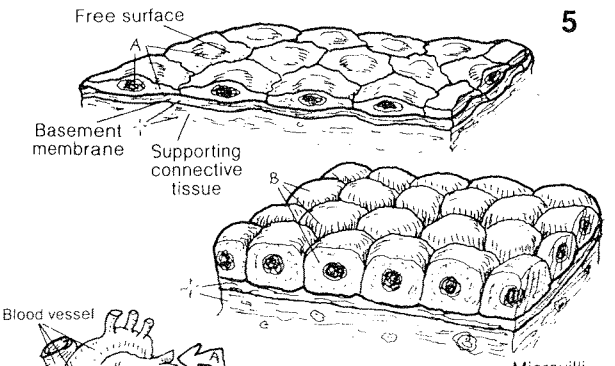
# I. ORGANIZATION OF THE BODY

## TISSUES: EPITHELIUM

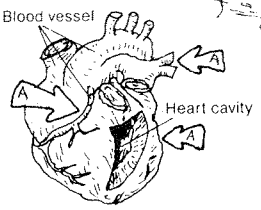
CN: Use very light colors throughout. (1) Color the arrows pointing to the location of the epithelial tissues in the body organs.

There are four basic tissues of the body: epithelial, connective, muscle, and nervous. Epithelial tissues (epithelium) form the body's surface (skin), the surfaces of the body's cavities and their contained viscera, glands, and all tubular organs, e.g., ducts and vessels. Neuroepithelia convey sensations. Epithelia are arranged into single (simple) or several (stratified) layers; their cells are bound together by specialized fibers and substances (e.g., the basement membrane). Epithelial tissues are generally sensitive but avascular, and receive their nutrition by diffusion.



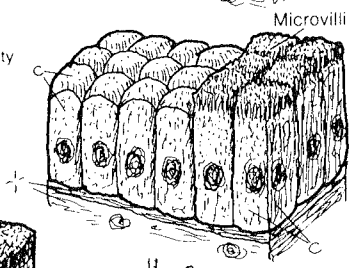

## SIMPLE EPITHELIUM*

Surface tissue functioning in filtration, diffusion, secretion, and absorption.



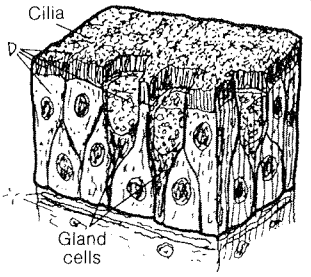

### SQUAMOUS A

Simple squamous epithelia line the heart cavities and the internal surfaces of all blood and lymph vessels (endothelia), the air cells of the lung, filtration capsules and thin tubules in the kidney, and the major body cavities (mesothelia). Rapid diffusion of gases in solution are characteristic activities in these cells.



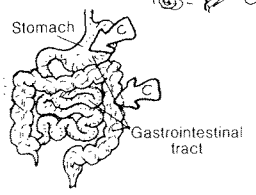

### CUBOIDAL B

Simple cuboidal epithelia are generally secretory cells, and make up glands throughout the body, tubules of the kidney, terminal bronchioles of the lungs, and ducts of the reproductive tracts.



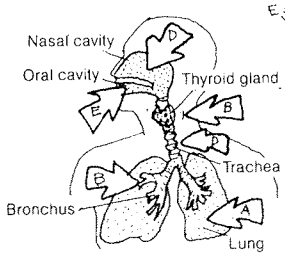

### COLUMNAR C

Simple columnar epithelia line the gastrointestinal tract and are concerned with secretion and absorption. Their free (apical) surface may be covered with finger-like projections of cell membrane called microvilli, increasing the cell's surface area for secretion/absorption.



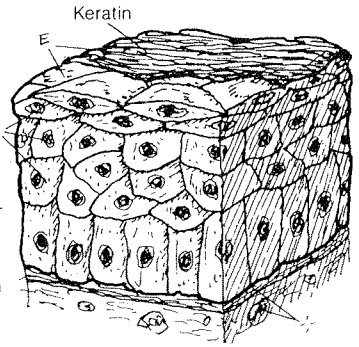

### PSEUDOSTRATIFIED COLUMNAR D

This tissue consists of simple columnar cells bunched together with irregularly placed nuclei giving the appearance of multiple cell layers. However, each of the cells is attached to the basement membrane. This tissue lines ducts of the reproductive tracts and air conduction pathways of the respiratory tract. They often exhibit cilia on their free surfaces and contain unicellular goblet-shaped (secretory) cells. The cilia collectively move surface material by virtue of undulating power strokes.



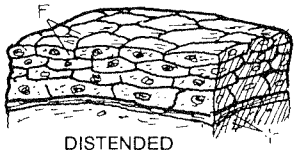

## STRATIFIED EPITHELIUM*

Stratified epithelia are generally resistant to damage by wear and tear because of ready replacement of cells. Passive diffusion through these layers is slow but not impossible.



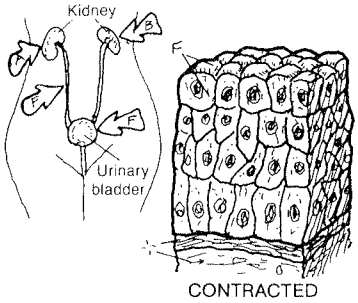

### STRATIFIED SQUAMOUS E

These layers of cells line the skin, oral cavity, pharynx, vocal folds, esophagus, vagina, and anus. The basal cells are columnar and germinal. The outermost layers of skin epithelia are fibrous-like, flat, desiccated, non-nucleated cells containing keratin (a scleroprotein).



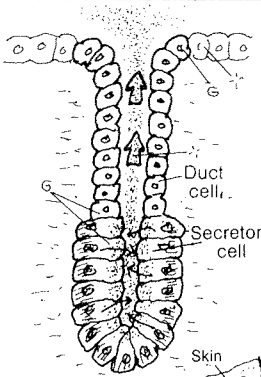

### TRANSITIONAL F

Multiple layers of cells lining the urinary tract. In the empty (contracted) bladder, the fibromuscular layer is contracted due to resting tension of muscle cells, and the surface layer of rounded cells is closely concentrated, creating a bumpy surface. With distension of the bladder, all the cells stretch out to form a smooth, thin surface. The bladder can store volumes of urine up to 1000 milliliters or so.



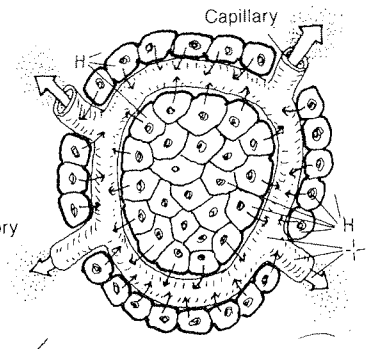

## GLANDULAR EPITHELIUM*

Glandular cells produce and secrete/excrete materials of varying composition, e.g., sweat, milk, sebum, cerumen, hormones, enzymes, and so on. Specialized contractile epithelial cells (myoepithelia) encourage discharge of the glandular material.



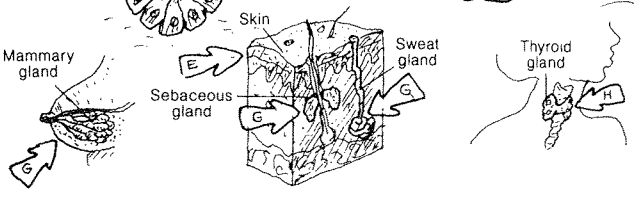

### EXOCRINE G

Exocrine glands (e.g., sweat, sebaceous, pancreatic, mammary, and so on) arise as outpocketings of epithelial lining tissue, retain a duct to the free surface of the cavity or skin, and excrete/secrete some substance. Secretory portions may have one of several shapes (tubular, coiled, alveolar) connected to one or more ducts.



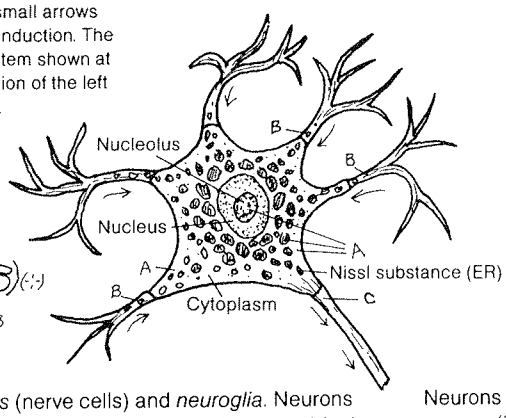

### ENDOCRINE H

Endocrine glands arise as epithelial outgrowths but lose their connections to the surface during development. They are intimately associated with a dense capillary network and secrete their products into them. See Plate 128 for examples of these glands.



# TISSUES: NERVOUS

CN: Use a light color for A. Note the small arrows which indicate direction of impulse conduction. The neurons of the peripheral nervous system shown at lower left are illustrated in the orientation of the left upper limb, although highly magnified.




## NEURON*

CELL BODY A

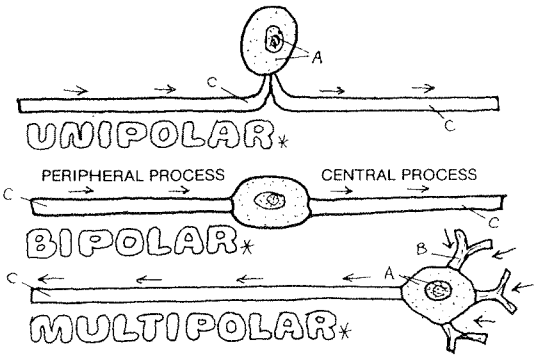
PROCESS(ES) (+)

DENDRITE B

AXON C

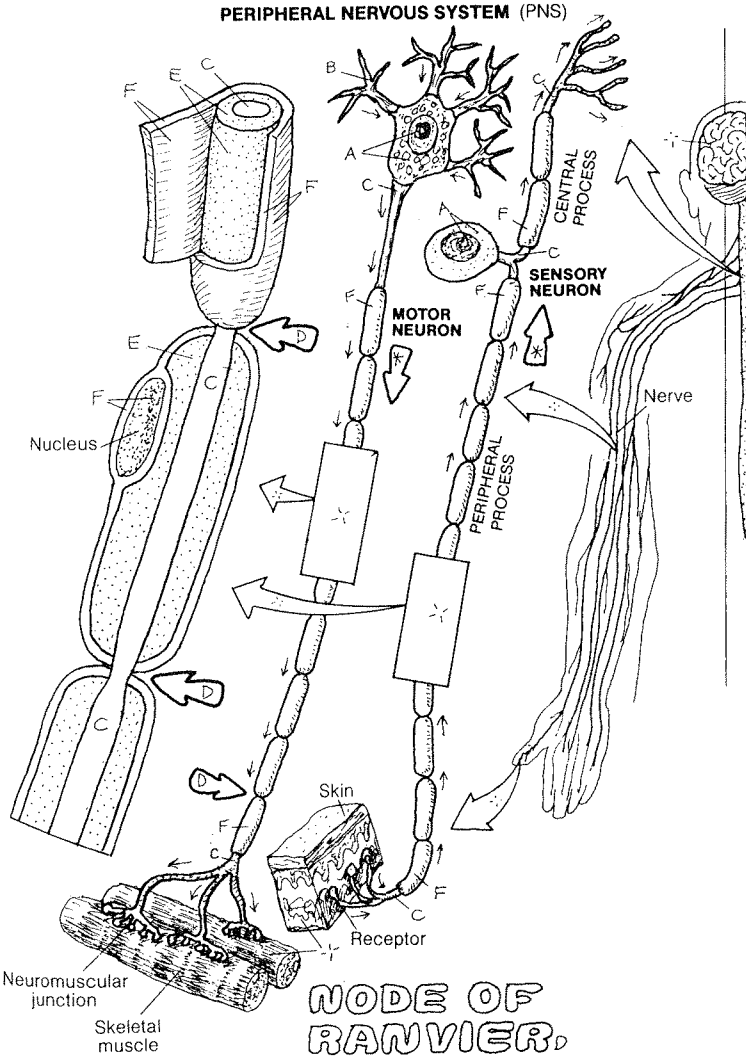
Nervous tissue consists of *neurons* (nerve cells) and *neuroglia*. Neurons generate and conduct electrochemical impulses by way of neuronal (cellular) *processes*. Neuroglia are the supporting, non-impulse generating/conducting cells of the nervous system. The main, nucleus-bearing part of the neuron is the *cell body*. Its cytoplasm contains the usual cell organelles. Uniquely, the endoplasmic reticulum occurs in clusters called Nissl substance. Neurons do not undergo mitosis after birth, compromising their ability to regenerate after injury. Neuronal growth consists of migration and arborization of processes. Neurons are the impulse-conducting cells of the brain and spinal cord (central nervous system or CNS) and the spinal and cranial nerves (peripheral nervous system or PNS).

## TYPES OF NEURONS*




Neurons fall into three structural categories based on numbers of processes ("poles"). Processes that are highly branched (arborized) and uncovered are called *dendrites*. Slender, long, minimally branched processes are called *axons*. Within each category, there is a great variety of shape and size of neurons. *Unipolar* neurons have or appear to have (pseudounipolar) one process which splits near its cell body into a central and peripheral process. Both processes conduct impulses in the same direction, and each is termed an axon (see the sensory neuron at lower left). *Bipolar* neurons have two (central and peripheral) processes, called axons, conducting impulses in the same direction (see Plate 131). *Multipolar* neurons have three or more processes, one of which is an axon (see PNS motor neuron at lower left, and CNS neuron at lower right).

**PERIPHERAL NERVOUS SYSTEM** (PNS)




**CENTRAL NERVOUS SYSTEM** (CNS)


## NEUROGLIA*

PROTOPLASMIC ASTROCYTE G

FIBROUS ASTROCYTE H

OLIGODENDROCYTE I

MICROGLIA J

Most axons are enveloped in one or more (up to 200) layers of an insulating phospholipid (*myelin*) that enhances impulse conduction rates. In the CNS (lower right), myelin is produced by *oligodendrocytes*; in the PNS (lower left), by *Schwann cells*. All axons of the PNS are ensheathed by the cell membranes of Schwann cells (neurilemma) but not necessarily myelin. The gaps between Schwann cells are *nodes of Ranvier*, making possible rapid node-to-node impulse conduction. Schwann cells make possible axonal regeneration in the PNS. Significant axonal regeneration in the CNS has not been observed.

Neuroglia exist in both the CNS and PNS (Schwann cells). *Protoplasmic astrocytes* occur primarily in gray matter (dendrites, cell bodies) of the CNS, *fibrous astrocytes* in the white matter (myelinated axons). Their processes attach to both neurons and blood vessels and may offer metabolic, nutritional and physical support. They may play a role in the blood brain barrier. Oligodendrocytes are smaller than astrocytes, have fewer processes, and are seen near neurons. *Microglia* are the small scavenger cells of the brain and spinal cord.

## NODE OF RANVIER D

## AXON COVERINGS*

MYELIN E

SCHWANN CELL F