no evidence of vascular invasion." If you would have seen it, you would write it down.) These sentences add nothing to your descriptions and take time to write.
9. Know your terminology and use it in your descriptions. This includes names of anatomic locations (which are often species-specific), features of protozoans and metazoans, and specific descriptors for varying types of inflammation and necrosis, as well as many other instances. Specificity in terminology imparts to the reader that you know what you are talking about, even if you are not quite sure. The use of buzzwords can cover up a tremendous amount of uncertainty.
10. Use size and shape whenever possible in your descriptions; these are powerful descriptors. Sarcocystis zoites can be described as "1 X 2 μ basophilic banana-shaped zoites". ("Guesstimations" are acceptable in testing situations - it is better to be little off on your estimate than not to have tried at all.)
11. Do not be afraid to interpret lesions, but make sure to separate this from your descriptions by a set of parentheses. (i.e. "Covering the pleura is a mat of loosely arranged eosinophilic beaded material (fibrin)....)
12. Avoid redundancies or otherwise useless terms that do not add anything to your description, like "blue in color", or "characterized by", or "associated with". These terms mean nothing and take up your valuable time while writing them down.
13. Little things are important - spelling, punctuation, grammar. All of these help your descriptions "flow". Descriptions that flow pick up all of the points awarded for style.
14. Work on your handwriting. If the audience can't read it, you won't get credit for either your effort or your genius.
15. Time, time, time. You'll never get credit for slides you don't get to look at. This one factor is the major stumbling block for people on the ACVP exam. Train yourself to take no more than twelve minutes per slide, and stick with your schedule. That will give you thirty minutes to come back to slides that you have had difficulty with. If

Quantify Everything.

you don't get to several slides, you're sunk.

16. When all else fails, go back to the basics. Look for something added, and if you don't see it, look for something lost. (Actually, when you add something to many organs, you generally lose something, namely parenchyma, or at least architecture. "...There is multifocal loss of hepatocytes with replacement by nodular aggregates of foamy macrophages admixed with lesser numbers of lymphocytes and rare neutrophils." *Tricentral changed.*)

NEOPLASMS *(2 Cases Likely)*

I. Organ. Most slides will be obvious. For those of which you are unsure, give a brief description and an interpretation.

II. SENTENCE ONE: Subgross description. This is THE most important sentence in any neoplasm description. You will receive a lot of points from this one sentence, and set the tone for the rest of the description.

1. Location. Does it extend to cut borders? Is it limited to one anatomical part of the tissue, such as the grey matter or the renal cortex?
2. Size (a powerful descriptor).
3. Densely or sparsely cellular.
4. Well-demarcated or poorly demarcated
5. Shape. (Nodular, multilobular, verrucous, etc.)
6. Expansile or infiltrative
7. Encapsulated or unencapsulated

Also, this is the place to state two populations of cells, or one population differentiating along several lines.

III. SENTENCE TWO: Patterns of cells and type of stroma.

A. Different broad classifications of neoplasms have fairly characteristic patterns.

1. Carcinoma - Nest, packets, lobules, cords

2. Adenocarcinoma - Tubules, acini
3. Sarcomas - Bundles, streams *whorls*.
4. Round cell tumors - Sheets. *Dysgerminoma = seminoma*

Avoid mixing patterns - "Nests, packets, and bundles". This sends mixed signals, and confuses the reader.

B. Modify your pattern description with adjectives such as closely-packed, loosely arranged, etc.

C. Stroma - fibrovascular, fibrous, pre-existing, fine, coarse, etc. This should be the last part of EVERY second sentence of EVERY neoplasm description that you do. (Almost always worth a point).

desmoplasia - carcinomas.

*Stream - all cells same way:
Bundles in different directions
Whorls - sarcomas / HP
meningioma*

IV. SENTENCE THREE: Cytologic features.

A. Shape (round, spindled, oval, cuboidal, columnar, polygonal, pleomorphic)

B. Size (a powerful descriptor)

C. Cell borders (distinct or indistinct).

D. Cytoplasm

1. Amount (scant, moderate amount, abundant).
2. Color (eosinophilic, basophilic, red, blue, etc.)
3. Character (homogenous, fibrillar, granular)

E. Nucleus.

1. Shape (round, oval, elongate, spindled, crimped, etc.)
2. Location in cell (central, paracentral, eccentric)
3. Chromatin distribution (vesicular, finely stippled, coarsely stippled, clumped, etc.)

4. Chromatin staining (hyperchromatic)

F. Nucleolus

1. Number
2. Color

V. SENTENCE FOUR. Unique features - multinucleate cells, variation in cells (anisokaryosis, anisocytosis, karyomegaly, etc.) *production - ataxia*.

VI. SENTENCE FIVE. Mitotic activity.

- A. Mitoses are _ per _ HPF.
- B. Mitoses range from _ to _ per HPF, averaging _ per HPF.
- C. Bizarre mitoses.

VII. SENTENCE SIX. Evidence of malignancy.

- A. Vascular invasion
- B. Capsular invasion
- C. Necrosis
- D. Hemorrhage (if applicable)
- E.

VIII. SENTENCE SEVEN (and more if necessary. Cleanup. These are observations not directly related to the neoplasm.

- A. Inflammation
- B. Ulceration
- C. Hemorrhage
- D. Mineralization
- E. Others

NON-NEOPLASTIC LESIONS

- I. Organ. (One word set off from your description by a period. As before, if you are unsure of the organ, describe it briefly and give an interpretation.)
- II. Location, distribution and size. This is an important first sentence. If you aren't including the all of the above descriptors, chances are your first sentence has little substance.
Diffusely there is
- III. Components. *Multifocally there is*
 - A. List all cell types seen in order of prevalence, and relate the numbers to each other. (i.e., large numbers of viable and degenerate neutrophils surrounded by lesser numbers of macrophages, lymphocytes, and plasma cells, and rare eosinophils and Langhans' type multinucleate giant cells.
 - B. Cellular components. Use the names of the cells. Refrain from using the terms "mononuclear cell infiltrate", non-suppurative inflammation" or "subacute inflammation".
 - C. Non-cellular components. These are often as important as the cellular components - fibrin, edema, hemorrhage, and that most commonly overlooked denizen of the inflammatory focus -- cellular debris.
 - D. Quantify everything. (Small amount, moderate amount, abundant amount; few neutrophils, moderate numbers of neutrophils, many neutrophils, myriad or innumerable neutrophils, etc.)
 - E. Do not be afraid to interpret your descriptions. ("Vessel walls contain a small brightly eosinophilic granular material admixed with a few neutrophils and cellular debris (fibrinoid necrosis)....
- IV. Causative agent.
 - A. Location.
 - B. Size and shape (powerful descriptors)
 - C. Interpretation (bacilli, cocci, fungal hyphae, etc.)
 - D. Inclusion body (eosinophilic, basophilic, or amphophilic, ICIB or INIB)

MORPHOLOGIC DIAGNOSIS

General. There are many ways to formulate a morphologic diagnosis, and they often vary from institution to institution. The "AFIP diagnosis" is well-known for its thoroughness, and often its length. For us, it works; it's not for everyone.

- I. Site. This should match the organ listed in the morphologic description, however, you should localize it further, if possible ("Kidney, glomeruli:" or "Brainstem, paraventricular nuclei:" or simply "Liver:")
- II. Lesion. Be as specific as you can by adding applicable modifiers to characterize the cellular infiltrate (Dermatitis, suppurative" or "Myocarditis, granulomatous and eosinophilic")
- III. Duration. Acute, subacute, chronic. (Perhaps its a combination such as a lesion with a lot of fibrosis and scattered areas of suppuration, so you may want to use the term "chronic-active". It's a short list of modifiers here, though.)
- IV. Distribution. Focal, multifocal, multifocal to coalescing, diffuse. (There are a few others - massive, disseminated, etc. You can even combine some: "multifocal and random".
- V. Severity. Minimal, mild, moderate, severe, and everything in between - "mild to moderate", etc.
- VI. Neoplasms. The morphologic diagnosis for a neoplasm is simply the site and type of neoplasm, i.e. (Femur: Osteosarcoma, telangiectatic or Haired skin: Plasmacytoma.) Ancillary changes seen in the tissue as a result of the presence of a neoplasm are usually not included in the morphologic diagnosis.

Example Microscopic Descriptions - Descriptive Path Course

NEOPLASMS

HISTORY: A rapidly growing cutaneous mass from a cat.

MORPHOLOGIC DESCRIPTION: Within, expanding and replacing the dermis, elevating and compressing the overlying superficial dermis, and extending to the cut border is a multilobulated, partially encapsulated, poorly demarcated, moderately cellular infiltrative mass composed of poorly defined interlacing streams and bundles of tightly packed spindle cells. The neoplastic cells have indistinct cell borders and a moderate amount of eosinophilic fibrillar cytoplasm. Nuclei are irregularly round to elongate with lightly stippled chromatin, prominent nuclear borders, and a single, usually central magenta nucleolus. There is scattered anisokaryosis and karyomegaly. Mitoses average 1 per 10 HPF but in areas are up to 2 per HPF. Multifocally within the mass are areas of necrosis with hemorrhage, fibrin, edema, and infiltrates of few lymphocytes, plasma cells, and macrophages (often containing hemosiderin). Multifocally lymphatics are distended by clear space (edema). Multifocally within the stroma and adjacent dermis are nodular perivascular aggregates of lymphocytes, plasma cells, and lesser macrophages. Multifocally there is minimal orthokeratotic hyperkeratosis of the overlying epithelium.

MORPHOLOGIC DIAGNOSIS: Haired skin, dermis: Fibrosarcoma, breed unspecified, feline.

HISTORY: Sclerotic mass in the intestine of a cow.

MICROSCOPIC DESCRIPTION: Small intestine. Multifocally expanding and infiltrating all layers of the intestinal wall is an unencapsulated, poorly demarcated, poorly cellular infiltrative mass composed of widely scattered tubules supported by an abundant dense fibrovascular stroma. Neoplastic cells are cuboidal to columnar, with variably distinct cell borders and small to moderate amounts of granular eosinophilic cytoplasm. Nuclei are basilar with coarsely stippled chromatin and one to two basophilic nucleoli. The mitotic rate averages 1-3 per HPF. There is multifocal vascular invasion. Tubules often contain variable amounts of eosinophilic and karyorrhectic cellular debris admixed with small numbers of degenerate neutrophils and macrophages. Multifocally, the stroma contains small to moderate numbers of lymphocytes, plasma cells, and fewer macrophages, scattered neutrophils and eosinophils, and often contains moderate amounts of a foamy, amphophilic material (mucin). Within the lamina propria and submucosa of the remaining preexisting tissue, there is a moderate increase in lymphocytes, plasma cells, and eosinophils. Lymphatics in the submucosa are dilated and connective tissue fibers are loosely arranged (edema).

MORPHOLOGIC DIAGNOSIS: Small intestine: Adenocarcinoma, tubular, breed not specified, bovine.

INFLAMMATORY LESIONS

HISTORY: Two cutaneous masses, one on the right distal tibia and one on the left forelimb digit were excised from a 2-1/2 year old female grey kangaroo (*Macropus fuliginosus*).

MORPHOLOGIC DESCRIPTION: Haired skin: There is a focally extensive, verrucous proliferation of the epidermis, characterized by multiple, closely associated, elongate folds (up to 1/2 cm) which compress the interposed dermis and extend above and below the adjacent unaffected epidermis. Within this area, severe ballooning degeneration thickens the stratum spinosum and occasionally the stratum granulosum 4-5X normal thickness; affected cells frequently contain a large (15-20 μ), irregularly shaped, homogenous, eosinophilic to basophilic, intracytoplasmic inclusion body (Molluscum body) which displaces the nucleus. The epithelium of hair follicles is similarly affected. There is diffuse mild parakeratotic hyperkeratosis, often containing retained inclusion bodies admixed with necrotic cellular debris and hemorrhage; similar material often fills hair follicles. Mildly thickening the deep dermis are nodular aggregates of moderate numbers of lymphocytes and macrophages, admixed with occasional plasma cells and neutrophils. Scattered throughout, within the remaining dermis are similar inflammatory cells and occasional mildly dilated lymphatics (edema).

MORPHOLOGIC DIAGNOSIS: Haired skin: Hyperplasia, epidermal and follicular, focally extensive, severe, with eosinophilic intracytoplasmic inclusion bodies and chronic dermatitis (molluscum contagiosum)

HISTORY: Tissue from a Mangabey monkey that died shortly after arrival from the supplier.

MORPHOLOGIC DESCRIPTION: Lung: Diffusely, alveoli and bronchioles are partially to completely filled with abundant RBCs, fibrin and edema admixed with variable combinations and concentrations of often degenerate macrophages, neutrophils, and rare lymphocytes. In some areas of the section, alveolar septa are thin, fragmented and discontinuous, and replaced by karyorrhectic debris (necrosis). In other areas, they are mildly thickened with similar inflammatory cells, fibrin and edema as described previously. Multifocally, there is mild hemorrhage in the bronchiolar mucosa and smooth muscle and mild peribronchiolar and perivascular hemorrhage and edema. Bronchiolar mucosa is segmentally lost and bronchioles are occasionally lined by flattened epithelium covered by scattered, small, surface colonies of 1 μ m basophilic cocci. Multifocally, low numbers of neutrophils, often degenerate, transmigrate the walls of pulmonary veins disrupting and fragmenting smooth muscle (vasculitis). There is diffuse mild congestion.

MORPHOLOGIC DIAGNOSIS: Lung: Pneumonia, fibrinohemorrhagic, acute, diffuse, with vasculitis and colonies of cocci, Mangabey monkey, primate.

ETIOLOGIC DIAGNOSIS: Pneumococcal pneumonia

ETIOLOGY: *Streptococcus pneumoniae* (Diplococcus)

Example Microscopic Descriptions - Descriptive Path Course

HISTORY: Tissue from a dog with a two-year history of progressive ataxia and posterior paresis with pain.

MICROSCOPIC DESCRIPTION: Cerebral cortex and diencephalon: Multifocally within and expanding the neuropil of both grey and white matter, more severely in the diencephalon, are multiple randomly scattered, often periventricular, nodular aggregates (up to 3 mm in diameter) of large numbers of macrophages, lymphocytes, and plasma cells, with fewer neutrophils and rare Mott cells. Similar individual or small clusters of these inflammatory cells extend into the surrounding fragmented neuropil. The periventricular inflammatory foci expand into the ventricle and elevate the overlying ependyma. Within these areas are multiple, small blood vessels lined by plump endothelium (neovascularization). Within the adjacent neuropil there is minimal to mild microgliosis, rounded astrocytes with eosinophilic cytoplasm (gemistocytes) and a few eosinophilic spheroids (swollen axons). Multifocally, blood vessels are surrounded by cuffs of low to moderate numbers of lymphocytes and fewer plasma cells, which occasionally extend into the adjacent neuropil. Low to moderate numbers of macrophages contain one to ten, 2-4 um, round to oval yeasts with a central 1 um basophilic dot surrounded by a clear space.

Morphologic Diagnosis: Cerebral cortex and diencephalon: Encephalitis, granulomatous and lymphoplasmacytic, subacute to chronic, multifocal, moderate with intrahistiocytic yeasts, etiology—consistent with Histoplasma capsulatum, breed unspecified, canine.

HISTORY: Esophageal lesion found in a dog.

MICROSCOPIC DESCRIPTION: Esophagus: Within a focally extensive area, thickening the wall of the esophagus (2x), and elevating the overlying mucosa, there is a large (1 x 1.5cm), expansile nodule which replaces much of the submucosa and tunica muscularis. The nodule is composed of a thick, 1 to 3mm fibrous connective tissue capsule, containing numerous small blood vessels, with an inner rim of abundant plasma cells, and lesser lymphocytes and macrophages (many containing hemosiderin) enmeshed in strands of fibrous connective tissue, which in turn, surrounds a central cavity containing multiple sections of a large (1 mm dia.) metazoan parasite and abundant necrotic cellular debris. The parasite is characterized by a smooth cuticle, coelomyarian-polymyarian musculature, prominent lateral cords, a pseudocoelom containing small amounts of an eosinophilic granular material, a large digestive tract lined by columnar epithelium with long microvilli, and reproductive organs. Multifocally within the adjacent muscularis, there are swollen and condensed muscle fibers (degeneration) often separated by small amounts of fibrous connective tissue. Diffusely, there is a mild increase in fibrous connective tissue within the lamina propria and remaining submucosa and there are low numbers of lymphocytes and plasma cells scattered throughout the section. There is a nodular focus on the adventitia containing occasional macrophages, haphazardly arranged fibrous connective tissue, necrotic cellular debris and numerous basophilic coccoid bacteria (probably postmortem overgrowth).

MORPHOLOGIC DIAGNOSIS: Esophagus, submucosa, tunica muscularis: Granuloma, focally extensive, severe, with nematode parasite consistent with Spirocerca lupi, breed unspecified, canine.

Example Microscopic Descriptions - Descriptive Path Course

HISTORY: Tissue from an adult rhesus monkey (Macaca mulatta).

MICROSCOPIC DESCRIPTION: Lung: Multifocally, bronchioles and bronchi have varying amounts of inflammatory and epithelial changes. Within the lumen and extending through the bronchiolar wall are moderate numbers of neutrophils and macrophages with fewer eosinophils, lymphocytes, and foreign body multinucleate giant cells. This inflammatory infiltrate often extends into adjacent alveoli. Mucosal epithelial cells vary from columnar to cuboidal to squamous and occasionally are denuded. Bronchiolar walls are also variably thickened by moderate to abundant amounts of increased fibrous connective tissue. Multifocally within bronchiolar walls and the pulmonary interstitium are numerous aggregates of large numbers of macrophages with intracytoplasmic golden-brown, globular to granular pigment containing refractile spicules. Also, there is a multifocal mild increase in peribronchiolar lymphoid aggregates (lymphoid hyperplasia) and there is a small focus of peribronchiolar hemorrhage. Three subpleural bronchioles contain round to oval sections of a metazoan parasite, 300-500 μ in diameter. These parasites have a body cavity, striated musculature, and jointed appendages with a lightly chitinized cuticle which lacks external segmentation. Other identifiable structures include the brain, gut segments, and uterus. Often surrounding the parasite is a concentrated infiltrate of neutrophils.

MORPHOLOGIC DIAGNOSIS - Lung: Bronchitis, bronchiolitis, and peribronchiolitis, pyogranulomatous, chronic, multifocal, moderate with peribronchiolar pigmentation and intraluminal acarine parasites, rhesus monkey, Macaca mulatta.

ETIOLOGIC DIAGNOSIS: Pulmonary acariasis.

ETIOLOGY: Pneumonyssus simicola

HISTORY: Incidental finding in a squirrel monkey.

MICROSCOPIC DESCRIPTION: Liver: Multifocally within large bile ducts, distending and occluding the lumina, are cross-sections of a trematode parasite which is slightly flattened, measuring up to 700 x 400 μ diameter, with a thin tegument overlying a narrow band of somatic muscle, and no discernible body cavity. Scant internal structures are suspended in a parenchymatous matrix, and consist of paired tubular organs lined by a ciliated epithelium (ceca), a few cells with small dense nuclei and globular, golden brown cytoplasm (vitellarian glands) and numerous yellow, thick shelled, rarely operculate eggs measuring up to 40 x 25 μ , often containing deeply eosinophilic, basophilic, or black, multinucleate structures (morula). Diffusely, portal areas are infiltrated by moderate numbers of lymphocytes, plasma cells, and fewer macrophages of neutrophils. There is diffuse mild hepatocellular vacuolar change.

MORPHOLOGIC DIAGNOSIS: Liver: Hepatitis, lymphoplasmacytic, diffuse, periportal, mild, with intraductal trematodes, squirrel monkey, Saimiri Sciureus, primate.

ETIOLOGIC DIAGNOSIS: Biliary distomiasis.

ETIOLOGY: Most likely Athesmia foxi, but A. heterolecithodes and A. wehri have been reported.

Example Microscopic Descriptions - Descriptive Path Course

HISTORY - Tissue from a female rhesus monkey that had a poor appetite for several months. She had lost 4 kg of body weight prior to death, and on gross necropsy a firm palpable mass was found in the abdomen.

MICROSCOPIC DESCRIPTION: Colon, mesentery and mesenteric lymph nodes: Multifocally within the tunica muscularis, extending into and replacing glands of the mucosa, and present within the mesenteric fat are discreet foci of tortuous glandular tissue surrounded by abundant, densely cellular stroma. The glands are lined by a pseudostratified columnar epithelium with palisading, often anti-basilar nuclei and moderate amounts of a clear to lightly eosinophilic cytoplasm (uterine glands). The stroma is composed of stellate to spindled cells with scant eosinophilic, fibrillar cytoplasm and oval to elongate nuclei. Mitoses in these areas are 1/HPF (uterine stroma). There is within the mesenteric fat a single focus of glands and stroma, as described, which is undergoing lytic necrosis, with scattered pyknotic and karyorrhectic cellular debris and infiltration by moderate numbers of viable and degenerate neutrophils, occasional macrophages and moderate hemorrhage, which extends into the adjacent adipose tissue.

The lymph node contains mildly increased numbers of erythrophagocytic macrophages within the paracortical and medullary sinuses.

MORPHOLOGIC DIAGNOSIS: Colon, mesentery: Endometriosis, transmural, moderate.

HISTORY: Incidental finding in a Sprague-Dawley rat.

MORPHOLOGIC DESCRIPTION: Small intestine and mesentery: Diffusely affecting up to 85% of mesenteric and mural arteries and arterioles, thickening the walls up to 20x normal are numerous plump fibroblasts which extend from the media to the adventitia and into the perivascular connective tissue. The intima and media of most vessels is disrupted, with segmental fragmentation of collagen bundles, loss of the internal elastic lamina, scattered karyorrhectic debris, and infiltration by moderate numbers of neutrophils, macrophages and fewer fibroblasts (necrotizing vasculitis). Occasionally the media is replaced by abundant, amorphous to flocculent, brightly eosinophilic material (fibrinoid necrosis). Within the media, adventitia and, less often, perivascular tissue there are moderate numbers of neutrophils, fewer lymphocytes, plasma cells, macrophages and eosinophils, with scattered minimal hemorrhage.

MORPHOLOGIC DIAGNOSIS: Small intestine and mesentery, arteries: Vasculitis, proliferative and necrotizing, chronic-active, diffuse, moderate.

CONDITION: Polyarteritis nodosa

Example Microscopic Descriptions - Descriptive Path Course

HISTORY: Tissue from a male German shepherd that developed an abnormal gait with a progressive loss of proprioceptive and motor nerve function.

MICROSCOPIC DESCRIPTION: Spinal cord (2 sagittal and 2 cross sections with dura and nerve roots): There is diffuse moderate degeneration of white matter affecting all funiculi and nerve roots with large variation in the diameter of axon sheaths, ranging up to 50 μm . Swollen sheaths contain axons which are swollen and rounded up to 30 μm diameter (spheroids). Sheaths also contain acidophilic fibrillar material, single or rarely multiple macrophages with abundant foamy cytoplasm (Gitter cells), or clear space (loss of axons, demyelination). On sagittal section, there are numerous linear 30 x 50 μm clear spaces containing degenerative/necrotic axons and gitter cells (ellipsoids, digestion chambers). There is a mild gemistocytic gliosis within white matter. Scattered neurons contain an intracytoplasmic finely granular, yellow-brown pigment (lipofuscin). One cross section contains multifocal dural ossification with bone marrow.

MORPHOLOGIC DIAGNOSIS:

1. Spinal cord and nerve roots: Degeneration, axonal, with swollen axon sheaths, and digestion chambers, diffuse, moderate
2. Spinal cord: Lipofuscin, intraneuronal, multifocal, mild.
3. Spinal cord, dura mater: Osseous metaplasia, multifocal, mild.