THE EFFECT OF STATIC AND ALTERNATING MAGNETIC FIELDS ON ACETYLCHOLINESTERASE AND MONOAMINE OXIDASE ACTIVITIES IN THE BRAIN AND BLOOD PLASMA OF MICE

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of

Master

in

Applied Medical Chemistry

By

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B.Sc, Chemistry Faculty of Science,
Alexandria University, 1989

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تأثير المجالات المغناطيسية الثابتة والمتغيرة على النشاط الإنزيمى لكلاً من الاستيل كولين إستيراز ومونو أمين أوكسيداز فى مخ وملازما م الفئران

رسالة علمية

مقدمة إلى معهد البحوث الطبية– جامعة الإسكندرية

إستيفاء للدراسات المقررة للحصول على درجة

الماجستير

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الكيمياء الطبية التطبيقية

مقدمة من

فرج محمد فرج إبراهيم

بكالوريوس **العلوم** كيمياء، كلية العلوم، **جامعة** الإسكندرية ١٩٨٩

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LIST OF ABBREVIATION

AC	**:**	Alternating current
ACh	**:**	Acetylcholine
AChE	**:**	Acetylcholinesterase
AChEI	**:**	Acetylcholinesterase inhibitors
AChR	**:**	Acetylcholine receptor
AD	**:**	Alzheimer's disease
AThChI	**:**	Acetylthiocholine iodide
BuChE	**:**	Butyrylcholinesterase
Ch AT:	**:**	Choline acetyltransferase
ChE	**:**	Cholinesterase
CNS	**:**	Central nervous system
DA	**:**	Dopamine
DC	**:**	Direct current
DFP	**:**	Diisopropylfluorophosphate
DTNB	**:**	Dithiobisnitrobenzoic acid
ELF-MF	**:**	Extremely low frequency magnetic filed
EMF	**:**	Electromagnetic field
G	**:**	Gauss
GHz	**:**	Gagga Hertz
HF	**:**	High frequency
Hz	**:**	Hertz-unit of frequency (one cycle per second).
5-HT	**:**	5 Hydroxytryptamine (Serotonin)
ICR	**:**	Ion cyclotron resonance
KHz	**:**	Killo Hertz
Kv	**:**	Killo volt.
LF	**:**	Low frequency
LSD	**:**	Least significant difference
mAChR	**:**	Muscarinic acetylcholine receptor
MAO	**:**	Monoamine oxidase
MAO-A	**:**	Monoamine oxidase type A
MAO-B	**:**	Monoamine oxidase type B
MF	**:**	Magnetic field
MPTP	**:**	1-methyl-4-phenyl-1,2,3,6 tetrahydropyridine.
mT	**:**	millitesla
mV	**:**	millivolt.
nAChR	**:**	Nicotinic acetylcholine receptor
NE	**:**	Norepinephrine
NMDA	**:**	N-methyl-D-aspartic acid.
OPI	**:**	Organophosphorus inhibitors of acetylcholinesterase
PChE	**:**	Pseudo-cholinesterase
PD	**:**	Pakinson's disease
PNS	**:**	Peripheral nervous system
SMF	**:**	Static magnetic field.
T	**:**	Tesla-unit of magnetic flux density(1Tesla=10,000 Gauss)
VAChT	**:**	Vesicular acetylcholine transprotein

LIST OF CONTENTS

Chapter **Page**

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

Neurotransmitters

The principles of nerve cell communication

The cell body, or soma, of a neuron is like that of any other cell, containing mitochondria, ribosomes, a nucleus, and other essential organelles. Extending from the cell membrane, however, is a system of dendritic branches which serve as receptor sites for information sent from other neurons. If the dendrites receive a strong enough signal from a neighboring nerve cell, or from several neighboring nerve cells. The resting electrical potential of the receptor cell's membrane becomes depolarized. This electrical signal travels down the cell's axon, a specialized extension from the cell body which ranges from a few hundred micrometers in some nerve cells, to over a meter in length in others. This wave of depolarization along the axon is called an action potential. Most axons are covered by myelin, a fatty substance that serves as an insulator and thus greatly enhances the speed of an action potential. In between each sheath of myelin is an exposed portion of the axon called a node of Ranvier. It is in these uninsulated areas that the actual flow of ions along the axon takes place.[1,2]

Dozens of neurons can be involved in such a circuit, necessitating a sophisticated communication system to rapidly convey signals between cells. Also, because individual neurons can be up to 3 feet long, a rapid-relay mechanism within the neurons themselves is required to transmit each signal from the site where it is received to the site where it is passed on to a neighboring cell. Two mechanisms have evolved to transmit nerve signals: First, within cells, electrical signals are conveyed along the cell membrane. Second, for communication between cells, the electrical signals generally are converted into chemical signals conveyed by small messenger molecules called neurotransmitters.[1,2]

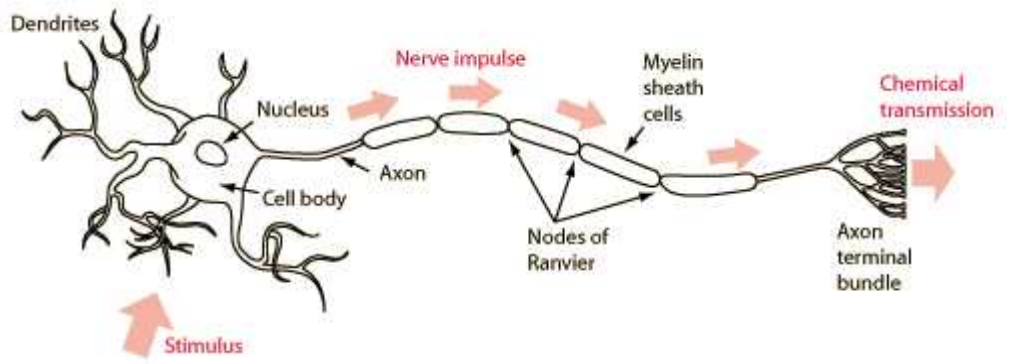

Fig. (1): Nerve Cell[2]

Definition of neurotransmitters

Neurotransmitters are small molecules that are liberated by a presynaptic neuron into the synaptic cleft and cause a change in the postsynaptic membrane potential.[3] This change can be either a direct depolarization or hyperpolarization, or the activation of second messengers that eventually lead to changes in firing rate. There are other molecules

that act on the neuron and change its firing characteristics, but act from a distance and are not involved in synaptic transmission, and these are called neuromodulators. The same kind of molecule can act as a neurotransmitter or a neuromodulator, depending on its action is synaptic or long range.(4)

A chemical can be classified as a neurotransmitter if it meets the following conditions:

1. There are precursors and/or synthesis enzymes located in the presynaptic neuron.
2. The chemical must be present in the presynaptic element .
3. It is available in sufficient quantity in the presynaptic neuron to affect the postsynaptic neuron .
4. There must be postsynaptic receptors and the ability for the chemical to bind to said receptors .
5. A biochemical mechanism for inactivation must be present.(5)

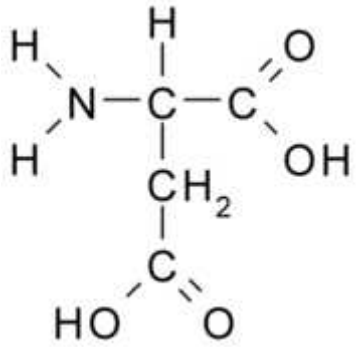

Fig. (2): Chemical structure of D-aspartic acid, a common amino acid neurotransmitter(5)

Classification of neurotransmitters

Neurotransmitters can be divided into three principal classes, since they share some enzymes or metabolic pathways ,Table (I).(6)

- The first class is made up of acetylcholine alone.
- The second class are the biogenic amines, that are molecules formed by an amino acid losing a hydroxyl or carboxyl group.
- The third class is made up of amino acids.(6)

Table (I): Classical neurotransmitters

Neurotransmitter	Function	Synthesis by (enzymes)
Acetylcholine	Mostly excitatory	Choline acetyltransferase
Bioactive amines		
Dopamine	Excitatory and inhibitory	Tyrosine hydroxylase
Epinephrine	Excitatory	Tyrosine hydroxylase and dopamine –b- hydroxylase
Norepinephrine	Excitatory	Tyrosine hydroxylase and dopamine –b- hydroxylase
Serotonin	Excitatory	Tryptophan hydroxylase
Amino acids		
Glutamate	Excitatory	Metabolic amino acid
Glycine	Mostly inhibitory	Metabolic amino acid
g- Aminobutiric acid (GABA)	Inhibitor	Glutamate decarboxylase

Neurotransmitters can act as inhibitory or excitatory signals to the postsynaptic cell, by hyperpolarizing or depolarizing its membrane.

This happens because there are small numbers of neurotransmitters but a great variety of their receptors on different types of cells. Acetylcholine, for instance can act as an excitator when it binds to one type of receptor, and as an inhibitor when bound on another kind, even if both types of receptors are present in the same cell.[7]

When the neurotransmitter is an excitatory one, it causes depolarization of the membrane. When it is an inhibitory neurotransmitter, it effectively causes hyperpolarization of the membrane.[8]

Each neurotransmitter has a particular biosynthetic pathway. Including a particular precursor, site of synthesis and specific enzymes ,Table (II).[9]