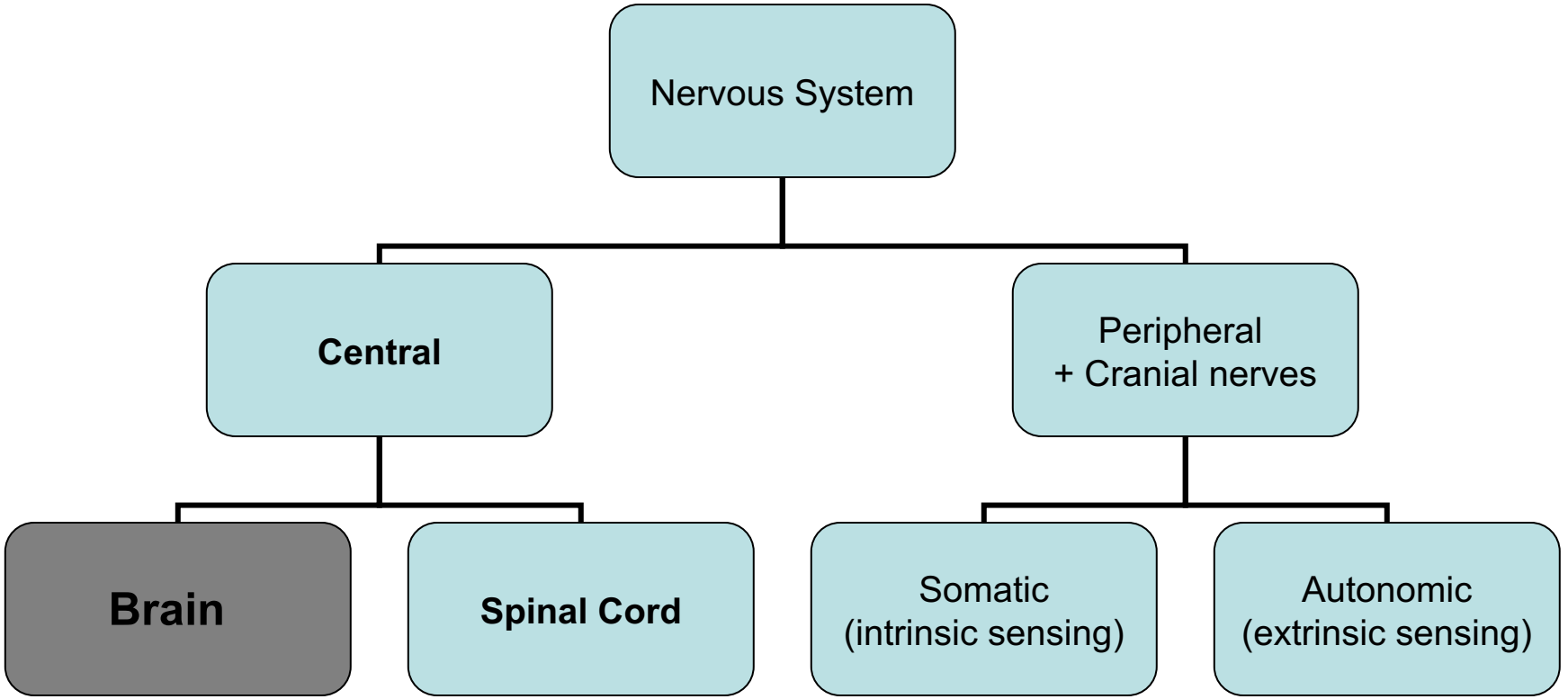
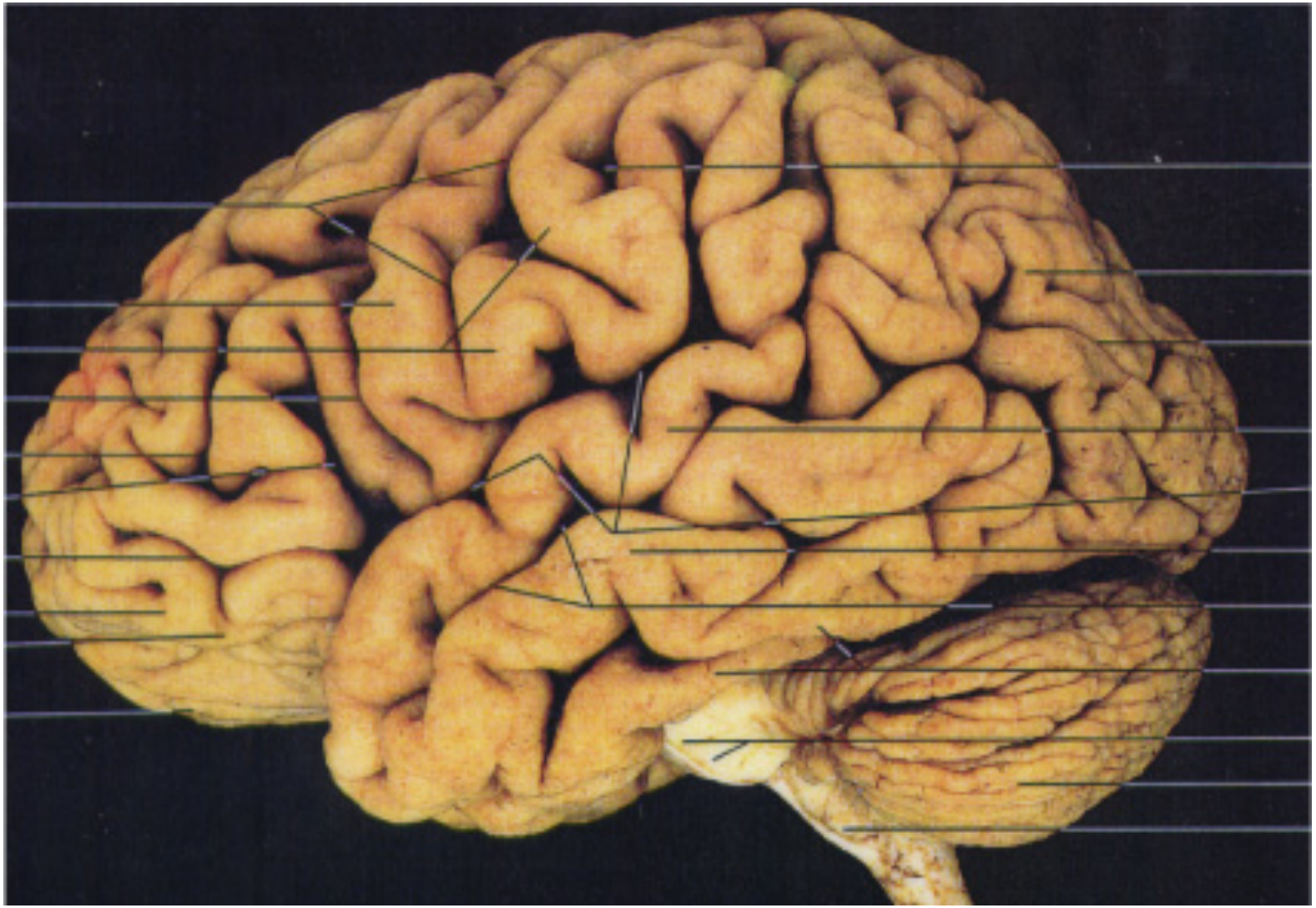
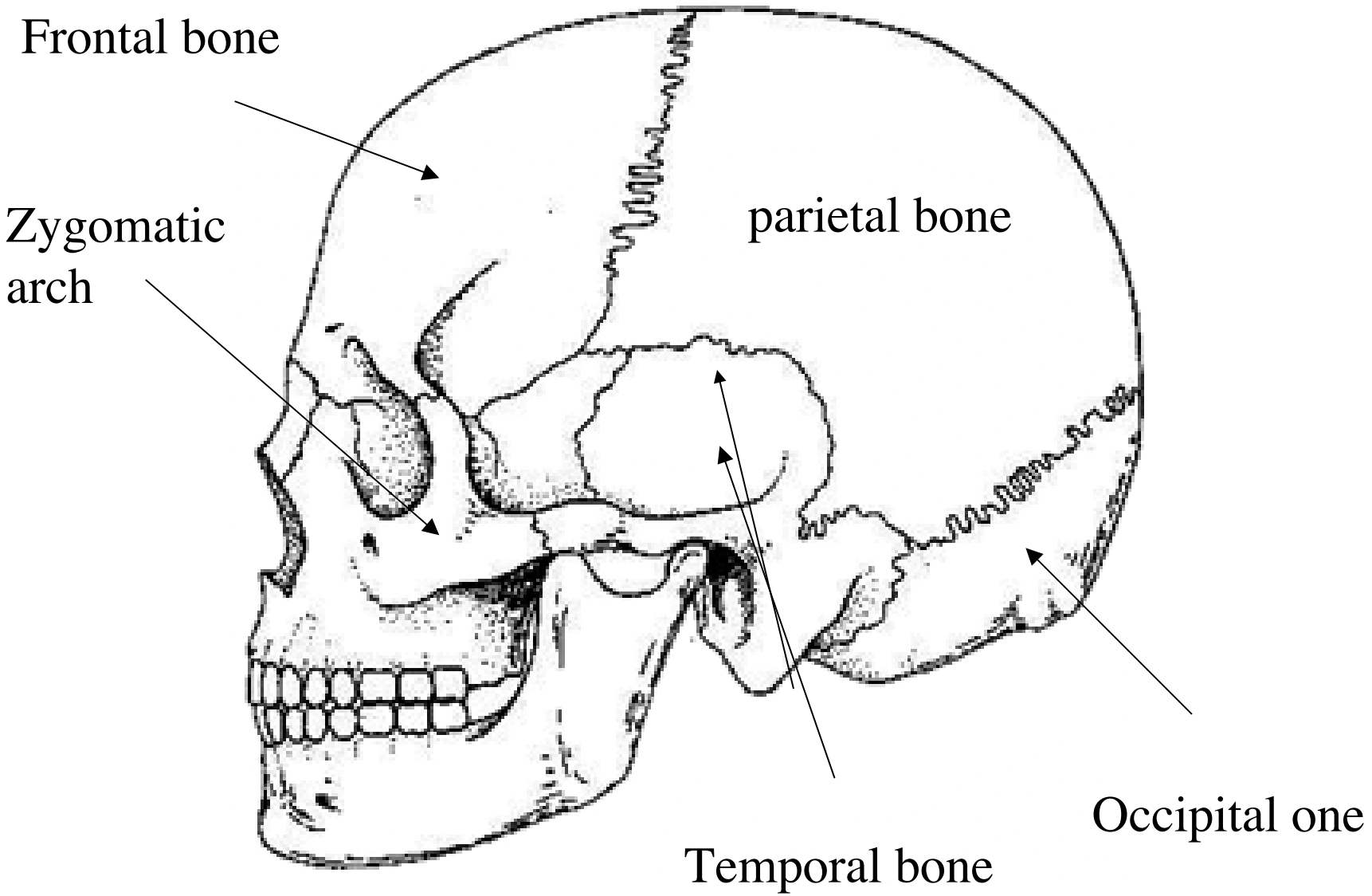

Nervous System
Central
Peripheral
+ Cranial nerves
Brain
Spinal Cord
Somatic
(intrinsic sensing)
Autonomic
(extrinsic sensing)

A fresh brain with dura removed. Note the numerous superficial blood vessels running in the arachnoid.

If we strip off the meninges we see the brain has a heavily folded surface or **cortex** (in latin: cortex =bark)

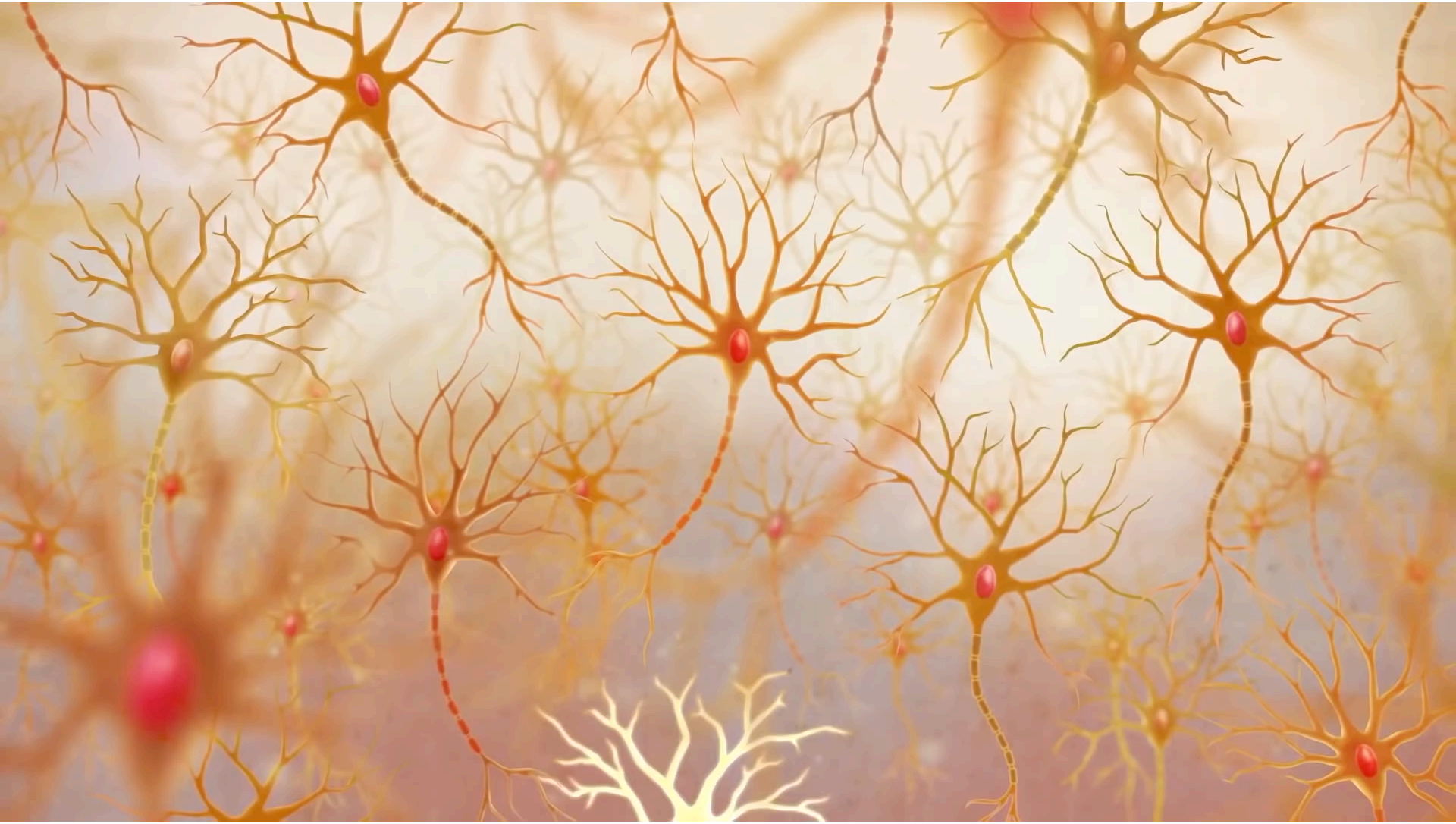


Recall that the main bones of the cranium are the frontal, parietal, occipital and temporal.

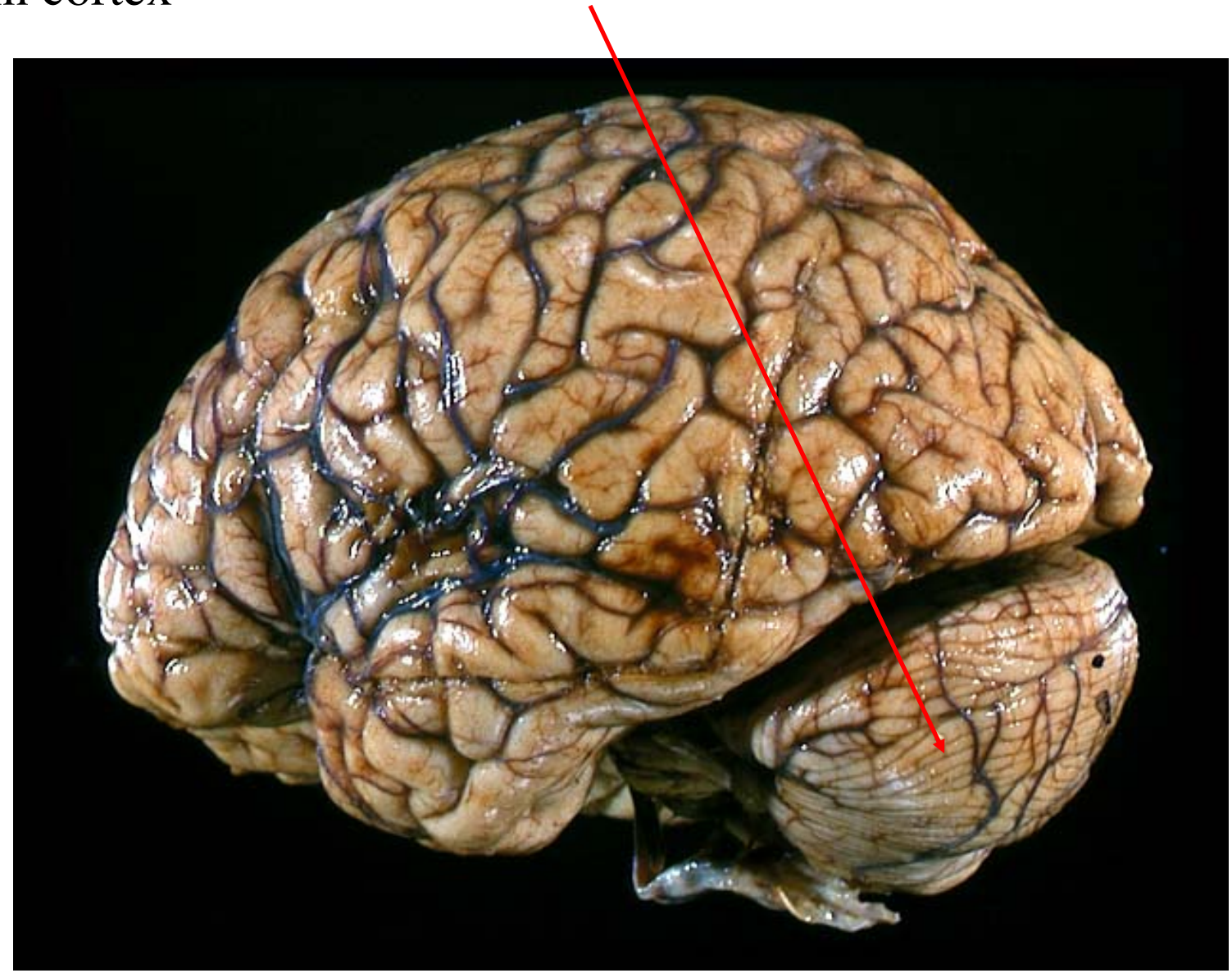


Anatomy and Functional Areas of the Brain

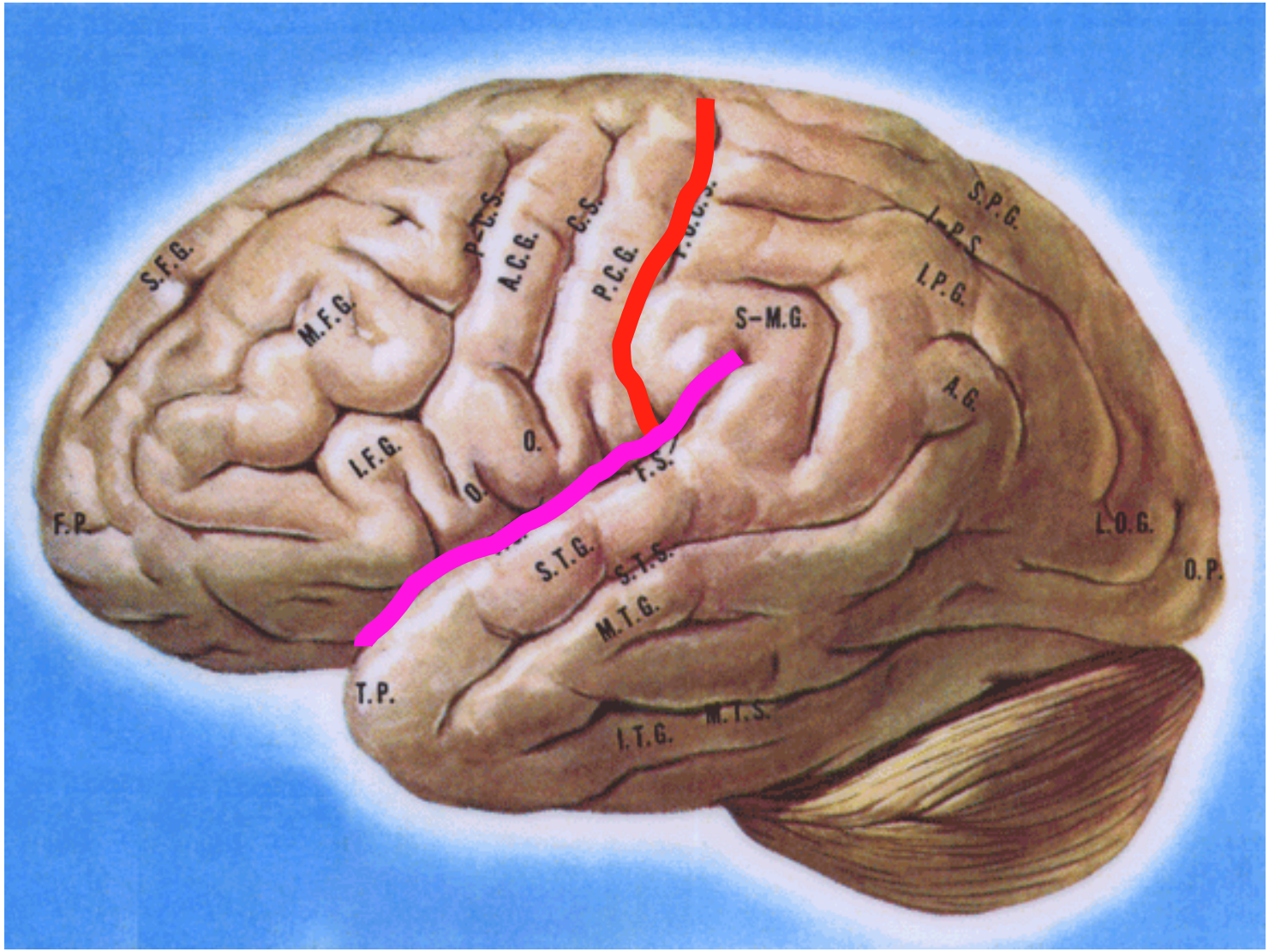
MLA



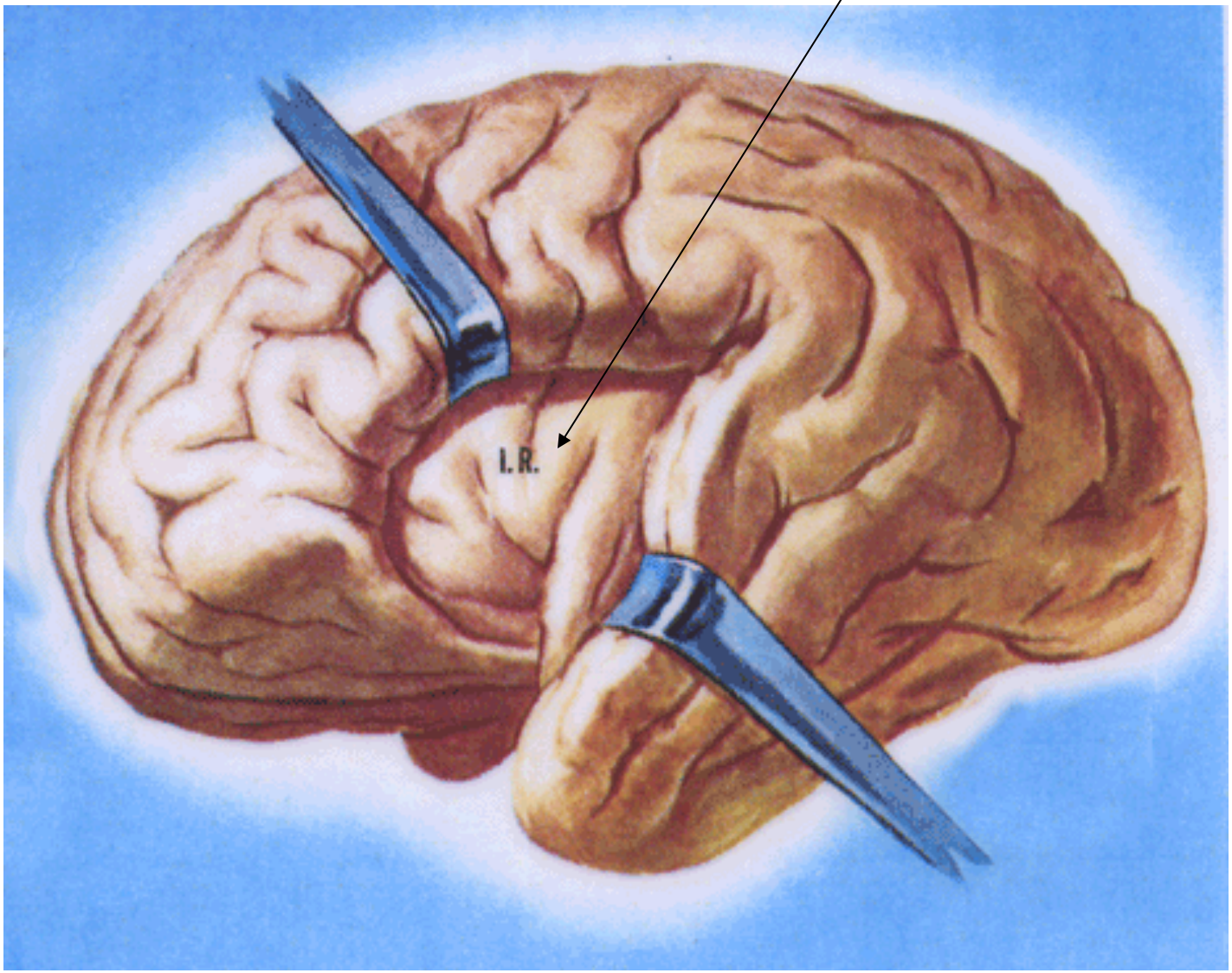
Note appearance of cerebellum; the gyri are thinner and straighter than in cortex



Most of the gyri and sulci have individual names but for now we only need to remember the central and lateral sulci.

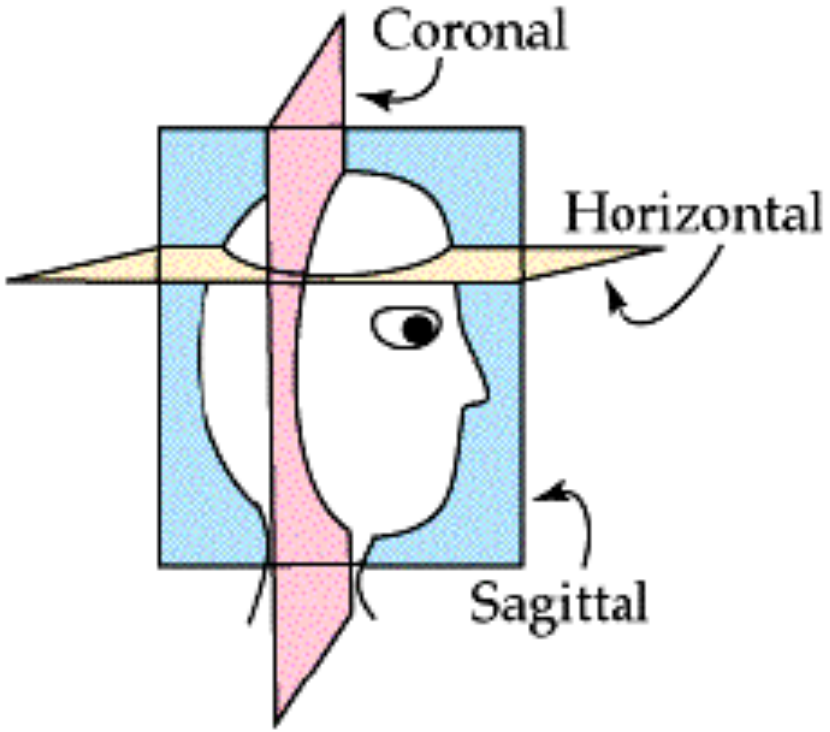


Inside the lateral fissure there is a hidden area of cortex, the **insula** or ‘Island of Reil’.




Rai 1

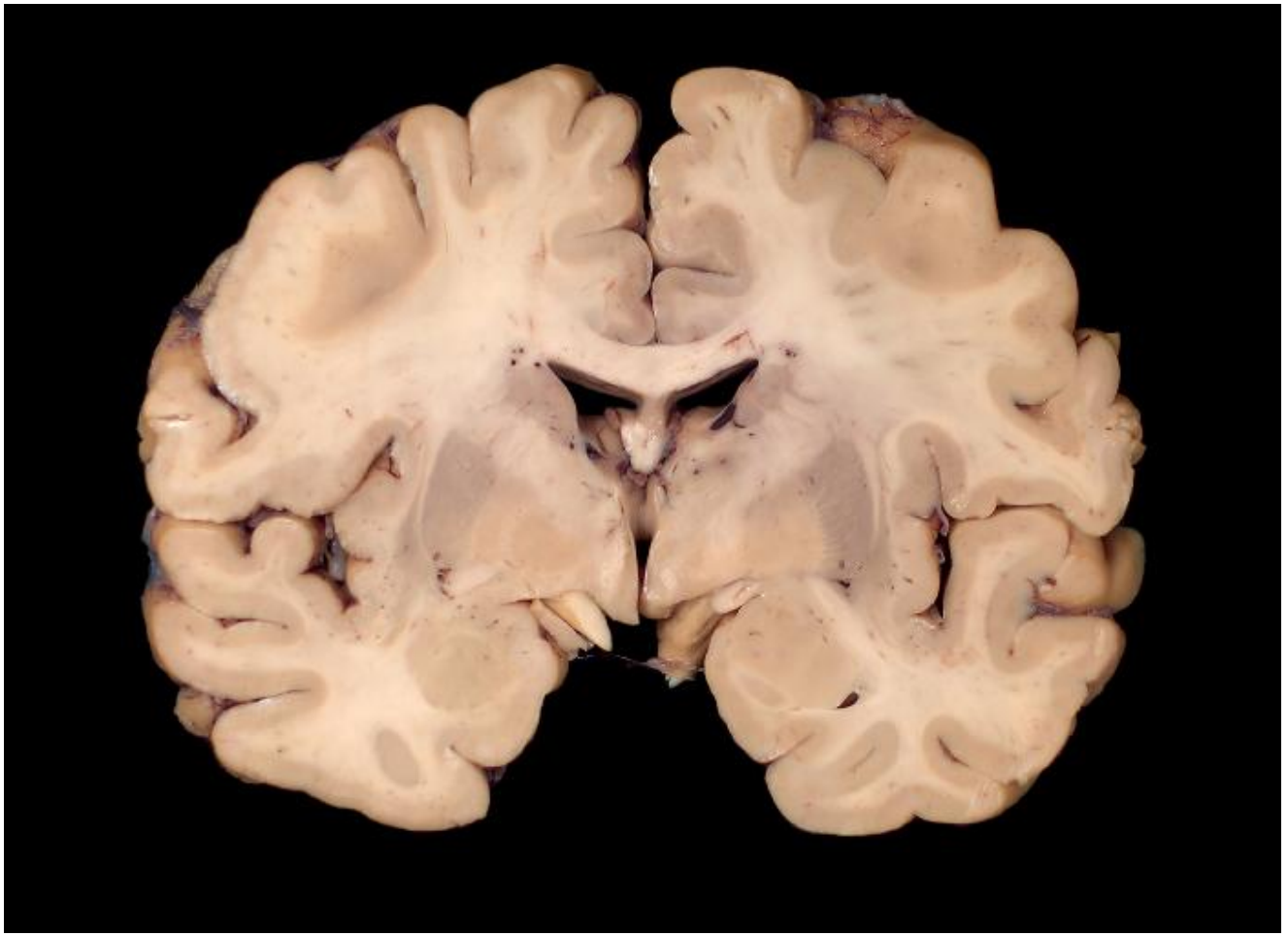
Before we can investigate the interior of the brain by cutting it up we need to **define the planes of the brain** that we will cut (section) in.



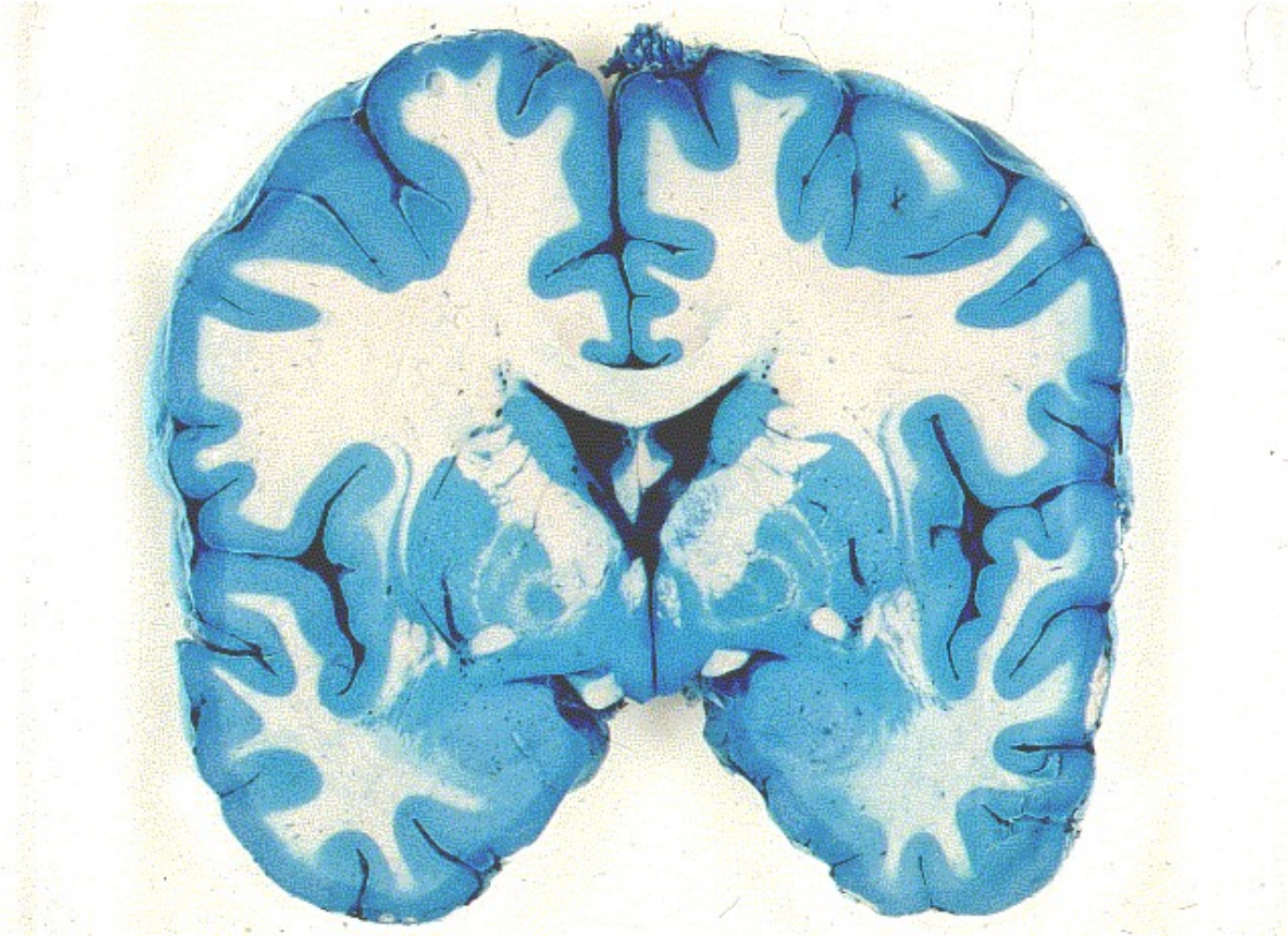
The coronal plane is also known as the **frontal** plane

Ggoing to a higher horizontal (axial) plane is going **rostral**. Going down towards the spinal cord and cauda equina is going **caudal.**

This is a brain cut in the **frontal** plane. Unstained brain tissue shows up as grey (actually pinky-grey) and white matter

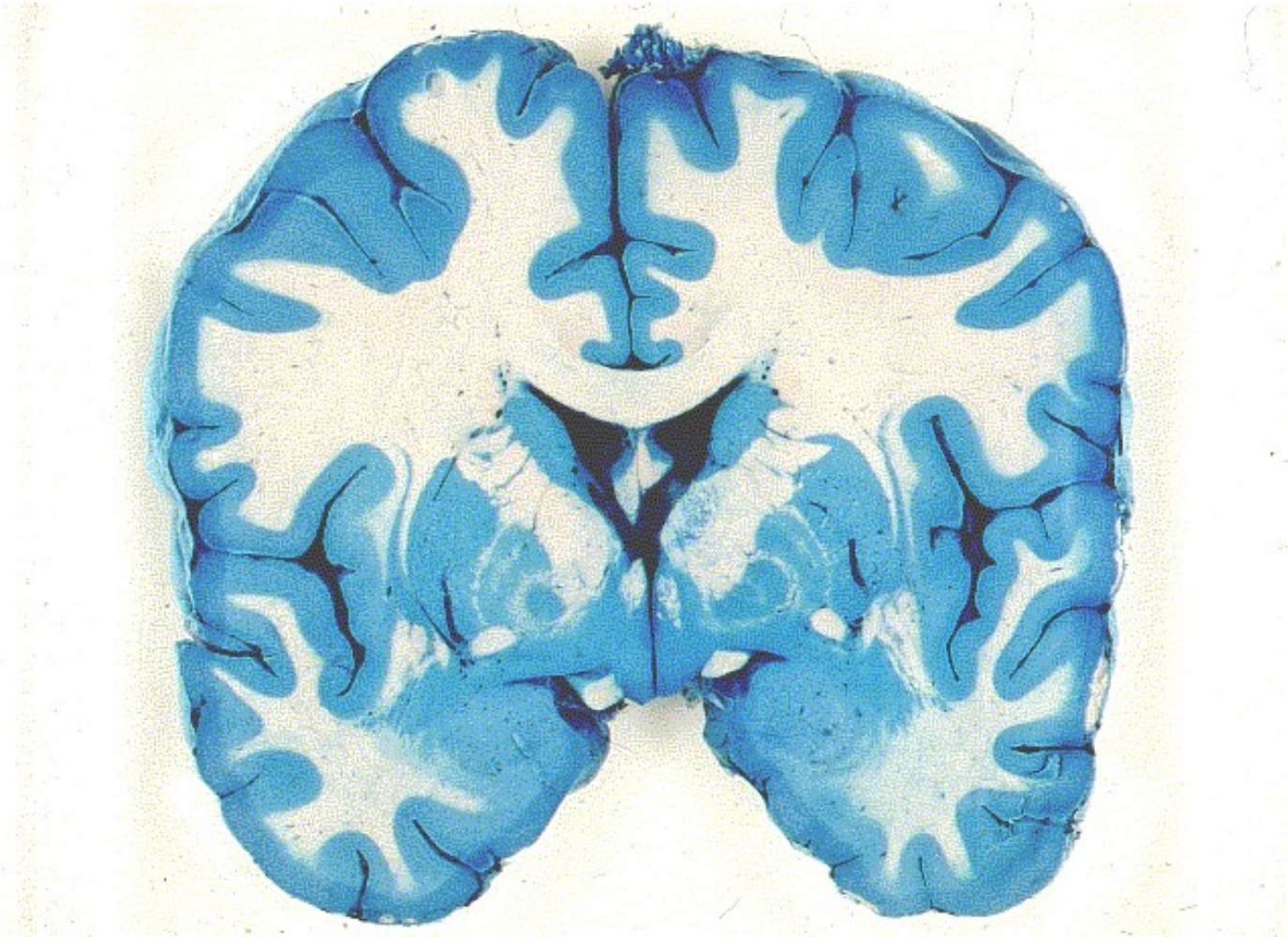


Staining the brain tissue is essential to differentiate structures. In this stain cell bodies are stained blue. Thus the cortex can be seen to contain large numbers of nerve cell bodies

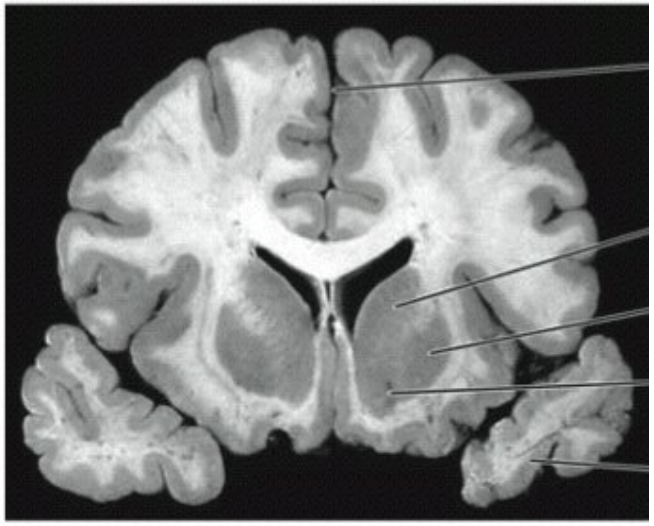


Grey matter = cell bodies & processes

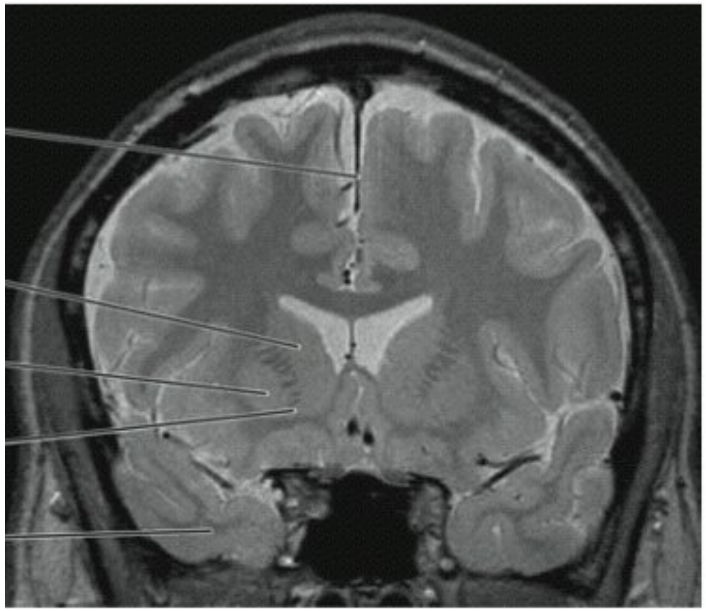
White matter = axons



Nowadays MRI enables us to see a histology-like picture in the living brain.



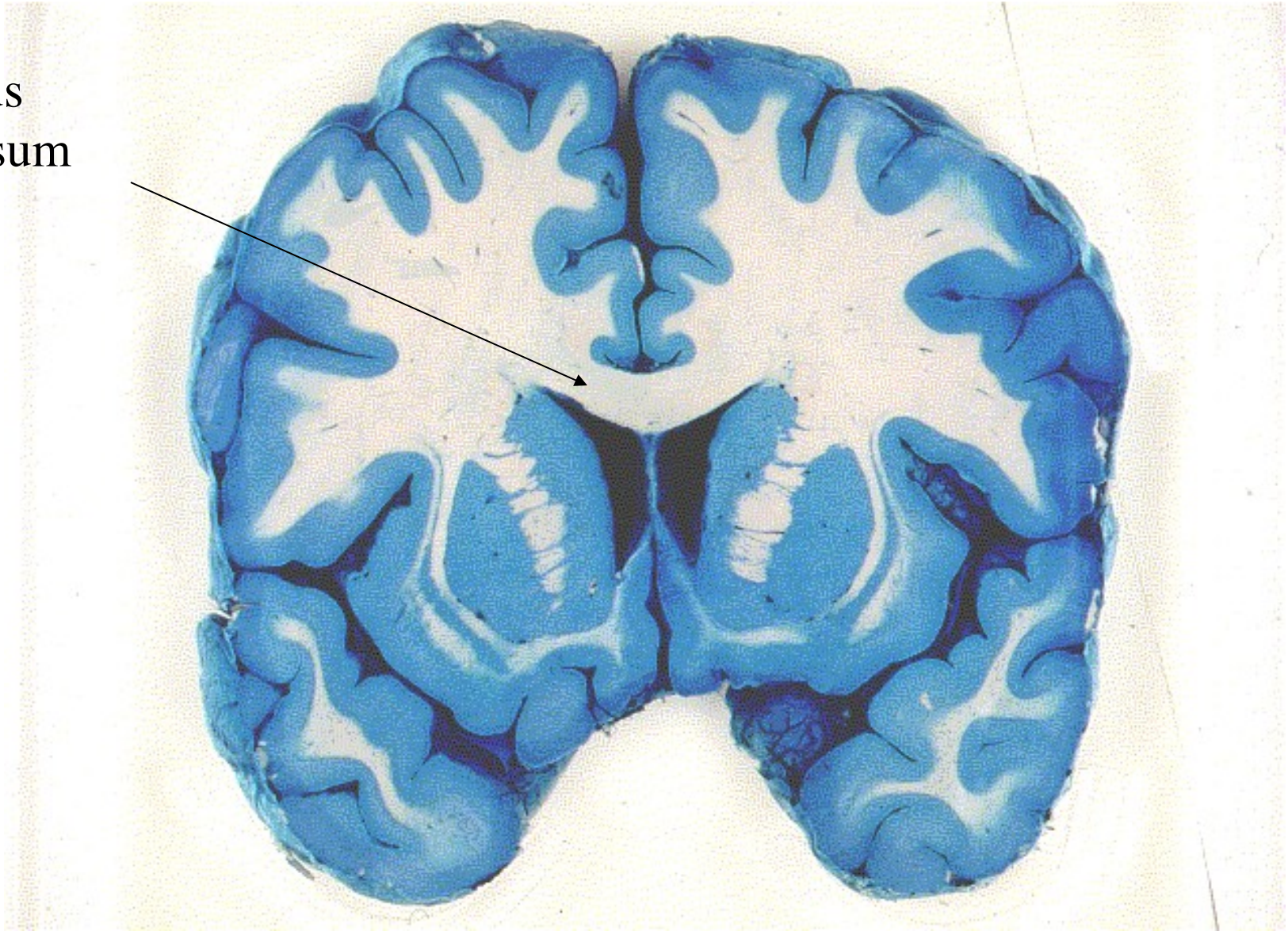
Stained post-mortem



Living

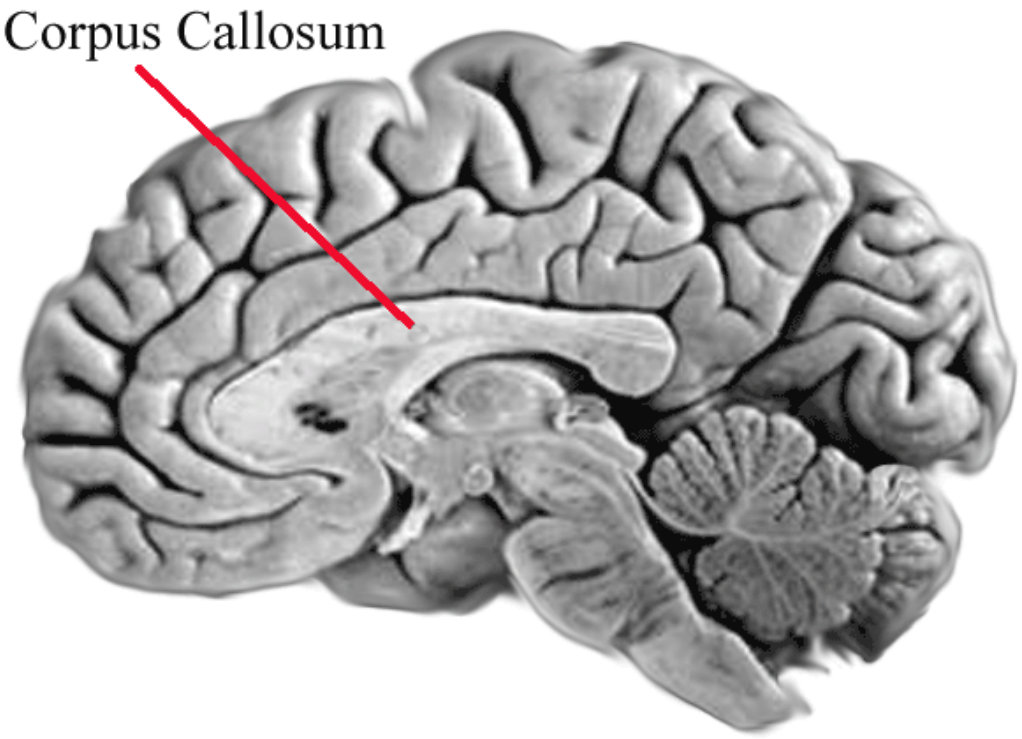
The corpus callosum is the most important landmark in the brain. It is a **bridge of axons** that joins the two hemispheres and allows communication between them.

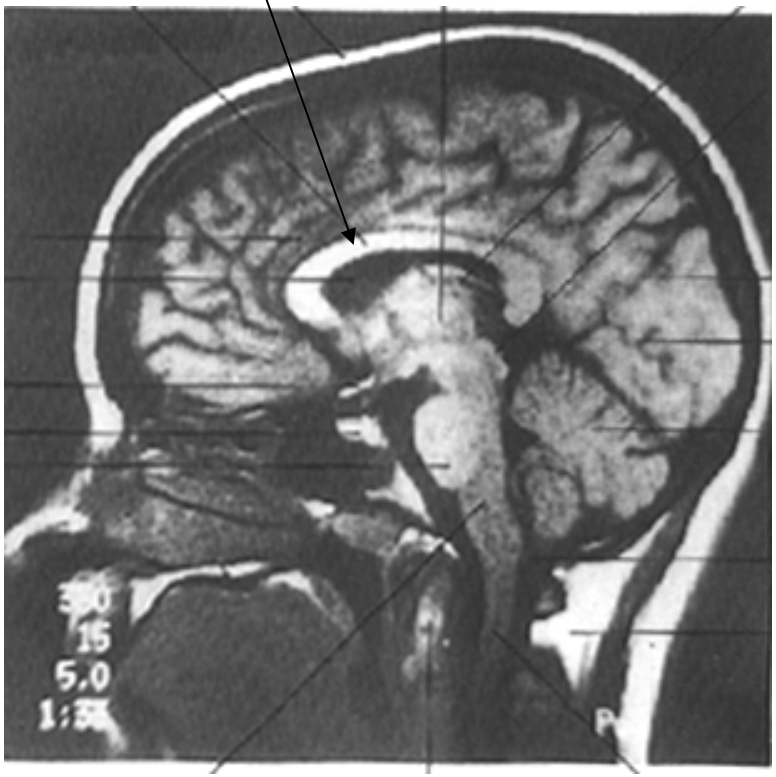
Corpus Callosum



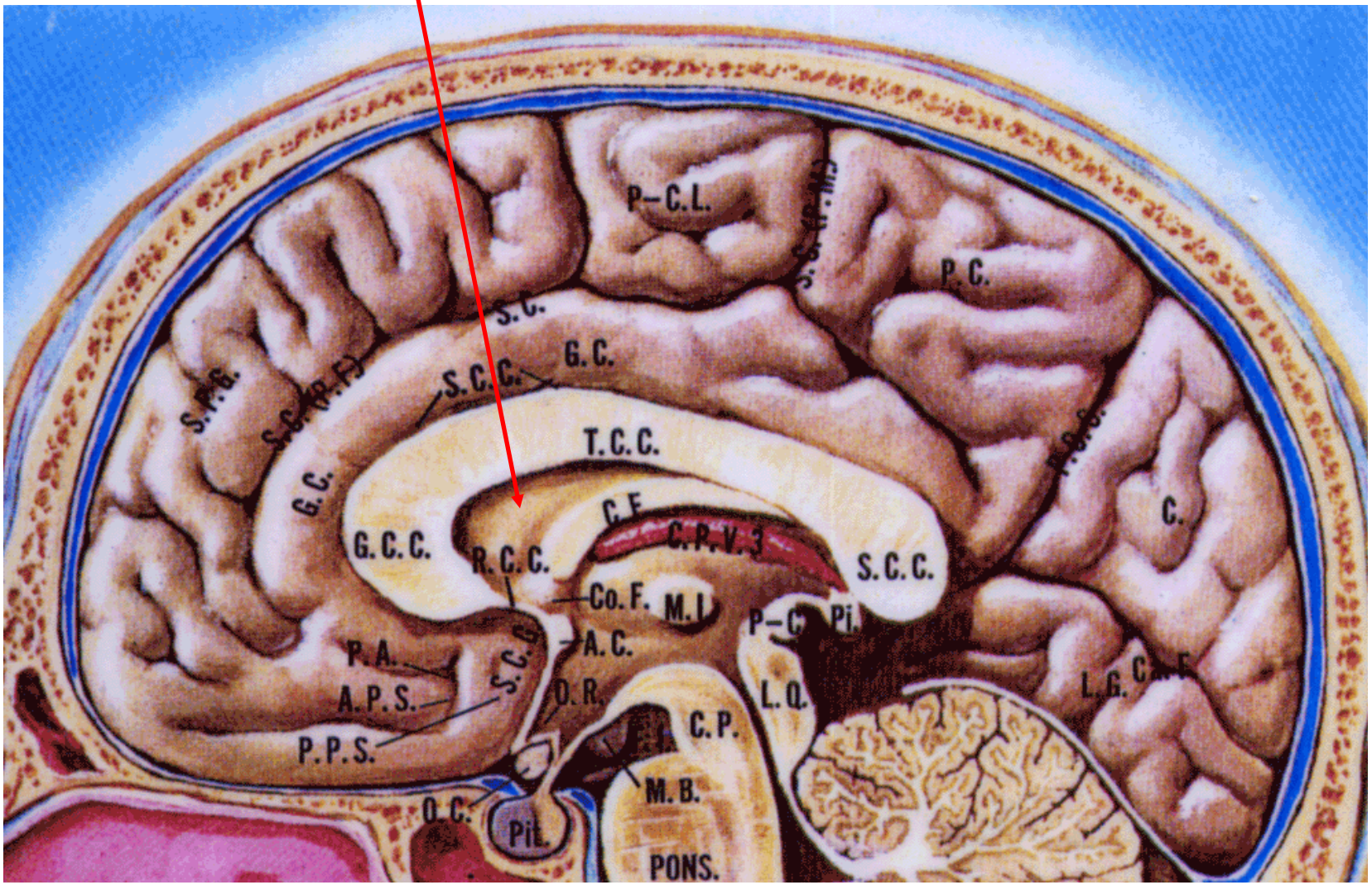
The corpus callosum is very easy to identify in the mid-sagittal plane (below).

Corpus callosum is easy to see on an MRI





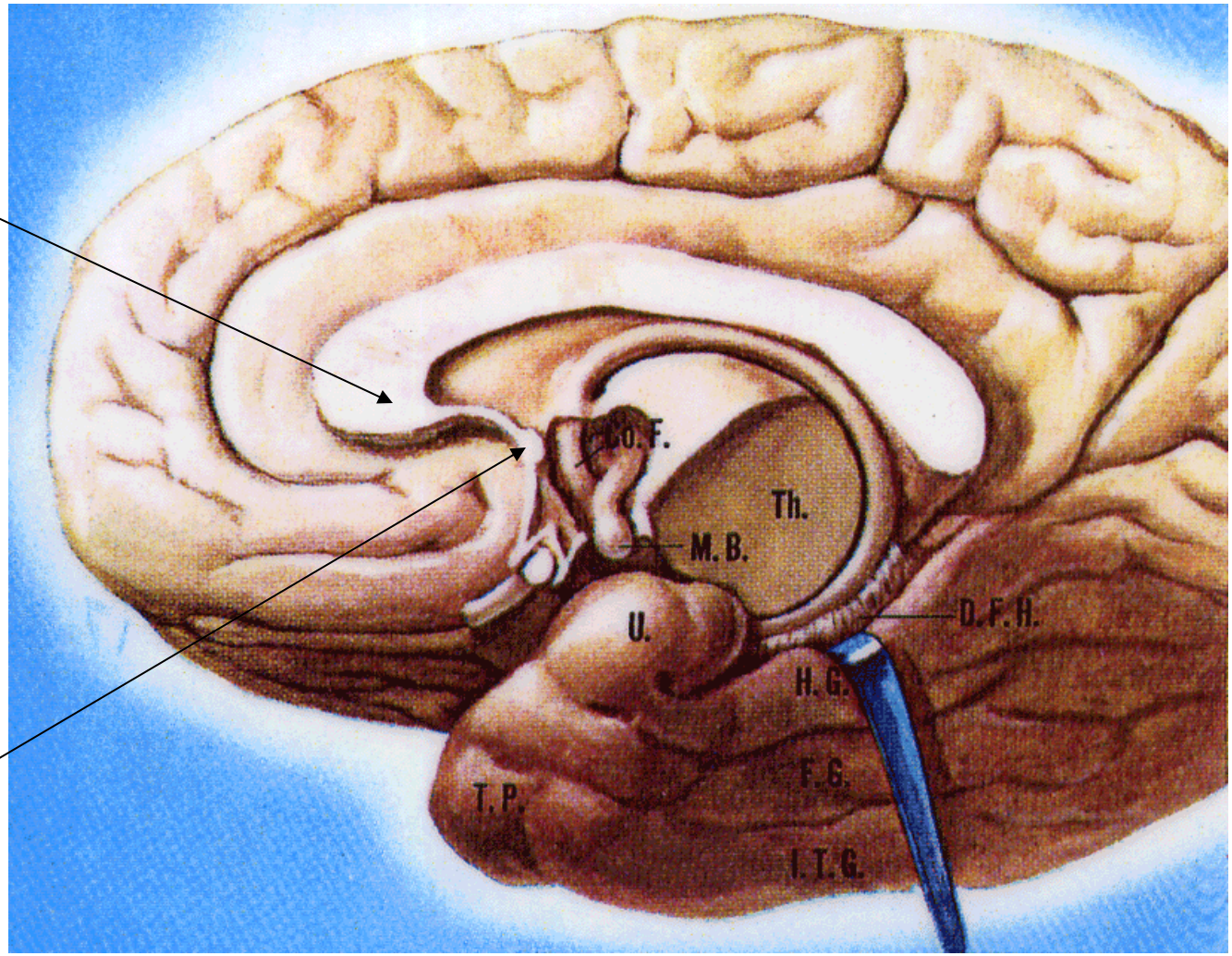
Underneath the anterior part of the corpus callosum we can see the lateral ventricles



Note that the corpus callosum folds back on itself rostrally. This region ends in the **anterior commissure**

‘Folded back’ region

Anterior commissure

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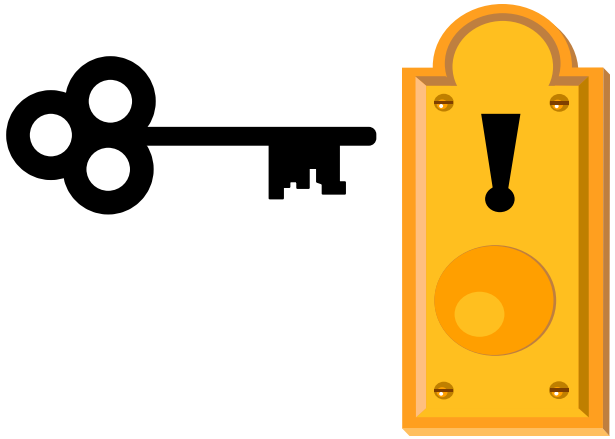
CRITERIA

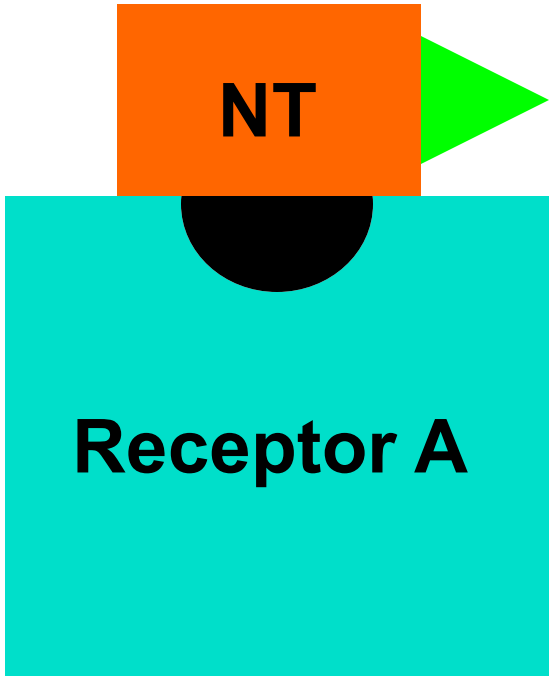
- **NT found in axon terminals**
- **NT released by action potentials**
- **Synthesis identified**
- **External application mimic normal Response**
- **Pharmacology same for normal and externally applied NT ~**

Lock & Key Model

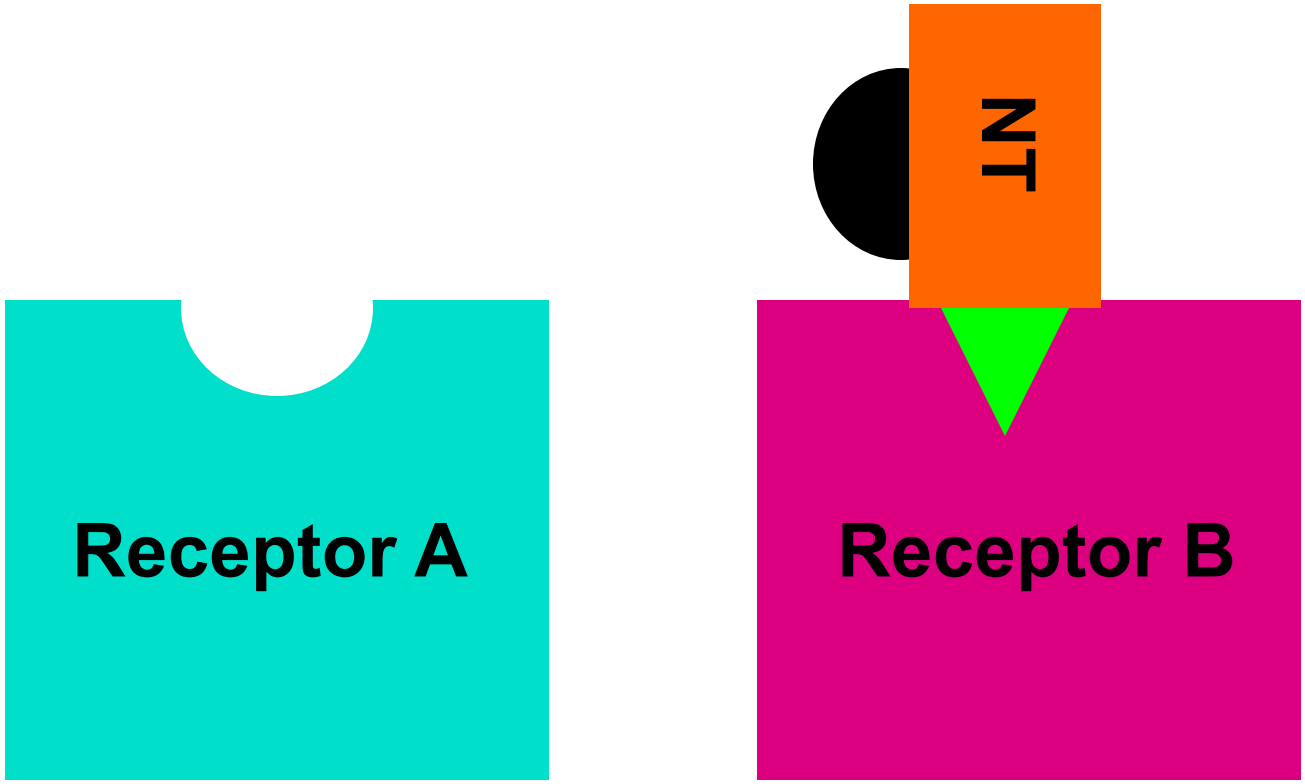
- **NT binds to receptor**
  - **NT = key**
  - **Receptor = lock**
- **Receptor changes shape**
  - **determines if EPSP or IPSP**
  - **receptor subtypes**
- **<u>NOT</u> NT ~**



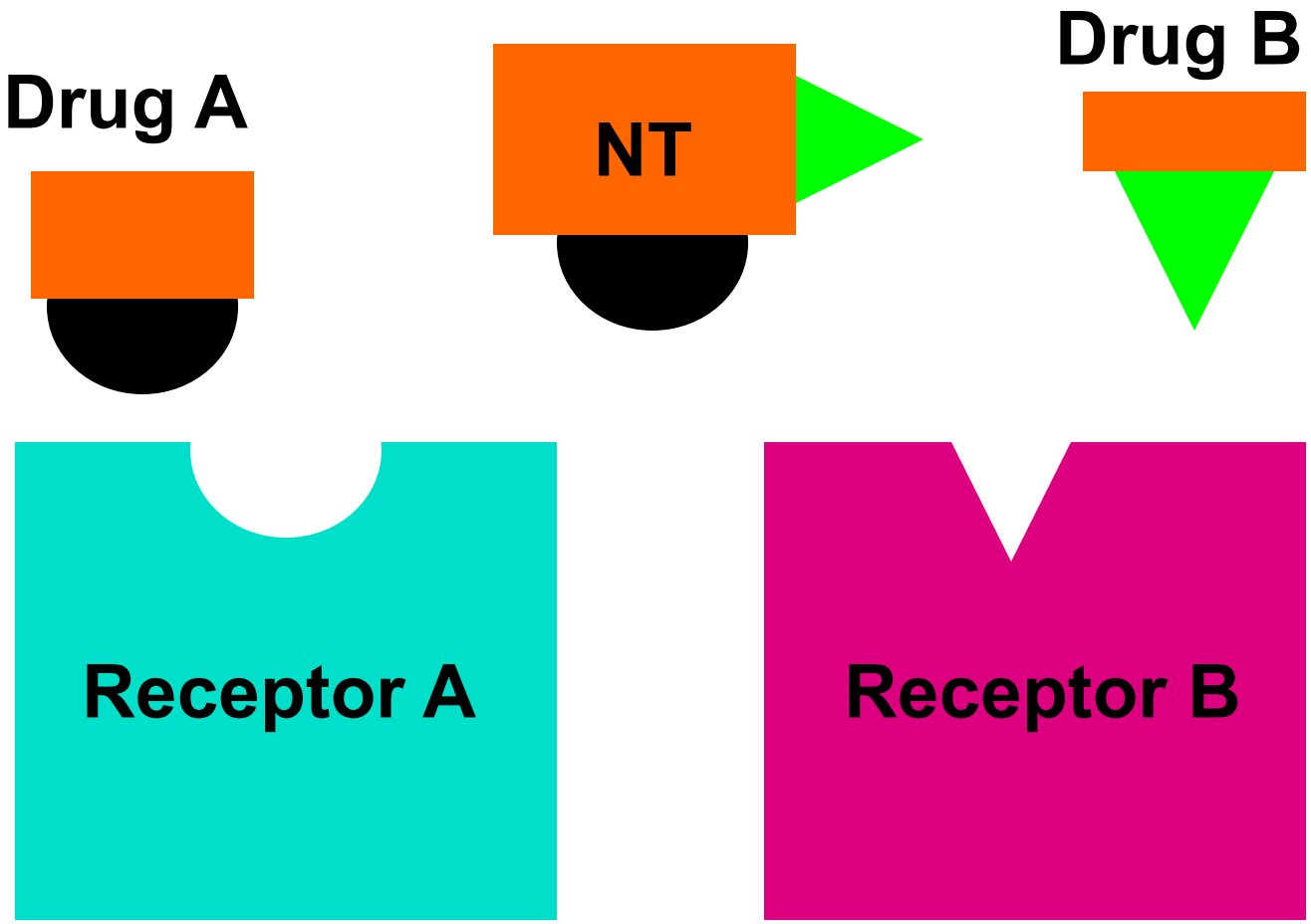
- ligand binds to receptor
- activation: + or - ~



- Same NT can bind to different -R
- different part of NT ~



Specificity of drugs



The Chemical Synapse

Images courtesy of McGraw-Hill Higher Education

Check us out on twitter and FB. @StudentHelp4AP

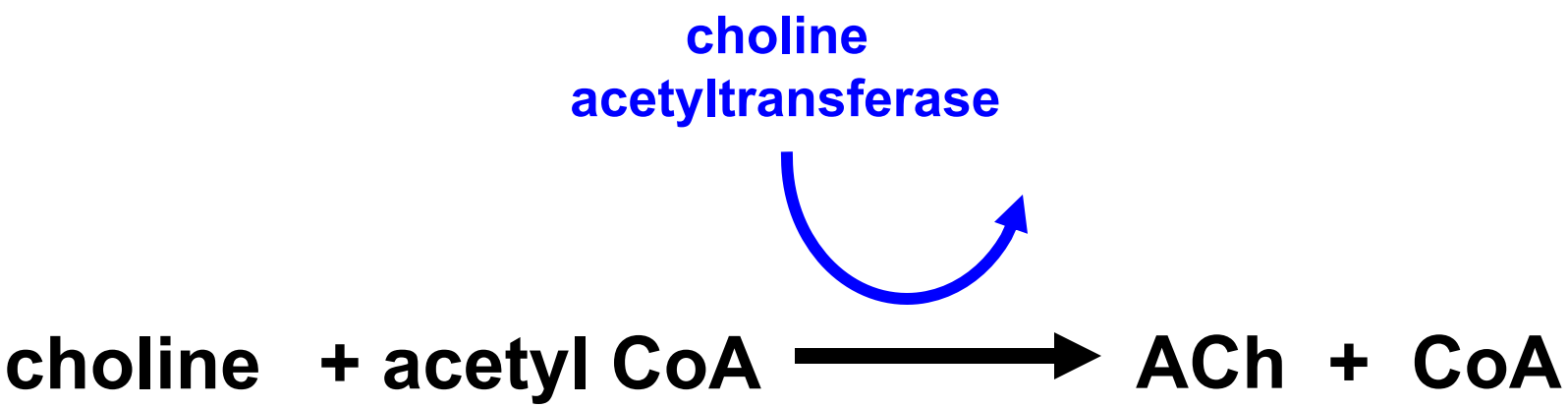
Acetylcholine - ACh

- **Most abundant NT in Peripheral N.S.**
  - **also found in Central N.S.**
- **Precursor = choline**

  nutrient
- **Degraded by acetylcholinesterase-**
  - **AChE**

    Membrane bound - pre- & postsynaptic
- **Nicotinic receptor - ionotropic**
- **Muscarinic receptor - metabotropic ~**

Acetylcholine Synthesis



Ach - Distrubution

- **Peripheral N.S.**
- **Excites somatic muscle**
- **Autonomic NS**
  - **Ganglia**
  - **Parasympathetic NS**
    - **Neuroeffector junction**
- **Central N.S. - widespread**
  - **Hippocampus**
  - **Hypothalamus ~**

Cholinergic Agonists

- **Direct**
  - **Muscarine**
  - **Nicotine**
  - **small doses**
- **Indirect**
  - **AChE Inhibitors ~**

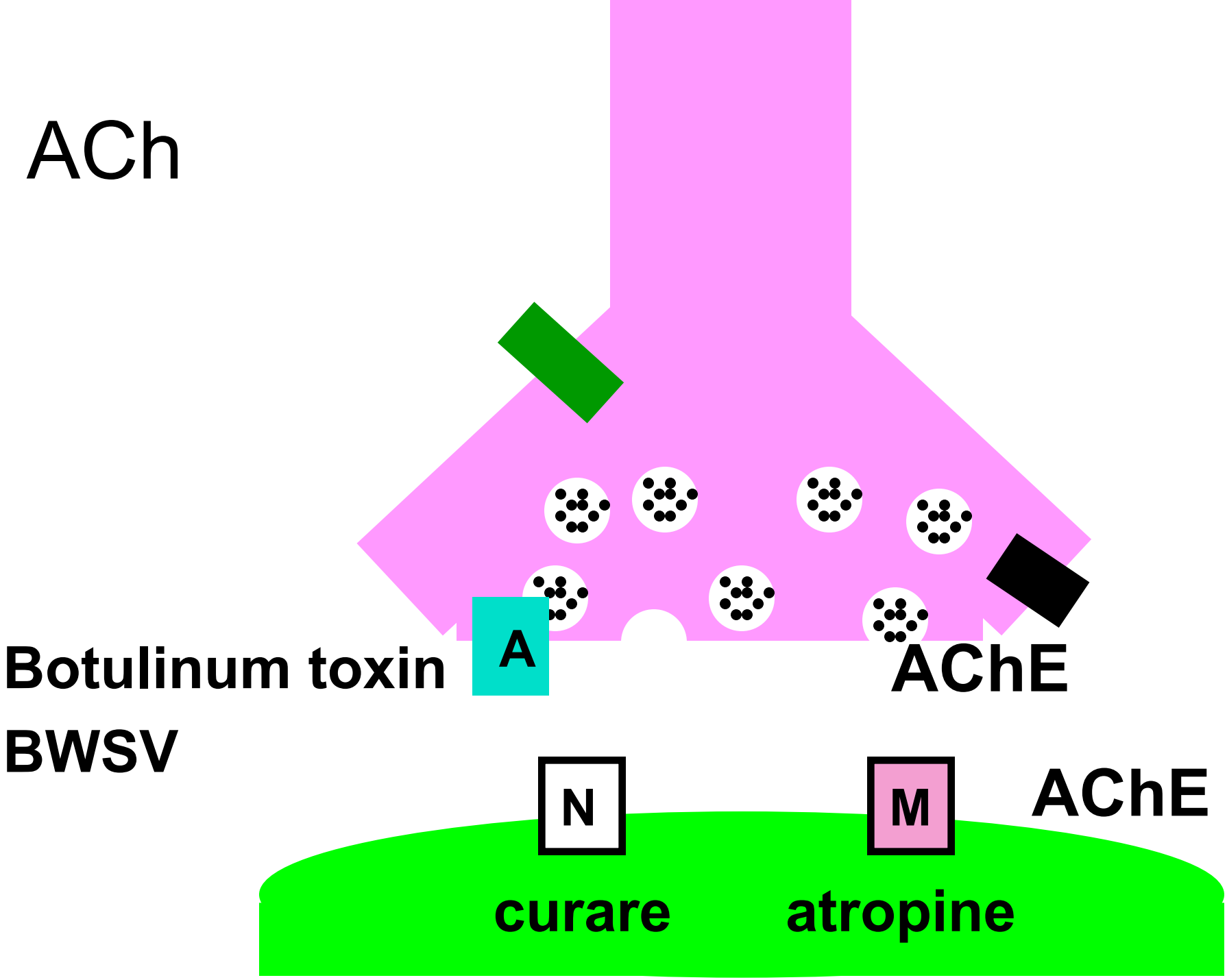
AChE inhibitors

- **Physostigmine**
- **Organophosphates - irreversible**
  - **DFP**
  - **Soman & Sarin**
  - **Malathion***
- **Agonist or Antagonist?**

  indirect agonist ~

Cholinergic Antagonists

- **Direct**
  - **Nicotinic - Curare**
  - **Muscarinic - Atropine**
    - **Scopolamine**
- **Indirect**
  - **Botulinum Toxin**
  - **Black Widow Spider Venom ~**


ACh
Botulinum toxin
BWSV
A
AChE
N
M
AChE
curare
atropine

Monamines

- **Amino acid precursors**
  - **single amine group**
- **2 groups**

  Catecholamines - catechol ring

  Indolamine - indole ring
- **Affected by many of same drugs ~**

Monoamines

- **Catecholamines**

  Dopamine - DA

  - **Dopaminergic**

  Norepinephrine - NE

  - **Noradrenergic**

  Epinephrine - E

  - **Adrenergic ~**

- **Indolamines**

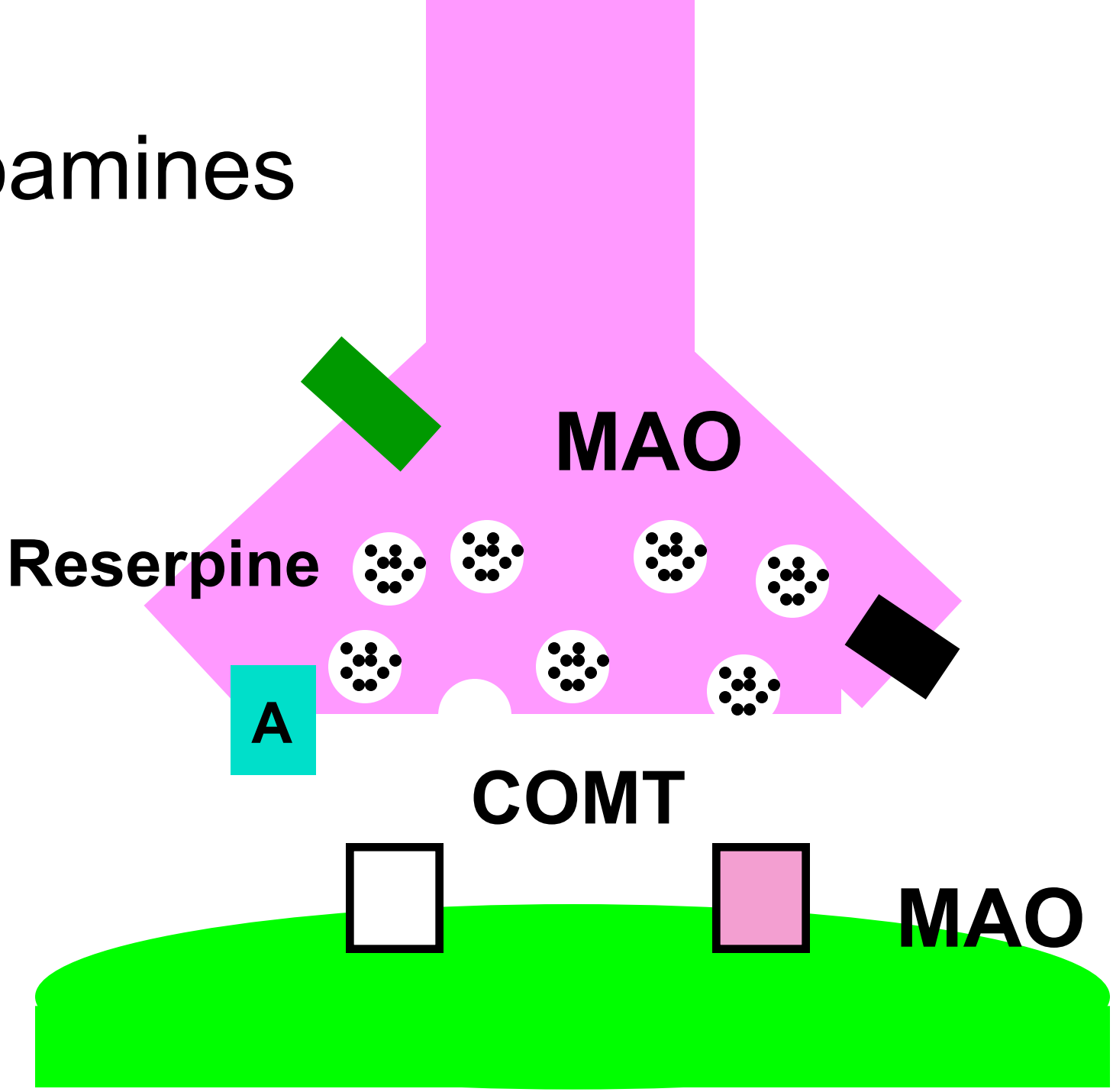
  _Serotonin - 5-HT

  - **Serotonergic**

Monoamines

- Terminated by...
  - reuptake
  - monoamine oxidase - MAO
  - catechol-O-methyltranferase - COMT
  - also in liver
- Reserpine ---> leaky vesicles
  - depletes monoamines ~

Monoamines



Indirect Monoamine Agonists

- **MAOIs**
  - **Iproniazid**
- **Reuptake blockers**
  - **Tricyclic antidepressants**
    - **Imipramine**
    - **Desipramine**
    - **Cocaine & Amphetamine ~**

Dopamine

- **Only in central nervous system**
  mostly inhibitory systems
- **Reward**
- **Schizophrenia**
- **Movement**
  - **Nigrostriatal Pathway**
- **At least 5 DA-R types: D_1, D_2, etc. ~**

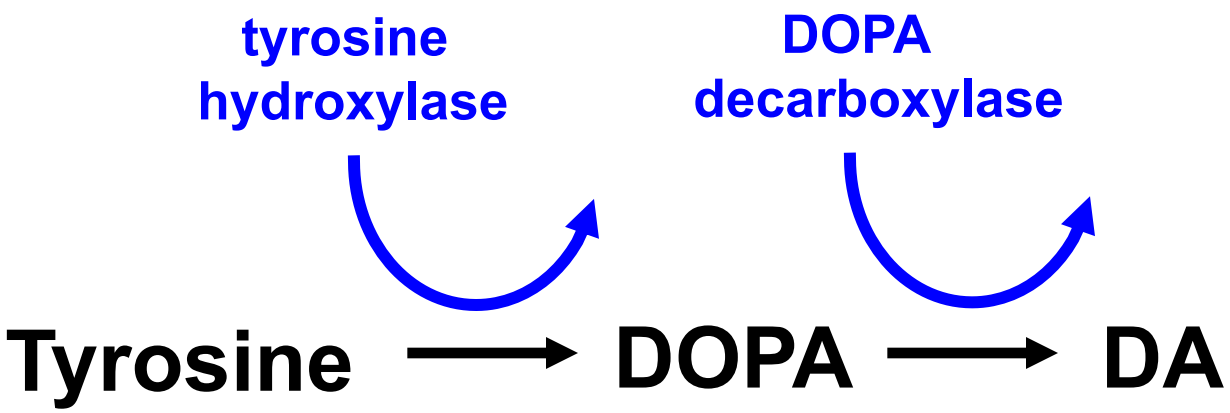
Dopaminergic Drugs

- **Agonist**
  - **L-dopa**
- **Antagonists**
  - **Chlorpromazine**

    D_1
  - **Haloperidol**

    D_2 ~

Dopamine Synthesis



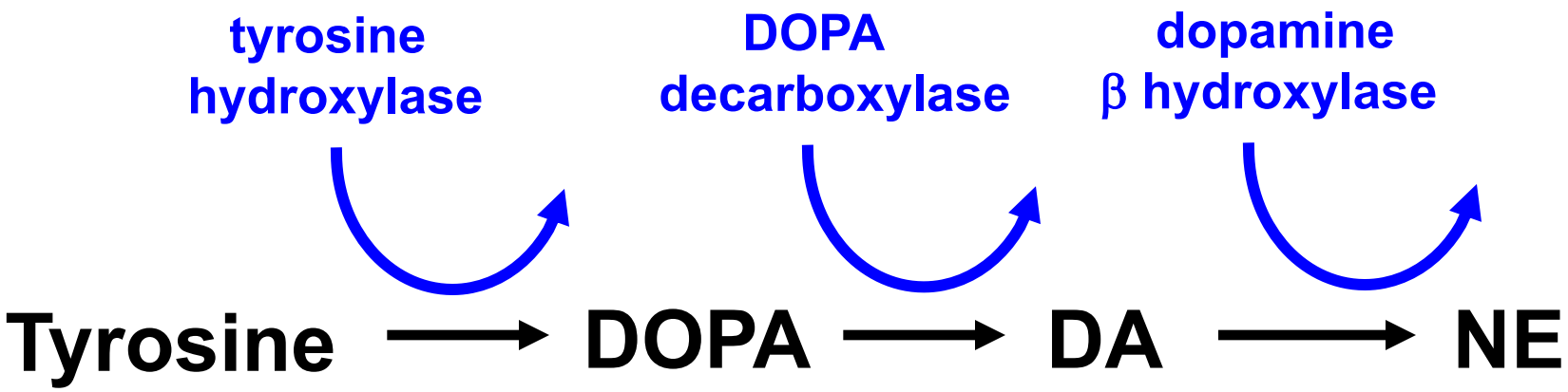
Norepinephrine

- **Peripheral N.S.**
  - **Sympathetic neuroeffector junction**
  - **Adrenal glands**
- **Central N.S.**
  - **Hypothalamus**
  - **Locus coeruleus**
- **Alpha & Beta receptor subtypes**
  - **NE_{α} & NE_{β} ~**

Noradrenergic Drugs

- **Agonists**
  - **Mescaline**
  - **Ephedrine**
- **Antagonist**
  - **Propranalol -**
  - **beta receptors ~**

Norepinephrine Synthesis



Serotonin

- **NOT a catecholamine**
- **Peripheral**
  - **98% in blood & smooth muscle**
- **Central N.S.**
  - **Raphe nucleus**
  - **Hypothalamus**
- **R subtypes: $5HT_1$ & $5HT_2$ ~**

Sertonergic Drugs

- **Agonists**
  - **SSRIs**

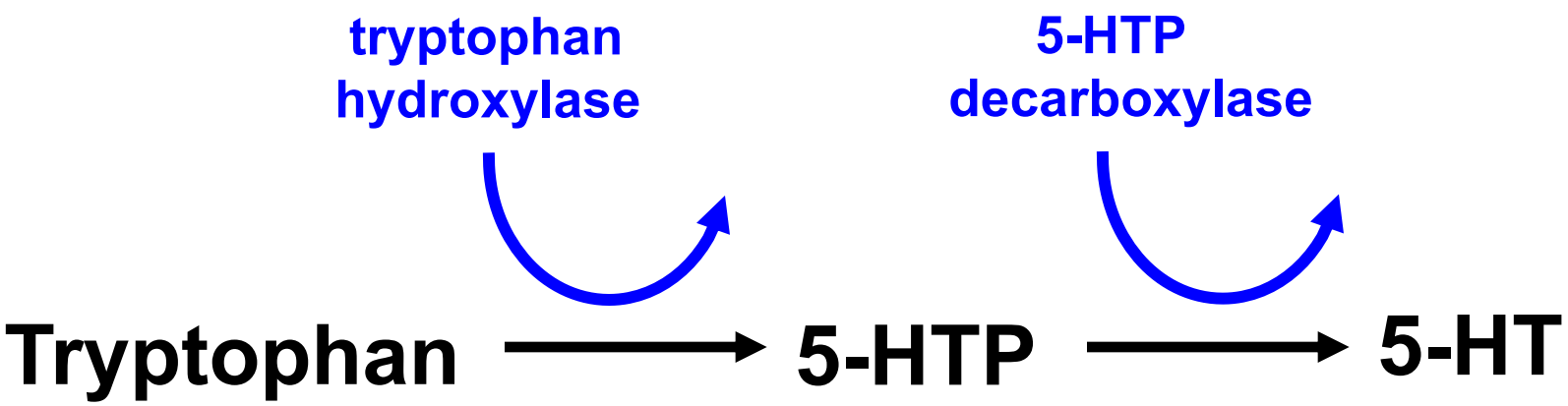
    Selective Serotonin Reuptake Inhibitors
  - **Buspirone**
  - **MDMA**

    Ecstacy ~

Sertonergic Drugs

- **Antagonists**
  - **Psilocybin**
  - **LSD in CNS**
- **Inverse agonist**
  - **ketanserin ~**

Serotonin Synthesis



Gamma-aminobutyric acid

- **GABA - GABAergic**
- **Major NT in brain inhibitory system**
- **Receptor subtypes**
  - **$GABA_A$ - controls Cl- channel**
  - **$GABA_B$ - controls K+ channel**
- **Precursor = glutamate ~**

GABAergic Drugs

- **Agonists**
  - **Benzodiazepines**
  - **Barbiturates**
  - **Ethyl alcohol (ETOH)**
- **Antagonists**

  Picrotoxin
- **Inverse agonist**
  - **Ro 15-4513**
  - **ß CCM ~**

GABA Synthesis & Reuptake

- **From Krebs cycle**

  metabolism of glucose

  in mitochondria

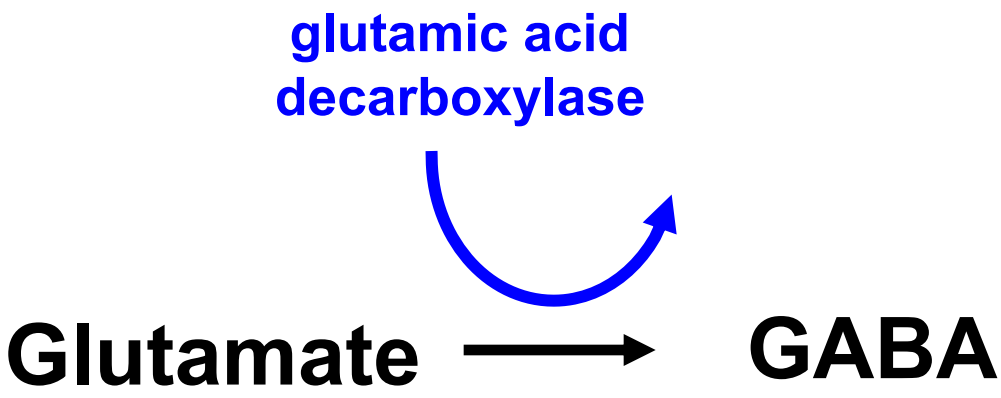
- **From Glial cells**

  GABA ---> Glutamate ---> Glutamine
  Glutamine into neurons

- **After release**

  GABA back into glia ~

GABA Synthesis



Neuropeptide

- **Chains of amino acids**
- **Synthesis in soma**
- **Often neuromodulators**
  - **alters sensitivity of neurons**
  - **slower, longer-lasting effects**
- **Substance P - pain signaling**
- **Endorphins - analgesia, euphoria ~**

Endorphins

- **Opioids**
  - **Dynorphin**
  - **met-enkephalin**
  - **leu-enkephalin**
  - **Beta-endorphin**
- **Receptor subtypes:**
  - **mu1, mu2, kappa, delta, omega ~**

Endorphins (cont.)

- **Agonists**
  - **morphine**
  - **heroin**
  - **codeine**
- **Antagonists**
  - **naloxone**
  - **naltrexone ~**

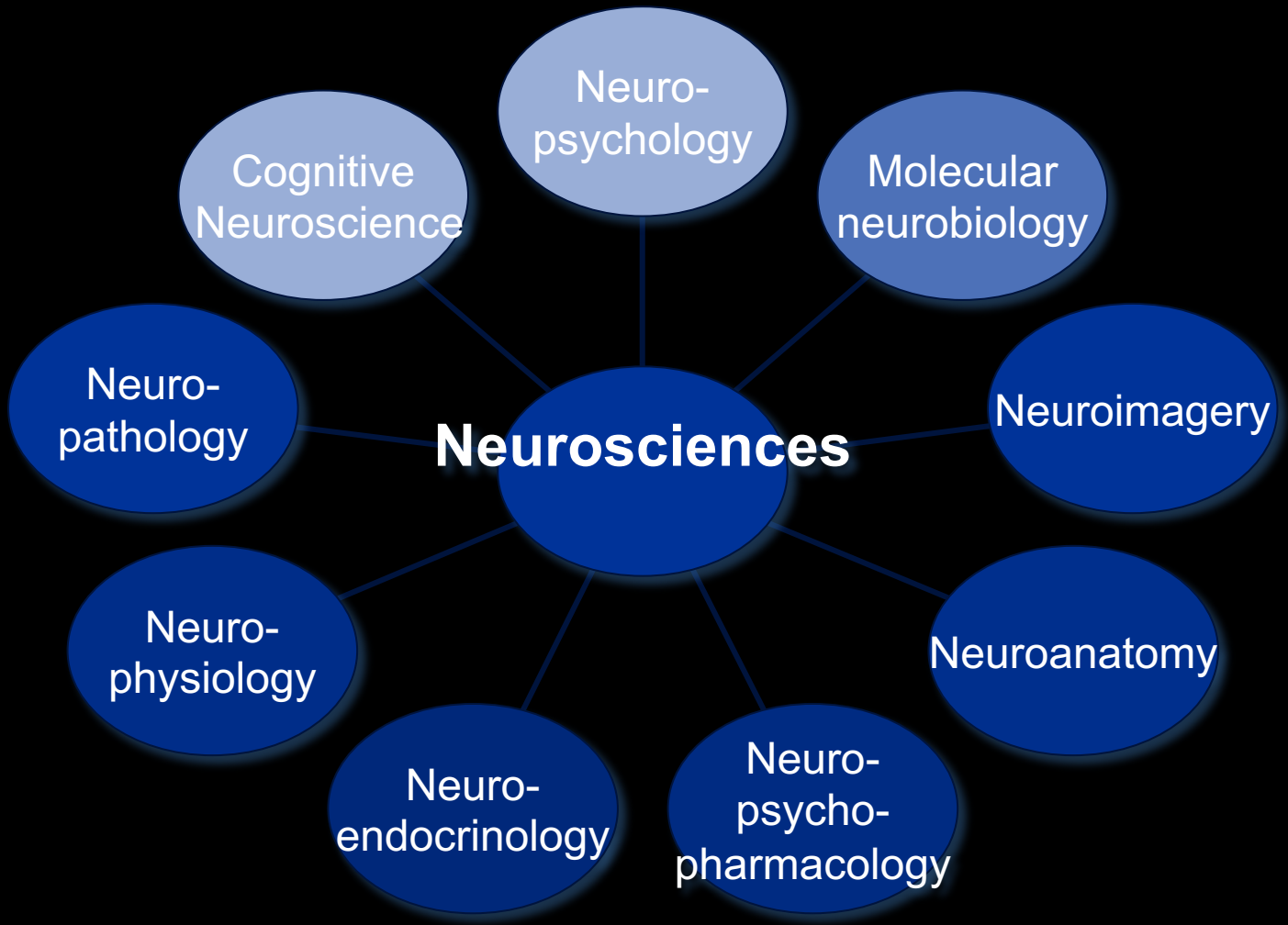
Other NTs

- **Excitatory amino acids**
  - **Glutamate & Aspartate**
- **Histamine**
  - **Inflammatory Response**
- **Nitric Oxide - It's a gas**
  - **Carbon Monoxide?**
- **Anandamide**

  ligand for THC-R ~

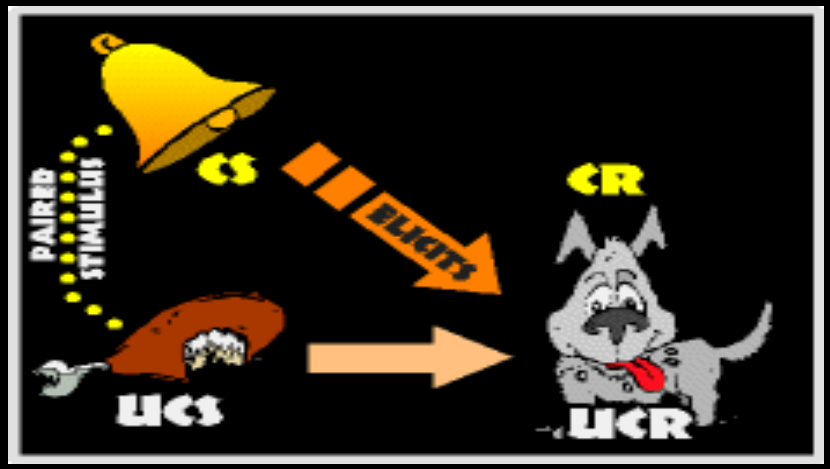
Why would anyone want to be a neuroscientist?

The scientific study of the nervous system and its relationship to cognition and behaviour.

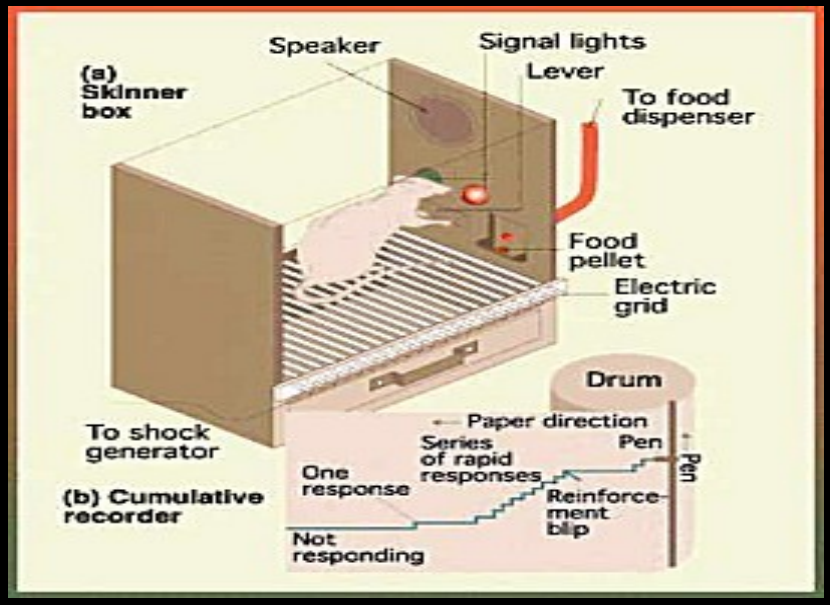


Associative Learning Mechanisms

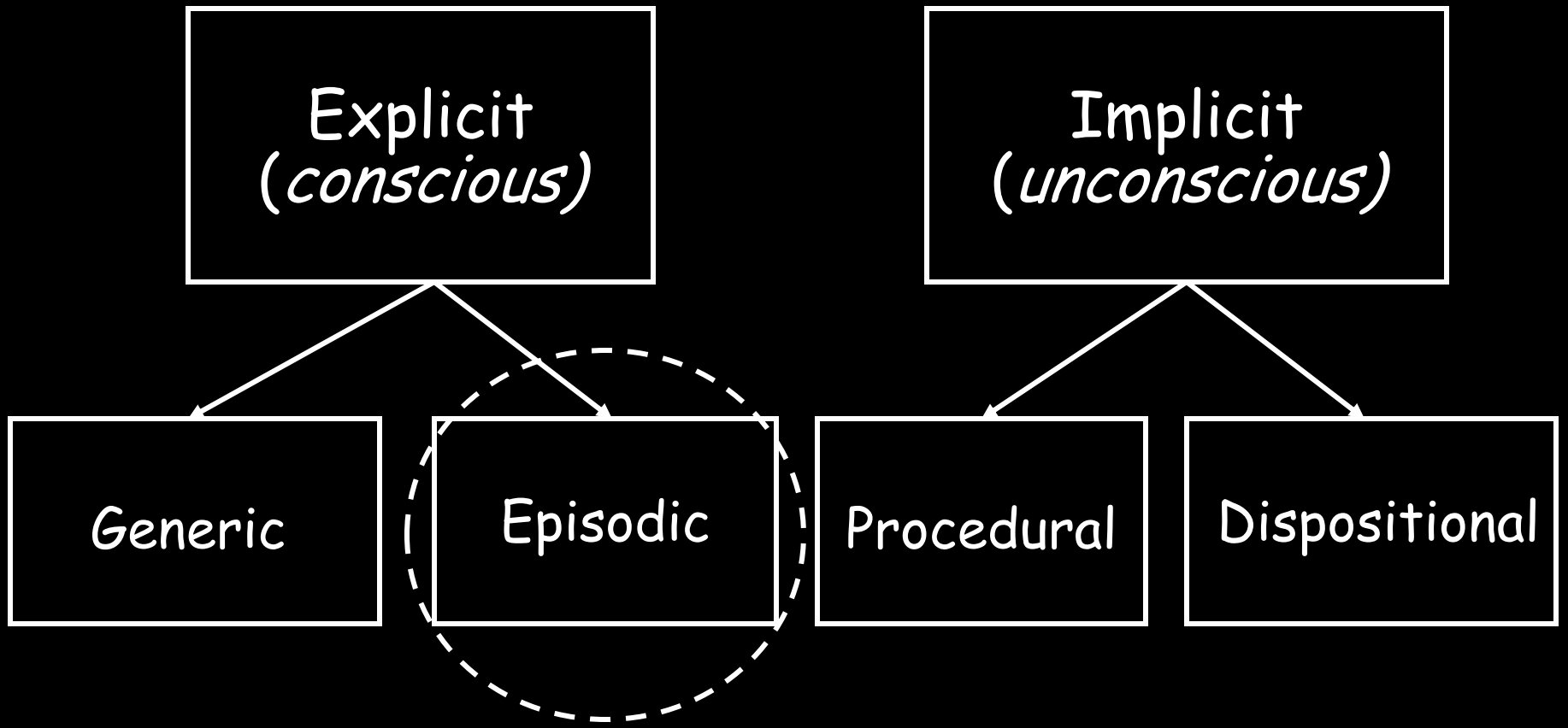
- Classical Conditioning
  - Discovered by Ivan Pavlov (1920s)
  - Passive learning



- Operant Conditioning
  - Discovered by B.F. Skinner (1960s)
  - Active learning

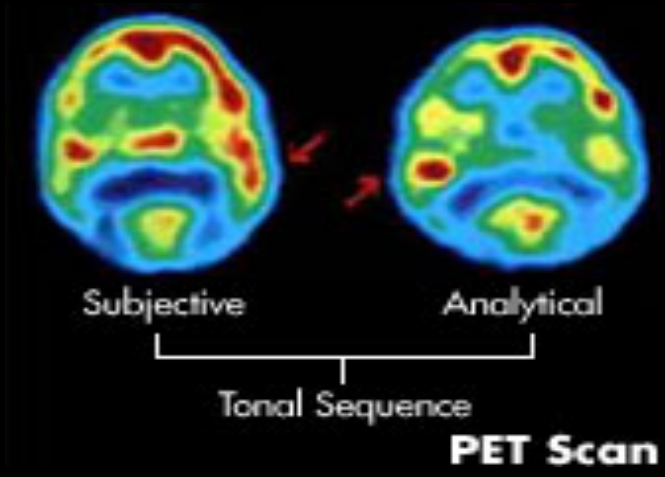


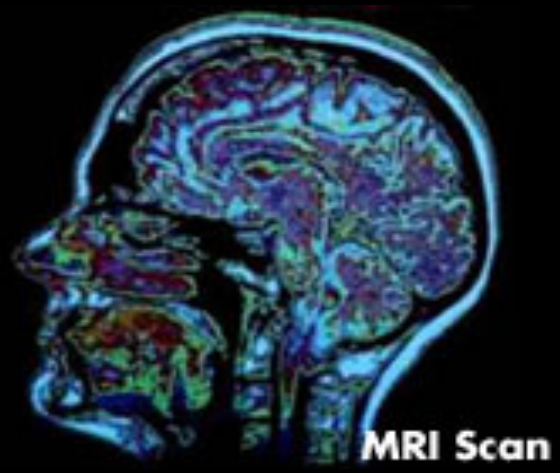
Types of Memory



How is the Brain studied?

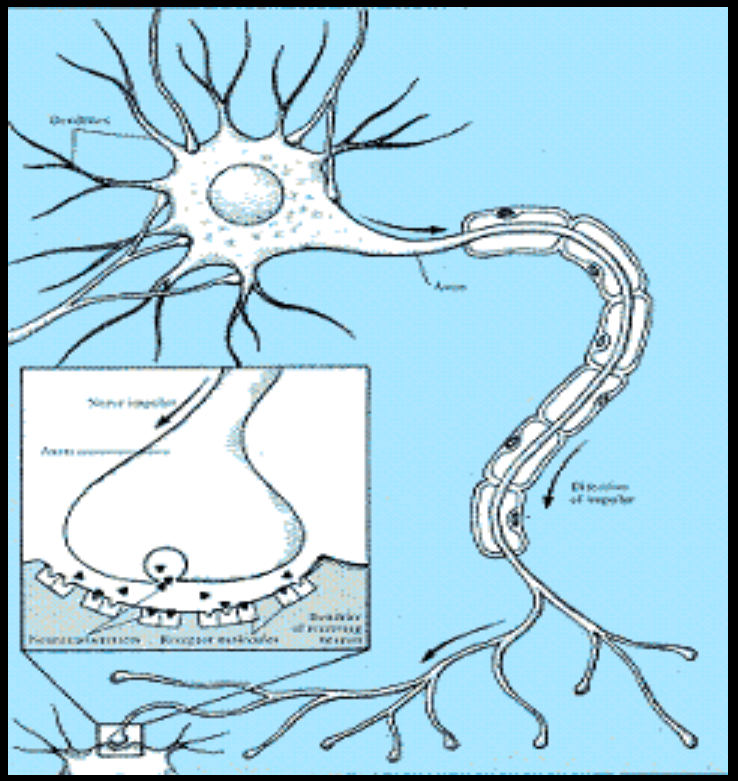
- Case Studies
- Gene Splicing
- Imaging
  - PET
  - EEG (electrical current detection)
- Transcranial Magnetic Stimulation (causes temporary disruption of a brain region)
  - MRI
  - fMRI
  - CAT





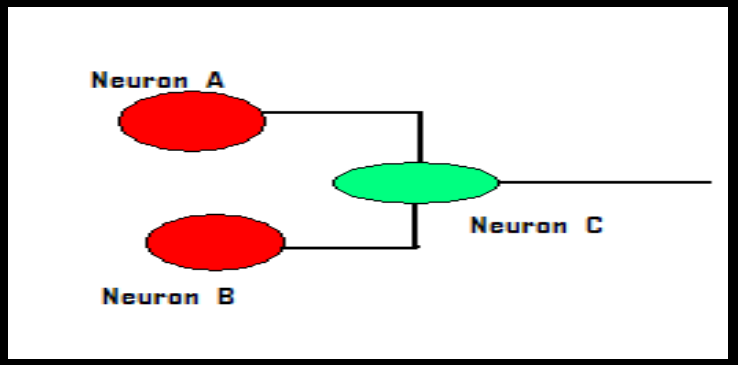
How is learning and memory enabled?

- **Signal Transduction:**
  - Inter-Neuron communication occurs via Neurotransmitters at the synaptic gap



- **Neural Plasticity:**
  - Through experience, Neurons can change the way they function

- **Long Term Potentiation:**
  - Cellular mechanism through which associations can be detected and recorded in the brain



Stage Theory of Memory