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Development of Complex Curricula for Molecular Bionics and Infobionics Programs within a consortial* framework**

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Consortium members

SEMMELWEIS UNIVERSITY, DIALOG CAMPUS PUBLISHER

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**Molekuláris bionika és Infobionika Szakok tananyagának komplex fejlesztése konzorciumi keretben

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BASICS OF NEUROBIOLOGY

Neurobiológia alapjai

NEUROTRANSMITTERS I.

(Neurotranszmitterek I.)

ZSOLT LIPOSITS

DEFINITION AND CRITERIA OF NEUROTRANSMITTERS

NEUROTRANSMITTERS ARE ENDOGENOUS BIOACTIVE SUBSTANCES SYNTHESIZED BY NEURONS. THEY ARE RELEASED FROM THE CELLS, ACT VIA SPECIFIC RECEPTORS COUPLED TO THE MEMBRANE OF POSTSYNAPTIC TARGET STRUCTURES AND MODIFY THE ELECTRIC AND METABOLIC CONDITIONS OF THE AFFECTED CELLS.

CRITERIA OF CHEMICAL NEUROTRANSMITTERS:

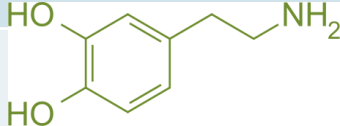
1. THE SYNTHESIS OF THE CHEMICAL TRANSMITTER TAKES PLACE IN THE PRESYNAPTIC NEURON
2. THE SYNTHESIZED TRANSMITTER OR IT PRECURSOR IS STORED IN THE RELEASE COMPARTMENT OF THE CELL, MOST FREQUENTLY IN AXON TERMINALS
3. RELEASE OF THE NEUROTRANSMITTER INTO THE SYNAPTIC CLEFT UPON EXCITATION OF THE PRESYNAPTIC ELEMENT
4. BINDING OF THE TRANSMITTER TO ITS RECEPTOR/S/ THAT BELONG TO IONOTROPIC AND METABOTROPIC CLASSES
5. TERMINATION OF THE ACTION OF TRANSMITTERS AND ITS TRIGGERED MECHANISMS

CLASSIFICATION OF NEUROTRANSMITTERS

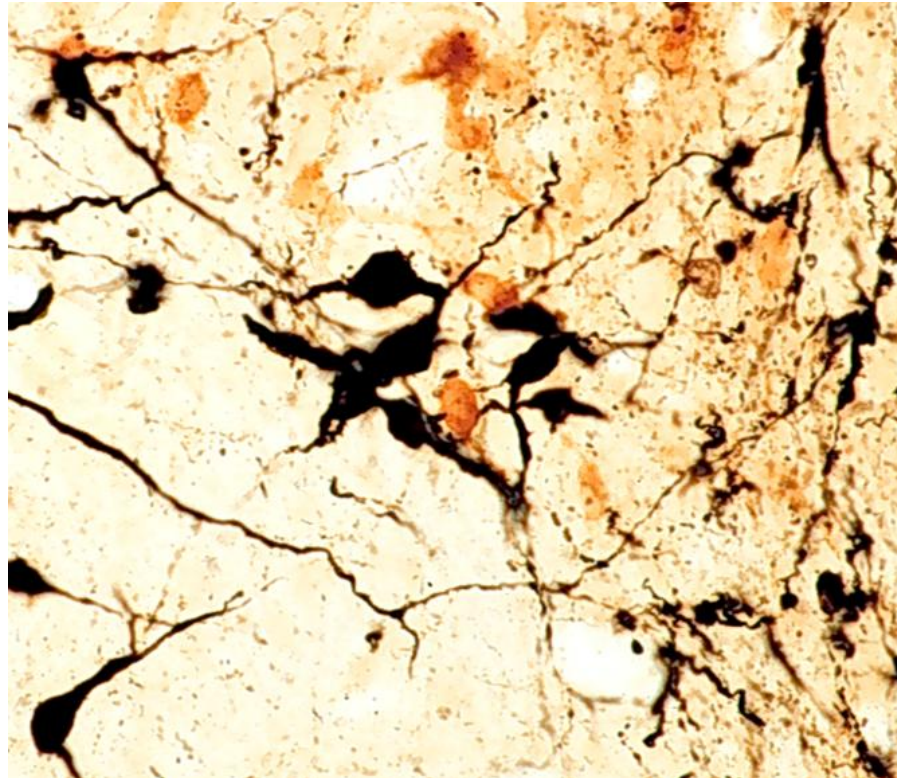
THE NEUROTRANSMITTERS BELONG TO TWO MAIN CATEGORIES, THE CLASSIC AMINE TYPE AND THE NON-CLASSIC PEPTIDE TYPE GROUPS

COMPARISON OF THE PRODUCTION OF CLASSIC AND NON-CLASSIC TRANSMITTERS

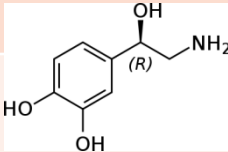
TYPE	CELL BODY	AXON	TERMINAL	EXAMPLE
AMINE	PRODUCTION OF 1. SYNTHESIZING ENZYMES 2. STORAGE VESICLES	AXONAL TRANSPORT OF 1. SYNTHESIZING ENZYMES 2. STORAGE VESICLES	SUPPLY OF CONSTITUENTS: 1. FROM CELL BODY 2. LOCAL SYNTHESIS 3. RE-UPTAKE	ACETYLCHOLINE GABA GLUTAMATE SEROTONIN NORADRENALINE
PEPTIDE	PRODUCTION OF 1. PEPTIDE PRECURSORS 2. CONVERTING ENZYMES 3. STORAGE VESICLES	AXONAL TRANSPORT OF STORAGE VESICLES	SUPPLY OF CONSTITUENTS FROM CELL BODY	ENKEPHALIN DYNORPHIN SUBSTANCE P VASOPRESSIN SOMATOSTATIN CHOLECYSTOKININ

ATTRIBUTES	DESCRIPTION	
NAME	DOPAMINE	
CHEMICAL NAME, STRUCTURE	4-(2-AMINOETHYL)BENZENE-1,2-DIOL	
SYNTHESIS	DERIVATIVE OF:	L-DOPA
	SYNTHESIZING ENZYMES:	TYROSINE HYDROXYLASE (TH), DOPA DECARBOXYLASE
	REGULATION	TRANSCRIPTIONAL AND POST-TRANSCRIPTIONAL OF SYNTHESIZING ENZYMES
STORAGE	CELLULAR STRUCTURE TRANSPORTER	SYNAPTIC VESICLE VESICULAR MONOAMINE TRANSPORTER-2 (VMAT-2)
RELEASE	BY EXOCYTOSIS, PRESYNAPTIC REGULATION VIA AUTORECEPTORS (D2 FAMILY)	
INACTIVATION	BY MONOAMINE OXYDASE (MAO), CATECHOL-O-METHYL TRANSFERASE (COMT), DOPAMINE TRANSPORTER (DAT)	
RECEPTORS	D1-LIKE FAMILY: D1 AND D5 RECEPTORS, G PROTEIN-COUPLED D2-LIKE FAMILY: D2, D3 AND D4 RECEPTORS , G PROTEIN-COUPLED	
EXPRESSION IN BRAIN	IN NUCLEI OF THE BRAIN STEM AND HYPOTHALAMUS, MESOLIMBIC, MESOCORTICAL, NIGROSTRIATAL, TUBEROINFUNDIBULAR DOPAMINERGIC SYSTEMS	
SIGNIFICANCE	COGNITION, ATTENTION, MEMORY, PROBLEM SOLVING, REWARD, MOOD, PROLACTIN SECRETION, PARKINSON DISEASE, SCHIZOPHRENIA, AGING	

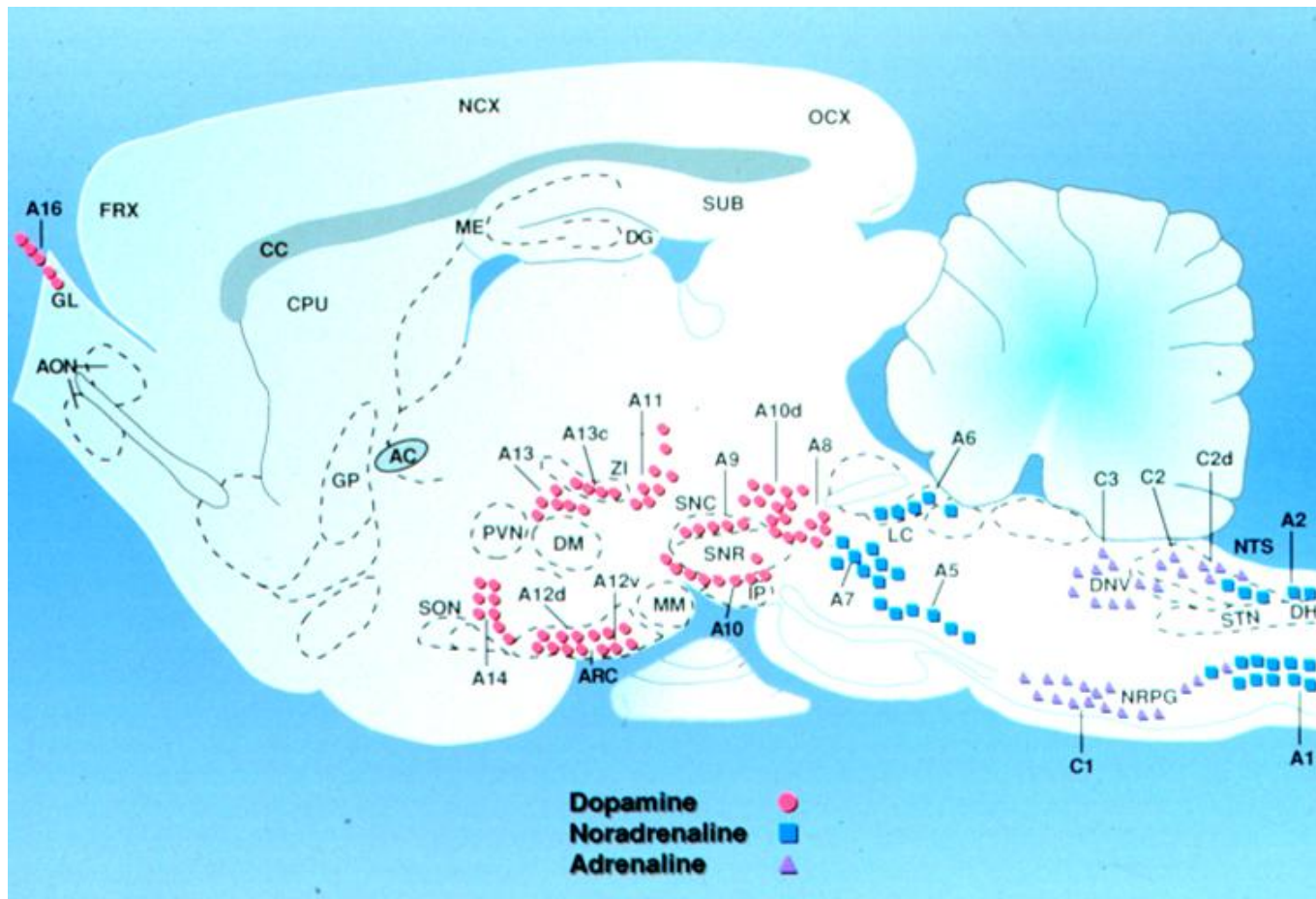
DOPAMINERGIC NEURONS IN THE HYPOTHALAMUS

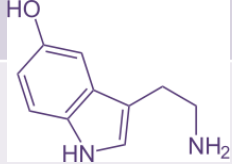


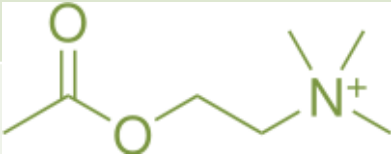
DOUBLE IMMUNOCYTOCHEMICAL LABELING REVEALS BLACK, DOPAMINERGIC NEURONS CONTACTING BROWN, CORTICOTROPIN-RELEASING HORMONE-SYNTHESIZING NEURONS IN THE PRAEVENSTRICULAR NUCLEUS

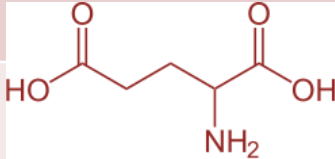
ATTRIBUTES	DESCRIPTION	
NAME	NOREPINEPHRINE (NORADRENALINE, NE)	
CHEMICAL NAME, STRUCTURE	4-[(1R)-2-AMINO-1-HYDROXYETHYL]BENZENE-1,2-DIOL	
SYNTHESIS	DERIVATIVE OF:	DOPAMINE
	SYNTHESIZING ENZYME	DOPAMINE BETA-HYDROXYLASE
	REGULATION	TRANS-SYNAPTIC INDUCTION, GLUCOCORTICOIDS
STORAGE	CELLULAR STRUCTURE TRANSPORTER	SYNAPTIC VESICLE VESICULAR MONOAMINE TRANSPORTER-2 (VMAT-2)
RELEASE	BY EXOCYTOSIS, PRESYNAPTIC REGULATION VIA AUTORECEPTORS (ALPHA-2)	
INACTIVATION	BY MONOAMINE OXYDASE (MAO) , RE-UPTAKE BY NOREPINEPHRINE TRANSPORTER (NET)	
RECEPTORS	G PROTEIN-COUPLED RECEPTORS, ALPHA AND BETA TYPES IN THE BAIN: ALPHA 2 INHIBITS ADENYLYL CYCLASE, BETA 1 ACTIVATES IT	
EXPRESSION IN BRAIN	CELL GROUPS IN THE CAUDAL PART OF THE BRAIN STEM	
SIGNIFICANCE	ATTENTION, AROUSAL, STRESS, FEEDING REGULATION, ANTI DEPRESSION DRUG DEVELOPMENT	

DISTRIBUTION OF CATECHOLAMINERGIC CELL GROUPS IN THE RODENT BRAIN

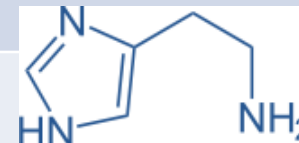



ATTRIBUTES	DESCRIPTION	
NAME	SEROTONIN	
CHEMICAL NAME, STRUCTURE	5-HYDROXYTRIPTAMINE (5-HT)	
SYNTHESIS	DERIVATIVE OF:	TRYPTOPHAN
	SYNTHESIZING ENZYMES:	TRYPTOPHAN HYDROXYLASE (TPH), AROMATIC L-AMINO ACID DECARBOXYLASE
	REGULATION	PRECURSOR CONCENTRATION, PHOSPHORYLATION OF TPH
STORAGE	CELLULAR STRUCTURE TRANSPORTER	SYNAPTIC VESICLE VESICULAR MONOAMINE TRANSPORTER-2 (VMAT-2)
RELEASE	BY EXOCYTOSIS, PRESYNAPTIC REGULATION VIA AUTORECEPTORS (5-HT _{1A})	
INACTIVATION	BY MONOAMINE OXYDASE (MAO) , RE-UPTAKE BY SEROTONIN TRANSPORTER	
RECEPTORS	LIGAND-GATED ION CHANNEL (5-HT ₃), G PROTEIN-COUPLED RECEPTORS (5-HT ₁₋₂ , 5-HT ₃₋₇)	
EXPRESSION IN BRAIN	RAPHE NUCLEI OF THE BRAINSTEM	
SIGNIFICANCE	AGGRESSION, OBSESSIVE-COMPULSIVE BEHAVIOR, FEEDING REGULATION, OBESITY, ANTI DEPRESSION DRUG DEVELOPMENT (SSRI)	

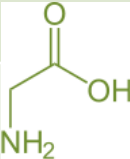
ATTRIBUTES	DESCRIPTION	
NAME	ACETYLCHOLINE (ACh)	
CHEMICAL NAME, STRUCTURE	2-ACETOXY- <i>N,N,N</i> -TRIMETHYLETHANAMINIUM	
SYNTHESIS	DERIVATIVE OF:	ESTER OF ACETIC ACID AND CHOLINE
	SYNTHESIZING ENZYME	CHOLINE ACETYLTRANSFERASE
	REGULATION	ACTIVITY, ALLOSTERIC INHIBITION, PRECURSOR AVAILABILITY
STORAGE	CELLULAR STRUCTURE TRANSPORTER	SYNAPTIC VESICLE VESICULAR ACh TRANSPORTER
RELEASE	BY EXOCYTOSIS, MINIATURE END-PLATE POTENTIALS, QUANTAL RELEASE	
INACTIVATION	ACETYLCHOLINESTERASE, CHOLINE TRANSPORTER	
RECEPTORS	NICOTINIC, IONOTROP, LIGAND-GATED ION CHANNEL, EXCITATORY MUSCARINIC, G PROTEIN-COUPLED, M1-M4	
EXPRESSION IN BRAIN	BASAL FOREBRAIN, HABENULA, BRAIN STEM	
SIGNIFICANCE	LEARNING, MEMORY, ATTENTION, AGING, ALZHEIMER DISEASE	

ATTRIBUTES	DESCRIPTION	
NAME	GLUTAMATE	
CHEMICAL NAME, STRUCTURE	GLUTAMIC ACID	
SYNTHESIS	DERIVATIVE OF:	ALPHA-KETOGLUTARATE AND GLUTAMINE
	SYNTHESIZING ENZYMES	AMINOTRANSFERASE, GLUTAMINASE
	REGULATION	THE GLUTAMINE-GLUTAMATE CYCLE (GLIA-NEURON)
STORAGE	CELLULAR STRUCTURE TRANSPORTER	SYNAPTIC VESICLE VESICULAR GLUTAMATE TRANSPORTER (VGLUT1-3)
RELEASE	BY EXOCYTOSIS, PRESYNAPTIC REGULATION VIA AUTORECEPTORS (mGluR2, mGluR3)	
INACTIVATION	NEURONAL AND GLIAL UPTAKE BY PLASMA MEMBRANE GLUTAMATE TRANSPORTERS	
RECEPTORS	IONOTROPIC, AMPA (GluR1-4), KAINATE (GluR5-7, KA1-2), NMDA (NR1, NR2A-2D) METABOTROPIC, G PROTEIN-COUPLED (mGluR1-7)	
EXPRESSION IN BRAIN	THROUGHOUT THE BRAIN	
SIGNIFICANCE	LEARNING, PLASTICITY, LONG TERM POTENTIATION, NEUROTOXICITY	

ATTRIBUTES	DESCRIPTION	
NAME	HISTAMINE	
CHEMICAL NAME, STRUCTURE	2-(1H-IMIDAZOL-4-YL)ETHANAMINE	
SYNTHESIS	DERIVATIVE OF:	HISTIDINE
	SYNTHESIZING ENZYMES	L-HISTIDINE DECARBOXYLASE
	REGULATION	PRECURSOR AVAILABILITY
STORAGE	CELLULAR STRUCTURE TRANSPORTER	SYNAPTIC VESICLE VESICULAR MONOAMINE TRANSPORTER-2 (VMAT-2)
RELEASE	BY EXOCYTOSIS, AUTORECEPTORS	
INACTIVATION	HISTAMINE-N-METHYL TRANSFERASE, MAO-B	
RECEPTORS	HISTAMINE RECEPTORS 1-4	
EXPRESSION IN BRAIN	TUBERO-MAMMILLARY NUCLEI OF THE CAUDAL HYPOTHALAMUS (E1-5)	
SIGNIFICANCE	SLEEP-WAKING CYCLE, PSYCHOMOTOR PERFORMANCE	



ATTRIBUTES	DESCRIPTION	
NAME	GABA	
CHEMICAL NAME, STRUCTURE	GAMMA -AMINOBUTYRIC ACID 	
SYNTHESIS	DERIVATIVE OF:	L-GLUTAMATE
	SYNTHESIZING ENZYMES	GLUTAMATE DECARBOXYLASE (GAD)
	REGULATION	ENDPRODUCT
STORAGE	CELLULAR STRUCTURE TRANSPORTER	SYNAPTIC VESICLE VESICULAR GABA TRANSPORTER (VGAT)
RELEASE	BY EXOCYTOSIS, PRESYNAPTIC INHIBITION	
INACTIVATION	GABA AMINOTRANSFERASE	
RECEPTORS	GABA A, CHLORIDE CHANNEL, WITH VARIOUS BINDING SITES (GABA, PICROTOXIN, BARBITURATE, BENZODIAZEPINE, STEROID) GABA B	
EXPRESSION IN BRAIN	DIFFUSELY DISTRIBUTED CELL GROUPS IN THE ENTIRE NEUROAXIS	
SIGNIFICANCE	GENERAL INHIBITION AND COUNTERBALANCING OF EXCITATORY ACTIONS, ROLE IN EPILEPSY, ANXIETY AND CONVULSION	

ATTRIBUTES	DESCRIPTION	
NAME	GLYCINE	
CHEMICAL NAME, STRUCTURE	AMINOETHANOIC ACID 	
SYNTHESIS	DERIVATIVE OF:	SERINE
	SYNTHESIZING ENZYMES	SERINE HYDROXYMETHYLTRANSFERASE
	REGULATION	ENDPRODUCT
STORAGE	CELLULAR STRUCTURE TRANSPORTER	SYNAPTIC VESICLE NOT KNOWN
RELEASE	BY EXOCYTOSIS	
INACTIVATION	CONVERTED TO GLUTATHIONE, GLYCINE TRANSPORTERS	
RECEPTORS	CHLORIDE CHANNEL	
EXPRESSION IN BRAIN	MOST STUDIES IN THE SPINAL CORD, BRAIN IS A RISING FIELD	
SIGNIFICANCE	GENERAL INHIBITION AND COUNTERBALANCING OF EXCITATORY ACTIONS	