FIFTH EDITION

TEXTBOOK OF MEDICAL PHYSIOLOGY

ARTHUR C. GUYTON, M.D.

Professor and Chairman of the Department of Physiology
and Biophysics, University of Mississippi, School of Medicine

W. B. SAUNDERS COMPANY Philadelphia London Toronto

ally does not cause exactly the same effects throughout the body as parasympathetic stimulation because the acetylcholine is destroyed by cholinesterase in the blood and body fluids before it can reach all the effector organs. Yet a number of other drugs that are not so rapidly destroyed can produce typical parasympathetic effects, and these are called parasympathomimetic drugs.

Three commonly used parasympathomimetic drugs are *pilocarpine, methacholine,* and *carbamylcholine.* Although these drugs have almost the same effects on the different effector organs as does parasympathetic stimulation, there are slight variations. For instance, carbamylcholine is especially active on the bladder and gastrointestinal tract, while methacholine is especially active on the cardiovascular system and eyes.

Parasympathomimetic drugs act on the effector organs of cholinergic *sympathetic* fibers also. For instance, these drugs cause profuse sweating. Also, they cause vascular dilatation, this effect occurring even in vessels not innervated by cholinergic fibers.

Drugs that Have a Parasympathetic Potentiating Effect. Some drugs do not have a direct effect on parasympathetic effector organs but do potentiate the effects of the naturally secreted acetylcholine at the parasympathetic endings. These are the same drugs as those listed in Chapter 12 that potentiate the effect of acetylcholine at the neuromuscular junction—that is, *neostigmine, physostigmine,* and *diisopropyl fluorophosphate.* These inhibit cholinesterase, thus preventing rapid destruction of the acetylcholine liberated by the parasympathetic nerve endings. As a consequence, the quantity of acetylcholine acting on the effector organs progressively increases with successive stimuli, and the degree of action also increases.

Drugs that Block Cholinergic Activity at Effector Organs. *Atropine* and similar drugs, such as *homatropine* and *scopolamine,* block the action of acetylcholine on cholinergic effector organs. However, these drugs do not affect the nicotinic action of acetylcholine on the postganglionic neurons or on skeletal muscle.

DRUGS THAT STIMULATE THE POSTGANGLIONIC NEURONS—"NICOTINIC DRUGS"

The preganglionic neurons of both the parasympathetic and sympathetic nervous systems secrete acetylcholine at their endings, and the acetylcholine in turn stimulates the postganglionic neurons. Therefore, injected acetylcholine can also stimulate the postganglionic neurons of both systems, thereby causing both sympathetic and parasympathetic effects in the body. *Nicotine* is a drug that can also stimulate postganglionic neurons in the same manner as acetylcholine because the neuronal membranes contain *nicotinic receptors,* but it cannot directly stimulate the autonomic effector organs, which have muscarinic receptors as explained earlier in the chapter. Therefore, drugs that cause autonomic effects by stimulating the postganglionic neurons are frequently called nicotinic drugs. Some drugs, such as *acetylcholine* itself, *carbamylcholine* and *methacholine,* have both nicotinic and muscarinic actions, whereas pilocarpine has only muscarinic actions.

Nicotine excites both the sympathetic and parasympathetic systems at the same time, resulting in strong sympathetic vasoconstriction in the abdominal organs and limbs, but at the same time resulting in parasympathetic effects, such as increased gastrointestinal activity and, sometimes, slowing of the heart.

Ganglionic Blocking Drugs. Many important drugs block impulse transmission from the preganglionic neurons to the postganglionic neurons, including *tetraethyl ammonium ion, hexamethonium ion,* and *pentolinium.* These inhibit impulse transmission in both the sympathetic and parasympathetic systems simultaneously. They are often used for blocking sympathetic activity but rarely for blocking parasympathetic activity because the sympathetic blockade usually far overshadows the effects of parasympathetic blockade. The ganglionic blocking drugs have been especially important in reducing arterial pressure in patients with hypertension.

REFERENCES

Axelsson, J.: Catecholamine functions. *Ann. Rev. Physiol.,* 33:1, 1971.

Banks, P., and Mayor, D.: Intra-axonal transport in noradrenergic neurons in the sympathetic nervous system. *Biochem. Soc. Symp.,* 36:133, 1972.

Bennett, M. R.: Autonomic Neuromuscular Transmission. Physiological Society Monograph, 1972.

Bhagat, B. D.: Recent Advances in Adrenergic Mechanisms. Springfield, Ill., Charles C Thomas, Publisher, 1971.

Carrier, O., Jr.: Pharmacology of the Peripheral Autonomic Nervous System. Chicago, Year Book Medical Publishers, 1972.

Costa, E., and Sandler, M. (eds.): Monoamine Oxidases—New Vistas. (Advances in Biochemical Psychopharmacology. Vol. 5.) New York, Raven Press, 1972.

Dahlström, A.: Aminergic transmission. Introduction and short review. *Brain Res.,* 62:441, 1973.

De Potter, W. P., Chubb, I. W., and De Schaepdryver, A. F.: Pharmacological aspects of peripheral noradrenergic transmission. *Arch. Int. Pharmacodyn. Ther.,* 196(Suppl. 196):258, 1972.

DiCara, L. V.: Learning in the autonomic nervous system. *Sci. Amer.,* 222:30, 1970.

Fonnum, F.: Recent developments in biochemical investigations of cholinergic transmission. *Brain Res.,* 62:497, 1973.

Gebber, G. L., and Snyder, D. W.: Hypothalamic control of baroreceptor reflexes. *Amer. J. Physiol.,* 218:124, 1970.

Geffen, L. B., and Livett, B. G.: Synaptic vesicles in sympathetic neurons. *Physiol. Rev.,* 51:98, 1971.

Guyton, A. C., and Gillespie, W. M., Jr.: Constant infusion of epinephrine: rate of epinephrine secretion and destruction in the body. *Amer. J. Physiol.,* 165:319, 1951.

Guyton, A. C., and Reeder, R. C.: Quantitative studies on the autonomic actions of curare. *J. Pharmacol. Exp. Ther.,* 98:188, 1950.

Häggendal, J.: Some aspects of the release of the adrenergic transmitter. *J. Neural Transm., Suppl.* 11:135, 1974.

Hess, W. R.: The Functional Organization of the Diencephalon. New York, Grune & Stratton, Inc., 1958.

Hingerty, D., and O'Bo
Medulla. Springfield
Jenkinson, D. H.: Clas
renergic receptors. B
Joó, F.: On the proble
sympathetic ganglia
Koizumi, K., and Bro
system reactions: a
trol and their ass
Physiol., 67:1, 1972
McGeer, P. L., and M
zymes. Prog. Neuro
Molinoff, P. B., Nels
hydroxylase and t
Adv. Biochem. Psy
Nickerson, M.: Adre
1973.
Paton, D. M. (ed.): Th
Transport of Catec
Réthelyi, M.: Spina
Neural. Transm.,