Thomas

Sandritter

Macropathology

Textbook and Color Atlas

Fifth Edition

Sandritter *Fifth Edition*

Macropathology

Textbook and Color Atlas

With 678 illustrations, 637 in color

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Note: This is a faithful translation of the German text. The publisher has made every effort to ensure that the information contained herein is accurate. However, because there are differences in practice in Germany and elsewhere, the reader should consult a standard reference for local practice.

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Foreword

The study of disease encompasses general, special, and experimental pathology. The division into histopathology and macropathology is, at best, a compromise that can be justified only by having courses in general pathology and special pathology, each with their particular emphasis on macroscopic and microscopic approaches. *Macropathology* and *Histopathology* supplement each other and together represent a single unit. In an atlas, the macroscopic and microscopic illustrations should be able to convey the necessary message all by themselves and require only minimal additional explanatory material. These two atlases were never meant to replace a conventional textbook, and so they were not organized along the lines of traditional subject matter. These volumes serve not just to assist in studying for an exam but rather to help students and young physicians improve their practical skills and knowledge. It is important to remember that, in spite of all the advances in laboratory diagnostics and imaging technology (such as sonography and computed tomography), the pathologic diagnosis still represents the most reliable (greater than 90% accuracy) and least expensive method of investigation. In the diagnosis of neoplastic diseases, it cannot be replaced by any other technique. It is also important that the attending clinician be familiar with the advantages, prognostic capabilities, and limitations of this discipline. A prerequisite for this is that the clinician understand and speak the pathologist's "language."

By definition, pathology is the central core of the medical sciences and for this reason carries an enormous responsibility for the student and young physician, who must still rely on the experiences of others. The exponential expansion of scientific knowledge, which confronts us daily, places great demands not only on students but also on the faculty who must convey this information to them. In this context, an old teaching adage must be considered: Only those facts should be taught that are likely to be valid 5 years hence.

Since pathology includes the entire field of medicine, its subject matter is particularly extensive and forces authors to make choices. The same is true in preparing a new and revised edition. Emphasis must be placed on a few areas (such as blood vessels, lungs, and kidneys).

Books like *Histopathology* and *Macropathology* are always the outcome of a major cooperative effort of a large group. It is therefore my pleasant task to thank all the contributors: the colleagues listed on the title page, the members of the Marburg Institute of Pathology, and the editors of the Schattauer Publishing Company. Special thanks are due to, among others, Dr. Matis; our business manager, Mr. Bergemann; Mr. Haub (Grafische Kunstanstalt Brend'amour); and the artist, Mr. Tschorner.

C. Thomas
Marburg

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1 Introduction

General Comments

The primary purpose of macropathology is the assessment of organ changes by inspection and palpation. The first step in a pathologic diagnosis is the autopsy or macroscopic evaluation of the changes in a surgical specimen. This procedure must not be underestimated by the pathologist as a diagnostic tool or by the student as a learning experience. Macroscopic diagnosis is the foundation of all surgical disciplines. It allows the pathologist to reach a preliminary conclusion based on a routine inspection and guides him or her in further study. Finally, the quality of the histologic examination depends on the quality of the preceding macroscopic examination, since the latter determines the choice of the appropriate sections for microscopic study.

Autopsy. Even today, autopsy is the most important task a pathologist has to perform. It concludes the medical care of a deceased patient and, at the same time, subjects it to critical scrutiny. An autopsy should answer many questions that remained unanswered while the patient was still alive: Was the diagnosis accurate and complete? How did the patient respond to therapy? Can the autopsy provide new information concerning the pathogenesis, diagnosis, or therapy? Are there certain findings that may be important to the family of the deceased (e.g., infectious diseases, hereditary diseases, or compensable diseases)?

Not uncommonly, the autopsy reveals unsuspected secondary diseases. For example, during the end stages of a neoplastic disease, an old tuberculous lesion may be reactivated. This lesion is purely exudative, produces no reaction, but is highly contagious. Latent, malignant tumors are, by definition, found only incidentally at autopsy or during surgical exploration.

Technique. An autopsy is performed on a cadaver or on organs removed in toto. First of all, the topographic relationships of individual organs are examined before their removal. This is followed by a macroscopic assessment, description of findings, and diagnosis. This method enables the autopsy to be performed quickly. After samples have been taken for histologic study, the organs are replaced in the body cavities. This autopsy technique is not suitable to demonstrate topographic relationships to a clinician (particularly a surgeon) or to a student.

The in toto removal of organs means that the organs of the neck, chest, abdomen, or pelvis are removed as a single block. This assures the anatomic continuity of the organs but makes study difficult because of the large size of the specimen.

As a reasonable compromise, the removal of individual organ "packages" is appropriate in order to assess body cavities individually.

1. *Brain with meninges and pituitary:* After removal of these organs, the skull, nasal cavities, sinuses, large vessels, and middle ear are examined.
2. *Neck and chest organs:* The tongue, tonsils, esophagus, larynx, trachea, lungs, thyroid, visceral pleura, heart, and great vessels are removed as a unit and examined.
3. *Intestines:* The small and large intestines, mesentery, mesocolon, and large omentum form a single anatomic unit.
4. *Upper abdominal organs:* The stomach, duodenum, liver, gallbladder, pancreas, and spleen are separated en bloc from the other abdominal and pelvic organs.
5. *Abdominal and pelvic organs:* Here, the large vessels (aorta and inferior vena cava) provide the scaffolding and link the kidneys, adrenals, ureters, bladder, rectum, and genitals.
6. *Other organs:* Bones (femur and sternum), skin, spinal cord, and eyes are removed only if there is a particular indication.

An autopsy must always be complete, and all organs must be examined. The occasional request to omit

examination of the brain (usually made by relatives) should be denied, if possible, as should the frequent request by neurologists to limit the autopsy to the brain. A partial autopsy is likely to raise more questions than it answers.

The autopsy should be regarded as a component of the clinical diagnostic process. Accordingly, both the macroscopic and histologic examinations are guided to a considerable degree by the clinical picture. The custom in some countries of having the attending clinician be present at the autopsy is an ideal that is only rarely fulfilled. A complete clinical record, the available laboratory values, and the formulation of pertinent questions by the clinician are the prerequisites for a meaningful autopsy diagnosis. The participation of the attending physician at the clinicopathologic conference as an expression of his or her responsibilities and respect for the deceased should be taken for granted.

Macroscopic Evaluation of Biopsy Material. A biopsy is defined as the removal of a specimen or an organ for diagnostic purposes.

Important Rule. All tissues and organs removed surgically must be examined histopathologically. This serves to confirm or complete the clinical diagnosis and also serves as evidence that a surgical procedure has indeed been performed. Appendicitis after an alleged appendectomy and pregnancy after tubal ligation or vasectomy are not unknown.

The macroscopic segment of the pathologic diagnosis is based on the usual classification of **systemic pathology**. Accordingly, a description of the affected organs stands in the foreground. Each section begins with a clinicopathologic definition. Scattered through the chapters are brief case histories that indicate the broader complexities of the various disease processes. Although these serve as a starting point, pathologists must approach each case individually and must reach conclusions only on the basis of specific findings.

Every chapter is arranged as follows:

1. Comments on anatomy, autopsy technique, and postmortem changes
2. Malformations
3. Changes in shape, size, surface, and orientation
4. Circulatory disturbances
5. Metabolic disturbances
6. Inflammations
7. Tumors.

The description of the illustrations uses the following outline:

1. Definition
2. Macroscopic description (abbreviated Ma)
3. Incidence, individual and regional (I)
4. Age (A) and sex (S); male (M), female (F)
5. Primary disease (PD)
6. Pathogenesis (Pg): Developmental pathogenesis (DP), or how the change occurred, and Etiology (E), or why the change occurred.
7. Complications (Com), sequelae (Seq) and localization (Loc).
8. Differential diagnosis (DD)
9. Clinical symptoms (Cl)
10. Prognosis (Pr)
11. Therapy (T)
12. Remarks (R).

Other abbreviations: CS = on the cut surface
> = more than
< = less than
Unless otherwise indicated, percentages refer to the incidence in autopsy material.

Figure 1.1. Items commonly used for indicating the size of macroscopic findings. *Top row*, walnut, almond, cherry pits, and plum stone. *Bottom row*, apple pits, rice, millet, and lentils.

Diagnostic Criteria

A general problem in the evaluation of diagnostic criteria is the level of consciousness necessary for an observation to become "significant." The number of observations (or impressions) is very large, but only a limited number are significant. Selecting the significant ones is an art, but it can be learned to some extent with experience. The basic condition for all recognition, however, is attention. It is only by paying the most careful attention that apparently insignificant phenomena are realized and incorporated into the diagnosis.

Position and Shape of the Organs

In this way, malposition of an organ can be easily diagnosed (e.g., pelvic kidney, diaphragmatic hernia with displacement of the abdominal organs, volvulus, or situs inversus). Adhesions (fibrin and/or connective tissue strands) can be recognized in their entirety.

As far as the shape is concerned, the normal organ must always serve as the basis for comparison. Frequent aberrations include congenital lobulations (e.g., in the lung, spleen, or kidney) or acquired distortions by external compression (e.g., scabbard trachea in goiter or atelectasis in spontaneous pneumothorax).

Size and Weight

Size is largely a matter of comparison with the normal organ. More accurate are measurements giving length, width, and height. These values are only relative because of the manifold configuration of the

TABLE 1.1 **Height (cm), Weight (kg), and Organ Weight (g) as a Function of Age and Sex**

Age	Height		Weight		Heart		Lungs*		Liver		Kidneys		Spleen		Adrenal Glands		Testes	Ovaries	Brain	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female			Male	Female
Birth	50.6	50.2	3.4	3.3	23	21	50	47	134	135	24	23	11	10	6.2	5.2	1.1	0.25	385	365
6 months	66.4	65.2	7.5	7.26	28	25	60	60	160	140	31	28	14	12	3.2	2.0	1.5	0.3	300	360
1 year	75.2	74.2	10.0	9.7	60	55	170	170	380	330	70	60	30	25	5.6	5.4	1.9	1.0	960	960
2 years	87.5	86.6	12.5	12.2	65	58	190	180	420	350	77	72	35	30	6.0	5.5	2.0	1.0	970	950
5 years	111.3	109.7	19.4	18.7	100	90	270	266	600	450	105	105	55	52	6.6	6.0	2.8	1.8	1,200	1,050
10 years	140.3	138.6	32.6	31.8	130	120	360	310	950	800	150	125	80	70	9.0	8.0	4.0	4.0	1,250	1,230
15 years	167.8	161.1	54.8	51.4	240	200	550	500	1,270	930	200	185	120	110	13.0	11.0	20.0	8.0	1,340	1,260
20 years	170.0	165.0	62.0	56.2	280	260	700	620	1,560	1,370	270	240	155	130	13.5	12.0	42.0	9.5	1,400	1,260
25 years	170.0	165.0	65.0	56.6	310	265	770	620	1,580	1,370	280	260	170	130	14.0	13.0	45.0	11.0	1,400	1,250
30 years	170.0	165.0	68.0	58.5	315	270	800	620	1,580	1,370	285	240	170	130	14.0	13.0	42.0	11.0	1,390	1,250
40 years	170.0	165.0	71.0	61.2	**320**	**285**	**800**	**660**	**1,590**	**1,400**	**275**	**240**	**150**	**130**	**14.0**	**13.5**	**40.0**	**9.0**	**1,380**	**1,250**
50 years	170.0	165.0	72.0	64.8	340	305	800	620	1,600	1,430	270	235	145	115	13.0	12.5	35.0	6.0	1,340	1,240
60 years	170.0	165.0	73.0	67.1	330	310	800	620	1,520	1,380	270	235	130	105	13.0	12.0	33.0	4.5	1,300	1,200
70 years	170.0	165.0	72.0	67.5	320	300	770	620	1,400	1,250	260	220	110	90	12.5	12.0	30.0	4.0	1,250	1,150

*The weight of the lungs is distorted by pulmonary edema. In deaths from electrocution (legal execution) the lung weight is given as 200 g.

organs. The only accurate measure of size is volume, i.e., the amount of water displaced by the organ. The volume and weight of an organ determine the specific gravity (weight ÷ volume = specific gravity). A fatty liver seems larger than a normal liver of the same weight, since the specific gravity of fat is less than that of protein. The same is true for carbohydrates, as in glycogen storage disease of the liver. (The specific gravity of granulocytes is 1.070; erythrocytes, 1.096; blood, 1.059; plasma, 1.027; and fat, .900).

The specific gravity of a liquid is measured with a hydrometer. Exudates, i.e., fluids with a high protein content, have a specific gravity over 1.018; transudates have a specific gravity under 1.018. (Cf. hollow organs.)

The size of *focal changes of organs* (e.g., tumor metastases) should always be given in centimeters, at least on the cut surface (6 × 4 cm) or, whenever possible, three-dimensionally (6 × 4 × 4 cm). A comparison to fruits or other food items is popular, and Figure 1.1 gives an overview of some of these. This form of comparison obviously has several advantages. Unfortunately, it is also quite inaccurate, particularly if items of considerable variability (apples, tomatoes, or eggs) are used. Terms such as fist-size or infant-head-size should be avoided.

In general, *organ size* is indicated by weight. Even considering the aforementioned limitations (specific gravity), weight is a reliable measure of size. Table 1.1 gives an overview of organ weights in relation to age, height, and body weight. These numbers are subject to a 10% standard deviation, particularly in childhood. In women, average weights are 20% less than in men. It is both impossible and unnecessary to try to commit these numbers to memory. If needed, they can always be looked up. Nevertheless, it is useful to remember the average weights in adults (boldface type). The following memory aid has been found useful: The heart weighs about 350 g; lungs weigh twice as much as the heart, or 700 g; the spleen and kidney weigh about half as much as the heart, or 150 g; the liver is 10 times larger than the spleen and weighs 1,500 g; the brain equals the liver minus the spleen, or about 1,350 g.

Organ Color

Of all the available sensory organs used to characterize a natural phenomenon, the most important are the eyes. It must be remembered that the experienced eye perceives much more than color and can recognize *shape, transparency, shine* (dry, wet), *surface* (rough, smooth), and *consistency.*

The verbal description of a color should be considered as an aid to guide us from description to diagnosis. It is therefore important to know which organic substance is responsible for what color and which substrate is responsible for a pathologic change in color. There are not many studies on this subject, so only a few guidelines can be given.

In general, blood content determines organ color. The red of hemoglobin predominates. Saturated blood (active arterial hyperemia) is responsible for the bright red color of the organ or the skin. Hypoxic and hypercapnic blood makes an organ appear dusky red or bluish-red, as in congestion of the kidney. A blackish-red color may result from a hemorrhagic pulmonary infarct. Carbon monoxide poisoning turns the blood a cherry-red color (see Fig. 17.3).

In jaundice, the metabolic breakdown products of hemoglobin, *bilirubin* (reddish-yellow) and *biliverdin* (greenish-yellow), stain all organs. The gradual change from red to yellow (or red-yellow to green-yellow) in a hematoma represents the degradation of hemoglobin to biliverdin.

Pigment deposits may change the color of the organ, as follows:

Melanin	Black	Examples: Malignant melanoma, melanuric nephrosis, black urine
Carbon	Black	Example: Anthracosis of the lungs
Hemosiderin	Brown	Examples: Hemosiderosis of the liver (see Fig. 6.35), chronic pulmonary congestion (see Fig. 4.42)
Lipofuscin	Brown	Examples: Brown atrophy of the heart, color of unsaturated fatty acids
Iron	Brown	Example: Hemosiderosis of the lung

The yellow color of adipose tissue, the adrenal cortex, or the corpus luteum is due to *carotenoids*. Humans cannot synthesize carotenoids but consume them in food. *Yellow discoloration* may be part of a pathologic process, such as fatty degeneration of the liver or heart. If icterus is superimposed onto a fatty liver, a yellowish-green color appears (saffron liver). Fatty granulocytes determine the yellow color of pus.

In some inflammations, *bacteria* may change the color of pus or granulation tissue: Staphylococcal pus is yellow (due to fatty granulocytes); streptococcal pus (phlegmon) is grayish-white (due to light scattering); pseudomonal pus is bluish-green.

In *necrosis*, the tissues are either pale, as in a recent *cerebral cortical infarct* (normally brown from neuronal cells and lipofuscin), or blackish-red, as in *hemorrhagic infarct*. In *ischemic infarct*, the yellow or grayish-yellow color is due to the absence of blood and a change in the refraction of light (gray); breakdown products of hemoglobin (lysis of erythrocytes) may also play a role.

After rinsing, many organs appear grayish-white (kidneys), provided the brown color of lipofuscin (liver) or of myoglobin (heart) does not predominate. In generalized anemia, all the organs have the same color.

The entire range from white to black, mostly grayish-white, is due to *light scattering*, or the Tyndall effect, with the degree of the scattering being a function of particle size and wavelength. Fresh granulocytes and all nucleated blood cells are gray to grayish-white. The same is true for dense aggregations of cells, such as tumors that are poorly vascularized. Fibrin on the surface, in a pre-existing cavity, or in coagulated blood and cartilage is grayish-white because of light scattering. In advanced age, cartilage can appear brown from changes in water content and thus light refraction. Compared with connective tissue, elastic fibers appear light yellow because of increased light scattering. In *ochronosis*, the cartilage is black from homogentisic acid. A pure white color is seen only in cholesterol and other crystalline deposits, as in cystinosis of the spleen. Thorium oxide (Thorotrast), formerly used as a radiographic contrast medium, also produces white deposits in the liver and spleen.

Black or greenish-black is the color of tissues in antemortem putrefaction (gangrene) caused by the formation of sulfur dioxide and the resulting sulfhemoglobin.

Surface, Cut Surface, and Cavities

In evaluating the surface or cut surface, the nature of the surface, pattern, blood content, consistency (see below), and presence of foreign deposits must be taken into account. The surface of the organs is usually covered by a serosa and therefore appears *smooth*, *reflective*, and *glistening* (moist). Fibrin deposits make the surface dull or, if heavier, grayish-white. In such cases, a parenchymal change must always be suspected (inflammations, e.g., bronchopneumonia with fibrinous pleuritis or myocardial infarct with fibrinous pericarditis). Both the surface and cut surface can become uneven (finely or coarsely granular); regularly or irregularly granular (as in cirrhosis of the liver and infarct or arteriosclerosis of the kidney); nodular, granular, lobular, or even wrinkled (as in acute liver necrosis or after acute hemorrhage in the spleen).

One can ordinarily see about ½ to 1 mm into the surface or cut surface of the liver, kidney, or heart (*transparency*). Proof: Thin sections of not more than a few millimeters assume the color of the underlying

material and appear very dark on a black surface. This transparency disappears in cloudy swelling (swelling of the mitochondria with increased scattering of light). At the same time, the parenchyma bulges slightly at the cut surface so that the cut edges appear dull, rather than sharp, and the shine (moisture) disappears. In *amyloidosis*, the transparency is increased. One can see fairly deeply into the organ, which has a glassy appearance, so that in thin sections the pattern of the underlying surface can be recognized (even newsprint).

In reference to color, mention must also be made of the *design* or *pattern* of the surface, i.e., the possibility of a characteristic color pattern that is due to foreign substances. The beautiful yellow-red pattern seen in chronic hepatic congestion is due to streaks of yellow fatty degeneration surrounded by dark red, dilated, congested areas. Another example is the cirrhotic liver, where gray connective tissue bands stand out from the brown or yellow parenchyma.

The *blood content* is reflected not only by the color of the cut surface, but also by the amount of blood oozing from the surface. The wall of the blood vessels must also be examined on the cut surface: Do the vessels collapse or stay open and rigid (as in arteriosclerosis of the kidney)? In the brain, hemorrhage can be differentiated from hyperemia by the fact that in the former the punctate hemorrhages on the surface cannot be wiped off.

The full extent of the *deposition of a foreign substance* can best be established on the cut surface. These usually focal or bandlike areas should be characterized by size, shape, color, consistency, margins (sharp or dull), shine (bright or dull), pattern, and surface (smooth, granular, protruding, or depressed). For example, bronchopneumonia foci are grayish-red, firm, dry, finely granular, poorly demarcated, and irregularly shaped.

The material that can be scraped off the cut surface may also give valuable information about the pathologic process. Normally, the knife blade is shiny from moisture in the tissues. In fatty degeneration of the liver, however, the blade is covered by tiny fat globules and appears dull. By scraping the surface, occasionally additional fluid can be obtained, as in pulmonary edema. The fluid may be viscous and grayish-red, as during the lysis stage of a pneumonia, or tenacious and elastic, as in bronchoalveolar carcinoma or Friedländer's pneumonia.

In the evaluation of **hollow viscera or cavities,** the same principles apply. The width of the space must be given; the size of the opening, thickness of the wall, structure of the inner surface (e.g., an old cavity is smooth-walled; a recent cavity has an irregular, ragged wall), and the content (volume in milliliters) must be described as well as the consistency of the contents (liquid, pasty, or solid), appearance (clear, cloudy, or stringy), sediment, specific gravity, transparency, color, opalescence, and reaction (acidic or alkaline).

Consistency

The consistency of an organ or a lesion is determined by the sense of touch and is usually described subjectively with an adjective, such as solid or firm (as in cirrhosis of the liver or silicosis); hard (calcified or ossified deposits); pulpy (as in medullary carcinomas); soft, doughy, or runny (as in septic spleen or acute liver necrosis); and friable, fragile, brittle, or loose (as in pneumonic foci or gangrene of the lung). A fatty liver has a doughy consistency, and pressure with the finger leaves an indentation, as in edema. Flaccid, soft, or flabby organs with poor consistency appear shrunken and have a wrinkled capsule. Cut sections from such organs do not stand up but collapse. When shaken, the organ undulates like a bowl of jelly.

Normal lung tissue is soft and elastic. In chronic pneumonia, the lung is firm and elastic. Sarcomas are also very elastic. Determining elasticity by stretching has proven useful in assessing the aorta (in arteriosclerosis, the vessel is rigid).

Olfactory and Other Senses

Smelling, tasting, and hearing are used less than the sense of sight and touch. Nevertheless, the sense of smell should not be ignored entirely, since the odor of acetone (rotten apples) in diabetic coma, the odor of raw liver in liver coma, the odor of ammonia (urine) in uremia, and the odor of decay in gangrene can all give valuable diagnostic hints. If poisoning is suspected, the bitter almond odor of cyanides, the onion odor

of phosphorus, and the garlicky odor of arsenic should be remembered. Hearing is used in evaluating crepitus of the lung. Pneumonic foci are not crepitant. The knife has a grating sound when cutting across indurated connective tissue (as in cirrhosis of the liver). The sound of breaking ribs should raise the suspicion of osteoporosis. The sense of taste is fortunately no longer called into service these days.

Artifacts

The beginner can be easily misled by postmortem artifacts. In advanced decomposition, all organs may have a black, grayish-black, or greenish-black color. A greenish-black color is frequently found on the underside of the liver (see Fig. 6.3), where it is in contact with the colon (the diffusion of H_2S leads to the formation of sulfhemoglobin on the surface of the liver). Different levels of postmortem oxidation of hemoglobin can be very misleading. If the cut surface was uncovered, the blood will be bright red; if the surface was covered, the color will be much darker. Hemoglobin liberated from the erythrocytes after death is a potent dye. It colors the normally white mucous membranes red and may simulate an inflammatory process.

It is a strict rule in the dissecting room that the gallbladder must be kept away from all other organs, since the bile pigments could easily make normal tissues appear jaundiced.

Round depressions or other surface irregularities may be due to the pressure from an organ container that has a perforated bottom for blood drainage.

Summary

Basic criteria for recognizing and diagnosing the most important features of autopsy findings are summarized in Table 1.2. Classification principles used in general pathology are in Table 1.3.

TABLE 1.2 **Diagnostic Criteria**

Position	**Cavities**	**Surface or Cut Surface**	**Fluids**
Shape	Width	Color, pattern, transparency	Amount
Size	Wall	Foci, deposits	Specific gravity
Weight	Content	Blood content	Color
Color		***Odor***	Transparency
Consistency			

TABLE 1.3 **Typical Macroscopic Findings Arranged According to the Principles of General Pathology**

Type of Change	Color	Shape and Weight	Consistency	Comments
Atrophy	Mostly brown	Reduced, diminished	Firm	—
Cloudy swelling	Dull	Enlarged, increased	Softer	Parenchyma protrudes from the capsule
Amyloid	Grayish-red, glassy	Increased	Very Firm	Transparent
Fatty degeneration	Yellow	Increased	Doughy	Knife blade "stained"
Pigments	—	—	—	—
Necrosis	Yellow	—	Dry, firm	Fresh: slightly raised over the surface Later: depressed
Ischemic infarcts (heart, kidney, spleen)				
Hemorrhagic infarct (lung, gut)	Dark, blackish-red	—	Dry, firm	Slightly raised over the surface
Fat necrosis	White, chalky spots	—	Firm	—
Granulation tissue	Red	—	Soft	Granular surface; red, sunken cut surface
Scar tissue	White, tendon-like, shiny	—	Firm	—
Active hyperemia	Bright red	Increased	Unchanged	—
Passive hyperemia (congestion)	Acute: dark red, Chronic: Brown (lung)	Increased	Firm to very firm	(Acute) (Chronic)
Aspiration of blood	Bright red	—	Normal	Bilirubin changed to biliverdin
Hemorrhages	Dark red	—	Increased	
Inflammations:				
serous	Bright red	Swelling	Soft	—
purulent	Yellow pus	—	Soft	***Phlegmon:*** Gray and pulpy. ***Abscess:*** Focal liquefaction.
fibrinous	Grayish-white	—	Soft	Surface dry
chronic	Grayish-red	—	Soft to firm	Depends on age
Lobar pneumonia	Red Grayish-red Yellow	—	Soft	Lysis: Red fluid; slightly stringy; can be scraped off.
Bronchopneumonia	Grayish-red	Irregular foci 3 to 4 cm in diameter	Friable	No crepitation
Gangrene	Dirty greenish-black	—	Easily torn, crumbly	Fetid

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