

ESSENTIALS OF HISTOLOGY

SECOND EDITION

HOSKINS AND BEVELANDER

ESSENTIALS OF HISTOLOGY

BY

MARGARET M. HOSKINS, Ph.D.

AND

GERRIT BEVELANDER, Ph.D.

New York University

WITH 135 TEXT ILLUSTRATIONS
AND 2 COLOR PLATES

SECOND EDITION

LONDON
HENRY KIMPTON
25 BLOOMSBURY WAY, W.C.1.

1952

COPYRIGHT, 1945, 1952, BY THE C. V. MOSBY COMPANY
(All rights reserved)

First Edition Reprinted
January, 1947
January, 1948
May, 1948
March, 1949

Printed in the
United States of America

Press of
The C. V. Mosby Company
St. Louis

CONTENTS

	PAGE
CHAPTER I	
EPITHELIA - - - - -	17
Simple Epithelia, 17; Squamous Epithelium, 17; Cuboidal Epithelium, 19; Columnar Epithelium, 19; Pseudostratified Epithelium, 20; Stratified Epithelia, 21; Stratified Columnar Epithelium, 21; Transitional Epithelium, 23; Stratified Squamous Epithelium, 23.	
CHAPTER II	
CONNECTIVE AND SUPPORTING TISSUES - - - - -	24
Connective Tissues, 26; Mucous Connective Tissue, 26; Reticular Tissue, 26; Fibrous Tissues, 29; Adipose Tissue, 32; Reticulo-Endothelial System, 32; Supporting Tissues, 33; Cartilage, 33; Bone, 37.	
CHAPTER III	
MUSCLE - - - - -	51
Smooth Muscle, 51; Skeletal Muscle, 53; Cardiac Muscle, 56; Circulation and Innervation of Muscle, 58.	
CHAPTER IV	
NERVOUS TISSUE - - - - -	59
Cell Bodies, 63; Nerve Cells in the Spinal Cord, 64; Nerve Cells of the Dorsal Root Ganglia, 65; Cells of Autonomic Ganglia, 66; Nerve Fibers, 67; Nerve Endings, 69; Motor Endings, 69; Sensory Endings, 70; Neuroglia, 71; Astroglia, 71; Oligodendria, 72; Microglia, 73.	
CHAPTER V	
BLOOD AND LYMPH - - - - -	74
Red Blood Corpuscles (Erythrocytes), 74; White Blood Corpuscles (Leucocytes), 75; Granulocytes, 75; Lymphocytes, 76; Monocytes (Large Mononuclears), 76; Platelets, 77; Lymph, 77.	
CHAPTER VI	
BLOOD-FORMING ORGANS - - - - -	78
Bone Marrow, 78; Reticular Tissue Cells, 78; Adipose Tissue Cells, 78; Hemocytoblasts (Stem Cell), 78; Promyelocytes, Myelocytes, Metamyelocytes, 78; Proerythroblasts, Erythroblasts, Normoblasts, 79; Giant Cells or Megakaryocytes, 79; Development of Blood Cells in the Embryo, 80; Germinal Centers of Lymph Nodes, 80; Theories of Development of Blood, 80; Monophyletic (Unitarian) Theory, 80; Dualistic Theory, 81; Polyphyletic Theory, 81.	
CHAPTER VII	
CIRCULATORY SYSTEM - - - - -	82
Blood Vessels, 82; Capillaries, 82; Arteries, 82; Veins, 85; Comparison of Veins and Arteries, 86; The Heart, 87; Endocardium, 87; Myocardium, 87; Epicardium, 88; Lymphatic System, 88.	

CHAPTER VIII

	PAGE
LYMPHOID ORGANS - - - - -	90
Lymph Node, 90; Cortex, 92; Medulla, 93; Spleen, 93; Capsule and Trabeculae, 96; Red Pulp, 96; White Pulp, 97; Function of the Spleen, 97; Tonsils, 98; Thymus, 99; Summary and Comparison of the Lymphoid Organs, 102; Lymph Node, 102; Spleen, 102; Tonsil, 102; Thymus, 102.	

CHAPTER IX

GLANDS - - - - -	103
General Morphology, 103; Cellular Differences, 105.	

CHAPTER X

THE INTEGUMENT - - - - -	107
Hairless Skin, 107; Epidermis, 107; Corium, 109; Hairy Skin, 109; Glands of the Skin, 110; Sweat Glands, 111; Sebaceous Glands, 111; Nails, 111.	

CHAPTER XI

ORAL CAVITY - - - - -	113
Lips, 113; Lining of the Oral Cavity, 113; Lips and Cheeks, 114; Gingivae and Hard Palate, 114; Teeth, 115; Early Development of Teeth, 115; Development of the Enamel Organ, 115; Cementum, 122; Pulp, 123; Gingiva, 123; Peridental Membrane, 124; Alveolus, 125; Tongue, 125; Filiform Papillae, 125; Fungiform Papillae, 125; Foliate Papillae, 127; Vallate (Circumvallate), 127; Glands of the Oral Cavity, 128; Pharynx, 129.	

CHAPTER XII

DIGESTIVE TRACT - - - - -	130
Mucosa, 130; Submucosa, 130; Muscularis, 130; Adventitia or Serosa, 130; Esophagus, 131; Mucosa, 131; Submucosa, 132; Muscularis, 132; Stomach, 133; Mucosa, 133; Submucosa, 136; Muscularis, 136; Serosa, 136; Small Intestine, 136; Mucosa of the Small Intestine, 137; Submucosa, 140; Muscularis, 141; Serosa, 141; Large Intestine, 141; Mucosa, 142; Submucosa, 143; Muscularis, 143; Serosa, 143; Rectum and Anus, 144; Vermiform Appendix, 144; Mucosa, 144; Submucosa, 145; Muscularis, 145; Serosa, 145; Blood Supply of Stomach and Intestines, 145; Nerve Supply of Stomach and Intestines, 146.	

CHAPTER XIII

GLANDS ASSOCIATED WITH THE DIGESTIVE TRACT - - - - -	147
Salivary Glands, 147; Parotid, 147; Submaxillary, 148; Sublingual, 149; Nerve Supply, 150; Pancreas, 150; Blood Supply, 151; Nerve Supply, 151; Summary of Salivary Glands and Pancreas, 151; Liver, 152; Liver Cells and Sinusoids, 152; Portal Canal, 154; Circulation in the Liver, 155; Gall Bladder, 157; Blood Supply, 157; Nerve Supply, 157.	

CHAPTER XIV

RESPIRATORY TRACT - - - - -	158
Trachea, 158; Bronchi, 158; Bronchioles, 158; Respiratory Bronchioles, 160; Alveolar Ducts, 160; Alveoli and Atria, 161; Blood Supply of the Lungs, 162; Nerve Supply of the Lungs, 162.	

	PAGE
UROGENITAL SYSTEM - - - - -	163
Urinary System, 163; Kidney, 163; Cortical Labyrinth, 163; Proximal Convoluted Tubule, 164; Henle's Loop, 166; Distal Convoluted Tubule, 168; Collecting Tubules, 168; Circulation of the Kidney, 169; Ureter, 169; Mucosa, 169; Submucosa, 170; Muscularis, 170; Adventitia, 170; Urinary Bladder, 170; Urethra, 171; Female Urethra, 171; Male Urethra, 171; Blood Vessels and Nerves of the Excretory Passages, 172; Male Reproductive System, 172; Testis, 172; Epididymis, 175; Ductus Deferens, 175; Seminal Vesicle, 177; Prostate, 177; Penis, 178; Nerves, 179; Female Reproductive System, 179; Ovary, 179; Atretic Follicles, 184; Fallopian Tube (Oviduct), 184; Uterus, 185; Endometrium, 186; The Proliferative Stage, 186; The Secretory (Progravid) Stage, 187; Premenstrual Stage, 187; Menstrual Stage, 187; Pregnancy, 187; Vagina, 189; Mammary Gland, 190; Resting Gland, 190; Active Gland, 190; Blood Vessels, Lymphatics, and Nerves, 193.	
CHAPTER XVI	
ENDOCRINE ORGANS - - - - -	194
Thyroid, Parathyroid, Hypophysis, and Adrenal Glands and the Islands of Langerhans, 194; The Gonads, 194; Thymus and Pineal Glands, 195; Organs From Which Hormones Have Been Isolated, 195; Liver, 195; Thyroid Gland, 195; Parathyroid Gland, 197; Hypophysis, 198; Anterior Lobe, 198; Posterior Lobe, 200; Adrenal Gland, 200; Cortex, 201; Medulla, 202.	
CHAPTER XVII	
BRAIN AND SPECIAL SENSE ORGANS - - - - -	204
The Brain, 204; Cerebrum, 204; Cerebellum, 207; Meninges, 209; The Eye, 211; Coats of the Eye, 212; Contents of the Eye, 218; Circulation and Innervation of the Eye, 219; The Ear, 219; External Ear, 219; Middle Ear, 219; Inner Ear, 220; Olfactory Organ, 225; Sustentacular Cells, 226; Olfactory Cells, 226; Basal Cells, 226.	

ESSENTIALS OF HISTOLOGY

ESSENTIALS OF HISTOLOGY

BY

MARGARET M. HOSKINS, Ph.D.

AND

GERRIT BEVELANDER, Ph.D.

New York University

WITH 135 TEXT ILLUSTRATIONS
AND 2 COLOR PLATES

SECOND EDITION

LONDON
HENRY KIMPTON
25 BLOOMSBURY WAY, W.C.1.

1952

COPYRIGHT, 1945, 1952, BY THE C. V. MOSBY COMPANY
(All rights reserved)

First Edition Reprinted
January, 1947
January, 1948
May, 1948
March, 1949

Printed in the
United States of America

*Press of
The C. V. Mosby Company
St. Louis*

PREFACE TO SECOND EDITION

In the second edition of this book the same general idea in the presentation of the morphological characteristics of tissues and organs has been retained. The organization and arrangement of the several chapters have not been materially altered but several sections have been revised and re-written with new material added in a number of instances.

In regard to the illustrations, some twenty in all have been revised or replaced by new drawings, a fact which we feel will help clarify the text and laboratory studies.

In the presentation of morphological material, the authors are well aware of the desirability of correlating structure and function. The complexity and rapidly changing concepts which arise in the fields of physiology and biochemistry, we feel, preclude in a text of this kind any treatment other than to indicate some typical well-established correlations between structure and function.

Finally, the authors wish to thank the teachers and colleagues who have submitted several helpful suggestions in connection with the present revision.

MARGARET M. HOSKINS
GERRIT BEVELANDER

New York, N. Y.

PREFACE TO FIRST EDITION

The purpose of this book is to present in simple and systematic form the most important morphological characteristics of the tissues and organs discussed. We have endeavored to make it clear in the text what features are to be seen in ordinary preparations, what points require special techniques for demonstration, and what is to be accepted as a result of investigation outside the scope of an elementary course. Most of the illustrations were drawn from slides in our student loan collections, and they may be taken as a guide to any similar set of preparations. Text and illustrations are intended to serve as a foundation for histological study on which the individual teacher may build such superstructure of detail or theoretical material as the conditions of his own course permit. What we have included are the facts which after some years of teaching we believe a beginner should have readily available before he undertakes the study of each tissue or organ.

Such material as was not obtained from direct observation of the microscopic preparations was drawn from various standard sources. Some of the figures, also, have been taken from other texts, a fact which is duly acknowledged in the accompanying legends.

MARGARET M. HOSKINS
GERRIT BEVELANDER

New York, N. Y.

CONTENTS

	PAGE
CHAPTER I	
EPITHELIA - - - - -	17
Simple Epithelia, 17; Squamous Epithelium, 17; Cuboidal Epithelium, 19; Columnar Epithelium, 19; Pseudostratified Epithelium, 20; Stratified Epithelia, 21; Stratified Columnar Epithelium, 21; Transitional Epithelium, 23; Stratified Squamous Epithelium, 23.	
CHAPTER II	
CONNECTIVE AND SUPPORTING TISSUES - - - - -	24
Connective Tissues, 26; Mucous Connective Tissue, 26; Reticular Tissue, 26; Fibrous Tissues, 29; Adipose Tissue, 32; Reticulo-Endothelial System, 32; Supporting Tissues, 33; Cartilage, 33; Bone, 37.	
CHAPTER III	
MUSCLE - - - - -	51
Smooth Muscle, 51; Skeletal Muscle, 53; Cardiac Muscle, 56; Circulation and Innervation of Muscle, 58.	
CHAPTER IV	
NERVOUS TISSUE - - - - -	59
Cell Bodies, 63; Nerve Cells in the Spinal Cord, 64; Nerve Cells of the Dorsal Root Ganglia, 65; Cells of Autonomic Ganglia, 66; Nerve Fibers, 67; Nerve Endings, 69; Motor Endings, 69; Sensory Endings, 70; Neuroglia, 71; Astroglia, 71; Oligodendria, 72; Microglia, 73.	
CHAPTER V	
BLOOD AND LYMPH - - - - -	74
Red Blood Corpuscles (Erythrocytes), 74; White Blood Corpuscles (Leucocytes), 75; Granulocytes, 75; Lymphocytes, 76; Monocytes (Large Mononuclears), 76; Platelets, 77; Lymph, 77.	
CHAPTER VI	
BLOOD-FORMING ORGANS - - - - -	78
Bone Marrow, 78; Reticular Tissue Cells, 78; Adipose Tissue Cells, 78; Hemocytoblasts (Stem Cell), 78; Promyelocytes, Myelocytes, Metamyelocytes, 78; Proerythroblasts, Erythroblasts, Normoblasts, 79; Giant Cells or Megakaryocytes, 79; Development of Blood Cells in the Embryo, 80; Germinal Centers of Lymph Nodes, 80; Theories of Development of Blood, 80; Monophyletic (Unitarian) Theory, 80; Dualistic Theory, 81; Polyphyletic Theory, 81.	
CHAPTER VII	
CIRCULATORY SYSTEM - - - - -	82
Blood Vessels, 82; Capillaries, 82; Arteries, 82; Veins, 85; Comparison of Veins and Arteries, 86; The Heart, 87; Endocardium, 87; Myocardium, 87; Epicardium, 88; Lymphatic System, 88.	

CHAPTER VIII

	PAGE
LYMPHOID ORGANS - - - - -	90
Lymph Node, 90; Cortex, 92; Medulla, 93; Spleen, 93; Capsule and Trabeculae, 96; Red Pulp, 96; White Pulp, 97; Function of the Spleen, 97; Tonsils, 98; Thymus, 99; Summary and Comparison of the Lymphoid Organs, 102; Lymph Node, 102; Spleen, 102; Tonsil, 102; Thymus, 102.	

CHAPTER IX

GLANDS - - - - -	103
General Morphology, 103; Cellular Differences, 105.	

CHAPTER X

THE INTEGUMENT - - - - -	107
Hairless Skin, 107; Epidermis, 107; Corium, 109; Hairy Skin, 109; Glands of the Skin, 110; Sweat Glands, 111; Sebaceous Glands, 111; Nails, 111.	

CHAPTER XI

ORAL CAVITY - - - - -	113
Lips, 113; Lining of the Oral Cavity, 113; Lips and Cheeks, 114; Gingivae and Hard Palate, 114; Teeth, 115; Early Development of Teeth, 115; Development of the Enamel Organ, 115; Cementum, 122; Pulp, 123; Gingiva, 123; Peridental Membrane, 124; Alveolus, 125; Tongue, 125; Filiform Papillae, 125; Fungiform Papillae, 125; Foliate Papillae, 127; Vallate (Circumvallate), 127; Glands of the Oral Cavity, 128; Pharynx, 129.	

CHAPTER XII

DIGESTIVE TRACT - - - - -	130
Mucosa, 130; Submucosa, 130; Muscularis, 130; Adventitia or Serosa, 130; Esophagus, 131; Mucosa, 131; Submucosa, 132; Muscularis, 132; Stomach, 133; Mucosa, 133; Submucosa, 136; Muscularis, 136; Serosa, 136; Small Intestine, 136; Mucosa of the Small Intestine, 137; Submucosa, 140; Muscularis, 141; Serosa, 141; Large Intestine, 141; Mucosa, 142; Submucosa, 143; Muscularis, 143; Serosa, 143; Rectum and Anus, 144; Vermiform Appendix, 144; Mucosa, 144; Submucosa, 145; Muscularis, 145; Serosa, 145; Blood Supply of Stomach and Intestines, 145; Nerve Supply of Stomach and Intestines, 146.	

CHAPTER XIII

GLANDS ASSOCIATED WITH THE DIGESTIVE TRACT - - - - -	147
Salivary Glands, 147; Parotid, 147; Submaxillary, 148; Sublingual, 149; Nerve Supply, 150; Pancreas, 150; Blood Supply, 151; Nerve Supply, 151; Summary of Salivary Glands and Pancreas, 151; Liver, 152; Liver Cells and Sinusoids, 152; Portal Canal, 154; Circulation in the Liver, 155; Gall Bladder, 157; Blood Supply, 157; Nerve Supply, 157.	

CHAPTER XIV

RESPIRATORY TRACT - - - - -	158
Trachea, 158; Bronchi, 158; Bronchioles, 158; Respiratory Bronchioles, 160; Alveolar Ducts, 160; Alveoli and Atria, 161; Blood Supply of the Lungs, 162; Nerve Supply of the Lungs, 162.	

	PAGE
UROGENITAL SYSTEM - - - - -	163
Urinary System, 163; Kidney, 163; Cortical Labyrinth, 163; Proximal Convoluted Tubule, 164; Henle's Loop, 166; Distal Convoluted Tubule, 168; Collecting Tubules, 168; Circulation of the Kidney, 169; Ureter, 169; Mucosa, 169; Submucosa, 170; Muscularis, 170; Adventitia, 170; Urinary Bladder, 170; Urethra, 171; Female Urethra, 171; Male Urethra, 171; Blood Vessels and Nerves of the Excretory Passages, 172; Male Reproductive System, 172; Testis, 172; Epididymis, 175; Ductus Deferens, 175; Seminal Vesicle, 177; Prostate, 177; Penis, 178; Nerves, 179; Female Reproductive System, 179; Ovary, 179; Atretic Follicles, 184; Fallopian Tube (Oviduct), 184; Uterus, 185; Endometrium, 186; The Proliferative Stage, 186; The Secretory (Progravid) Stage, 187; Premenstrual Stage, 187; Menstrual Stage, 187; Pregnancy, 187; Vagina, 189; Mammary Gland, 190; Resting Gland, 190; Active Gland, 190; Blood Vessels, Lymphatics, and Nerves, 193.	
CHAPTER XVI	
ENDOCRINE ORGANS - - - - -	194
Thyroid, Parathyroid, Hypophysis, and Adrenal Glands and the Islands of Langerhans, 194; The Gonads, 194; Thymus and Pineal Glands, 195; Organs From Which Hormones Have Been Isolated, 195; Liver, 195; Thyroid Gland, 195; Parathyroid Gland, 197; Hypophysis, 198; Anterior Lobe, 198; Posterior Lobe, 200; Adrenal Gland, 200; Cortex, 201; Medulla, 202.	
CHAPTER XVII	
BRAIN AND SPECIAL SENSE ORGANS - - - - -	204
The Brain, 204; Cerebrum, 204; Cerebellum, 207; Meninges, 209; The Eye, 211; Coats of the Eye, 212; Contents of the Eye, 218; Circulation and Innervation of the Eye, 219; The Ear, 219; External Ear, 219; Middle Ear, 219; Inner Ear, 220; Olfactory Organ, 225; Sustentacular Cells, 226; Olfactory Cells, 226; Basal Cells, 226.	

ILLUSTRATIONS

FIG.		PAGE
1A.	Surface view of mesothelium - - - - -	18
1B.	Portion of kidney, showing types of epithelium - - - - -	18
2.	Tall columnar epithelium from intestine - - - - -	20
3.	Pseudostratified epithelium from trachea - - - - -	21
4.	Transitional epithelium from urinary bladder - - - - -	22
5.	Stratified squamous epithelium from esophagus - - - - -	22
6.	Peripheral portion of section of lymph node - - - - -	26
7.	Reticular tissue of lymph node stained with hematoxylin and eosin - - - - -	27
8.	Reticular tissue of lymph node, silver nitrate preparation, to demonstrate fibers - - - - -	27
9.	Areolar tissue from submucosa of intestine - - - - -	28
10.	Dense fibrous tissue from section of scalp - - - - -	29
11.	Tendon cut longitudinally - - - - -	30
12.	Fibrocartilage - - - - -	34
13.	Hyaline cartilage, trachea - - - - -	36
14.	Elastic cartilage, epiglottis - - - - -	37
15.	Spicule of developing intramembranous bone from pig embryo, decalcified - - - - -	39
16.	Developing intramembranous bone, pig embryo, under lower magnification than shown in Fig. 15 - - - - -	40
17.	Replacement of cartilage by bone, rat femur - - - - -	42
18.	Spicule of endochondrial bone from femur of rat - - - - -	44
19.	Compact bone, ground section (human) - - - - -	46
20.	Compact bone, ground section, higher magnification than shown in Fig. 19 - - - - -	47
21.	Compact bone decalcified - - - - -	47
22.	Joint from finger of newborn child - - - - -	49
23.	Smooth muscle from wall of intestine (monkey) - - - - -	52
24.	Diagram of four sarcoyles of striated muscle - - - - -	54
25.	Striated muscle from tongue (dog) - - - - -	54
26.	Cardiac muscle (monkey) - - - - -	56
27.	Diagram showing relation of somatic and visceral neurones to spinal cord, sympathetic ganglia, and viscera - - - - -	60
28.	Spinal cord (cat) - - - - -	62
29.	Motor neurones stained in three different ways - - - - -	63
30.	Motor neurone, Golgi method - - - - -	64
31.	Sensory neurone, Golgi method - - - - -	65
32.	Longitudinal section through spinal ganglion - - - - -	66
33.	Sensory cells from spinal ganglion - - - - -	66
34.	Myelinated nerve fibers in longitudinal and transverse sections - - - - -	68
35.	Myelinated nerve fibers forming small trunks in areolar tissue - - - - -	68
36.	Motor nerve endings of intercostal muscle fibers of rabbit - - - - -	70
37.	Small lamellar corpuscle from mesentery of cat - - - - -	71
38.	Astrocytes - - - - -	72
39.	Neuroglia cells from brain of rabbit - - - - -	72