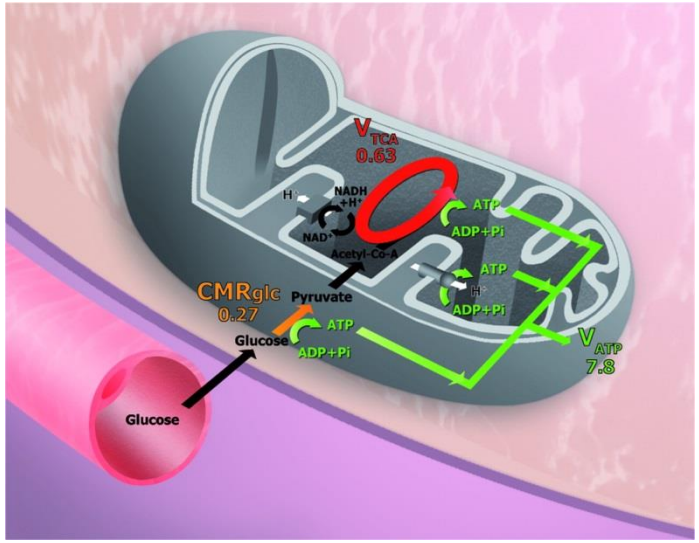
Brain Energy Metabolism

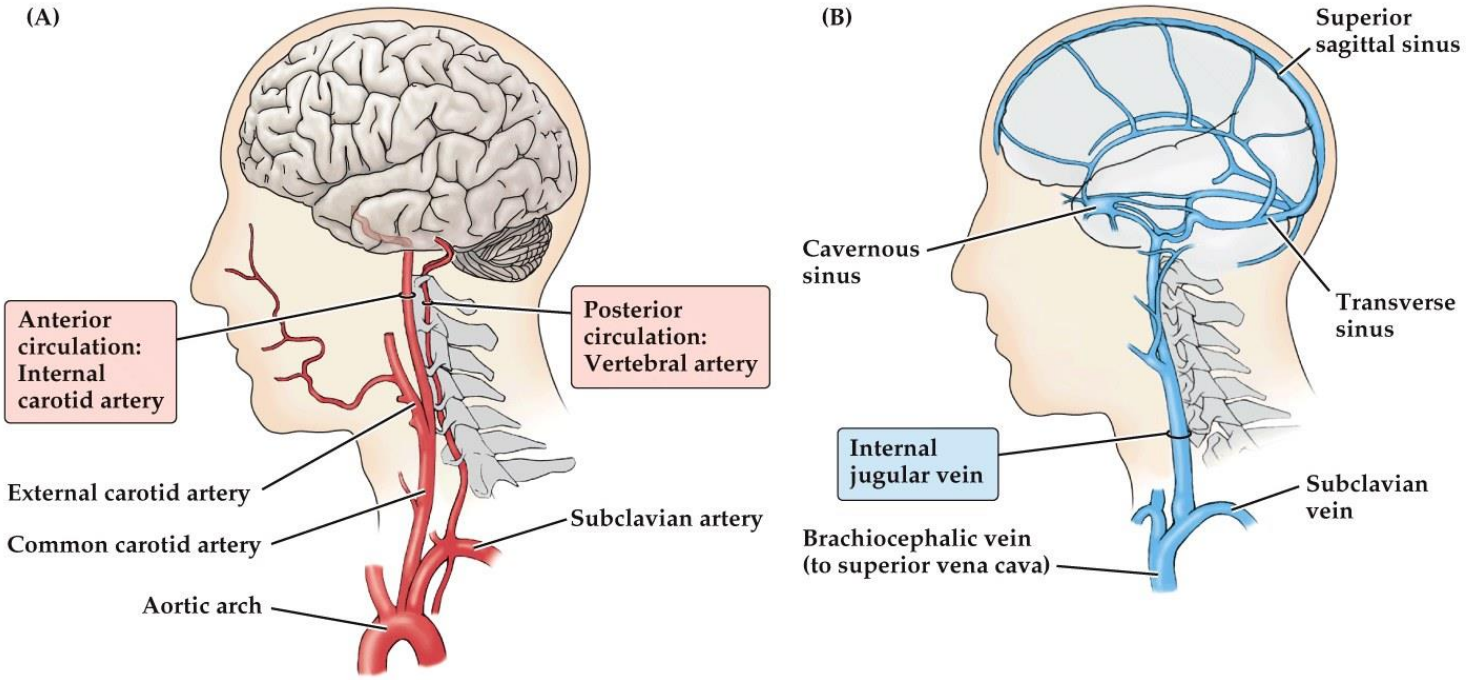


Brain Blood Supply
Basic Biochemistry
Metabolic Imaging
Astrocyte – Neuron Metabolic Unit

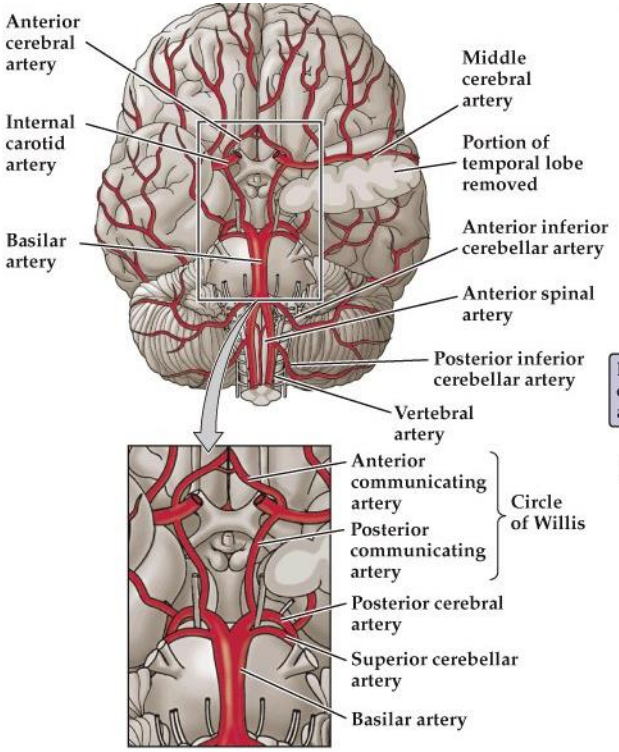
BIO327

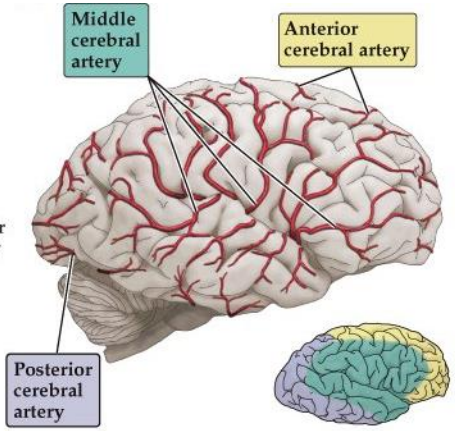
Blood Supply to the Brain

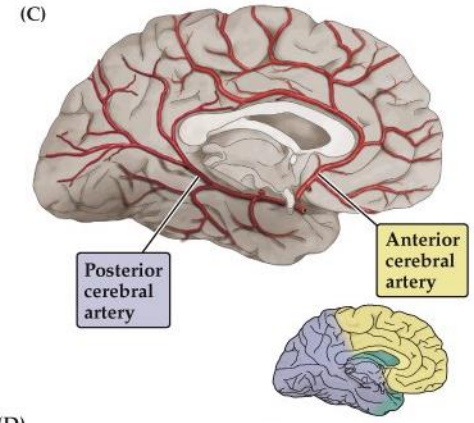
Consciousness is already lost after a 10 second interruption of blood supply.
Irreparable brain damages after about a minute of ischemia/anoxia.

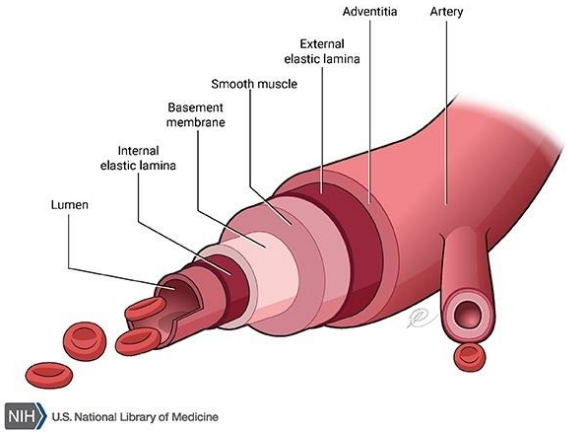


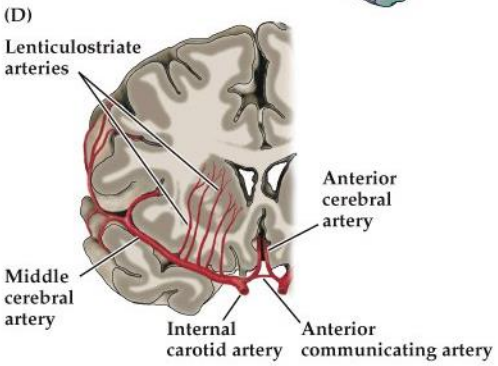
lec: this slide no exam content



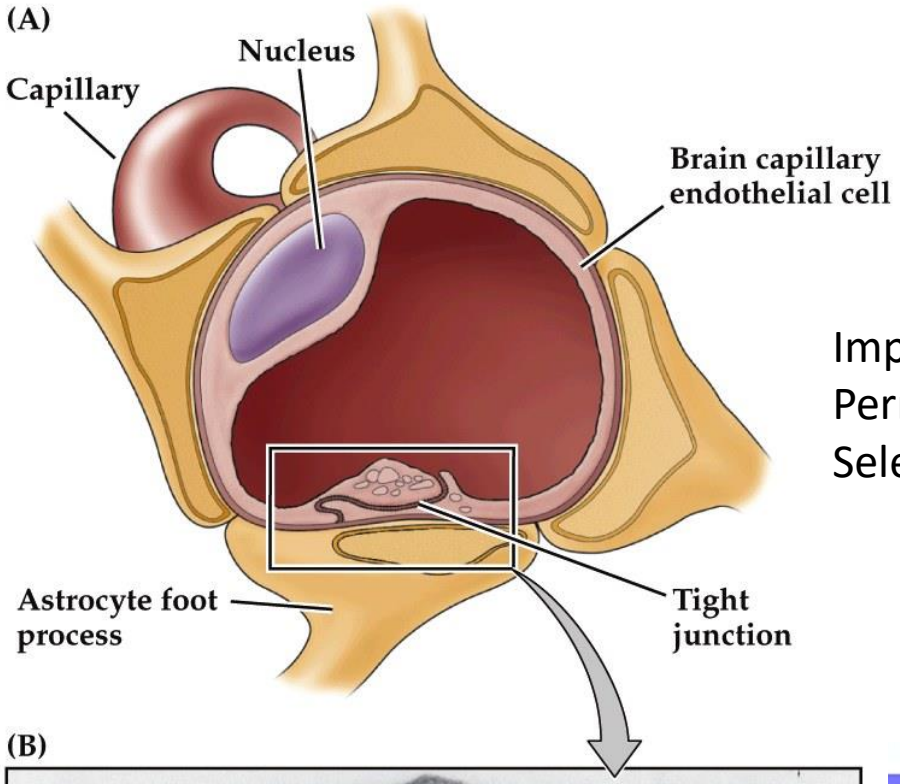




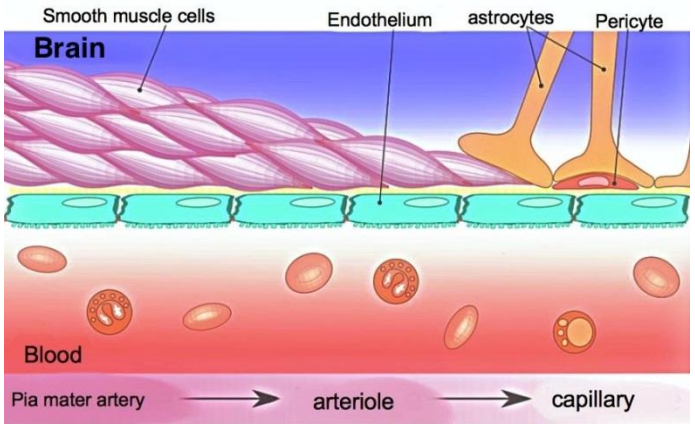




Blood Brain Barrier



Impermeable for most substances
Permeable for some lipophilic substances and gases
Selective transport by dedicated transporter proteins

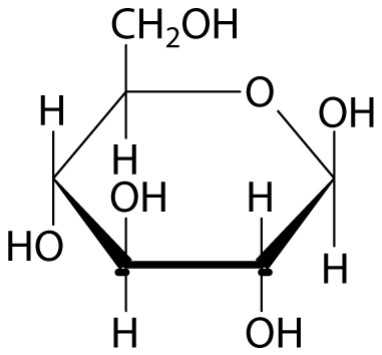


***NEUROSCIENCE 5e*, Figure A20**

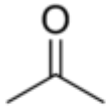
Glucose is the Main Energy Source of Brain Tissue

100g brain tissue consumes about 160 mmol oxygen per minute, about 10x more than average body tissue.
Respiratory quotient is close to 1, demonstrating that carbohydrates (glucose) accounts for practically all oxidative metabolism.

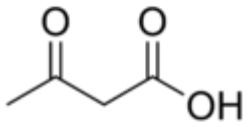
Under special conditions (ketosis: low carbohydrate, lactation, fasting …) ketone bodies can compensate for glucose.



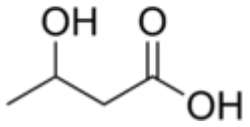
glucose



acetone

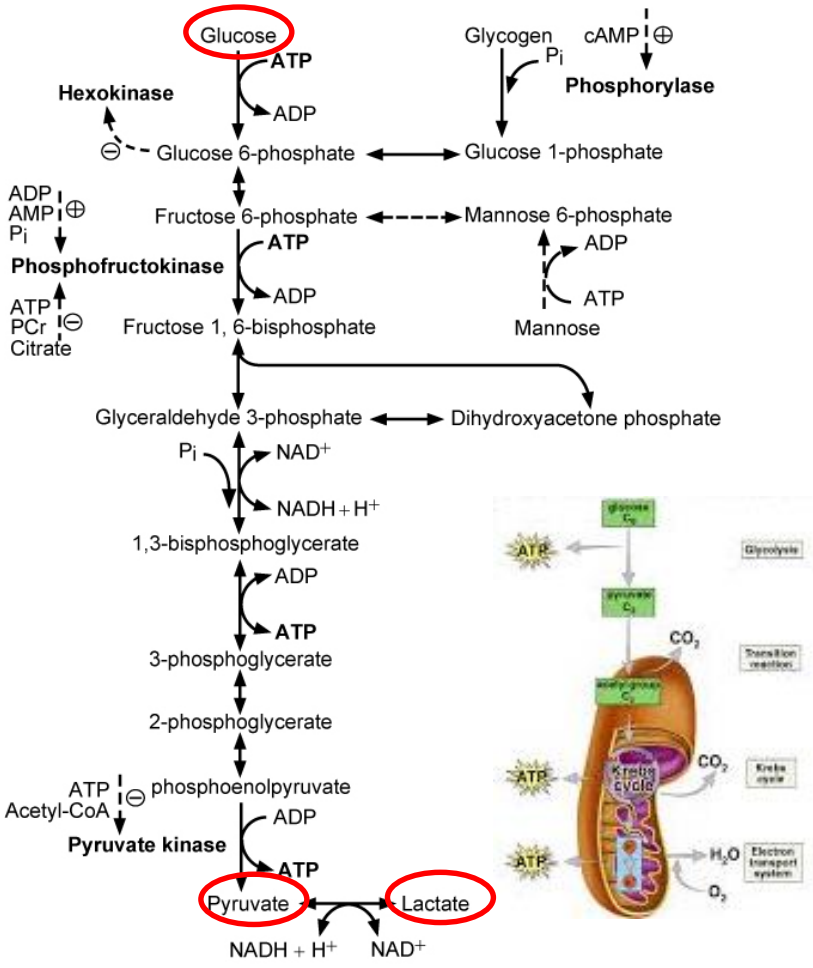


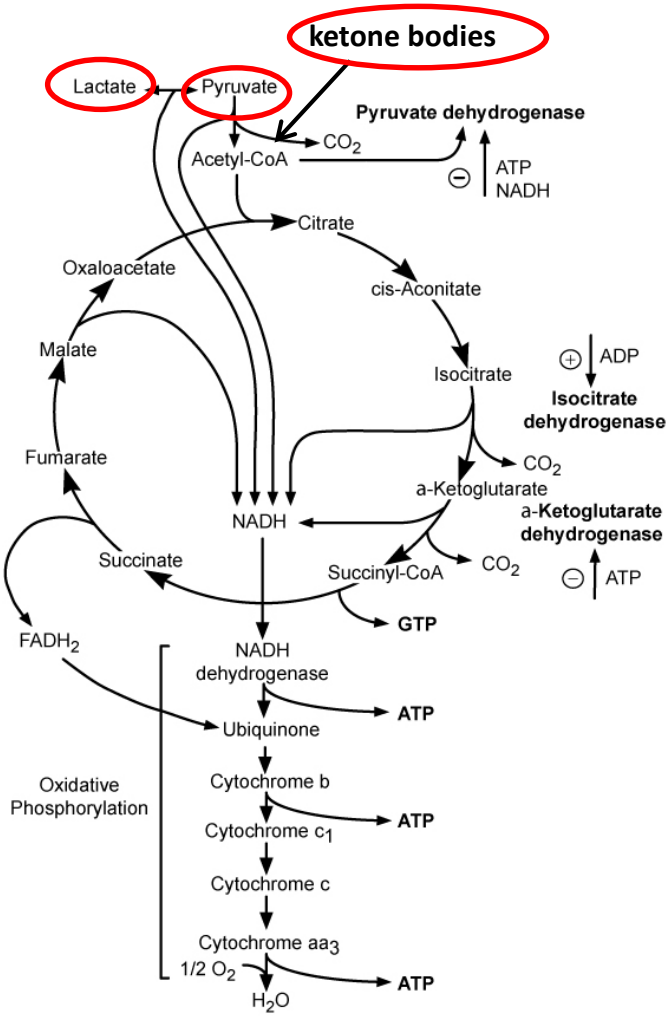
acetoacetic acid



beta hydroxy-butyric acid

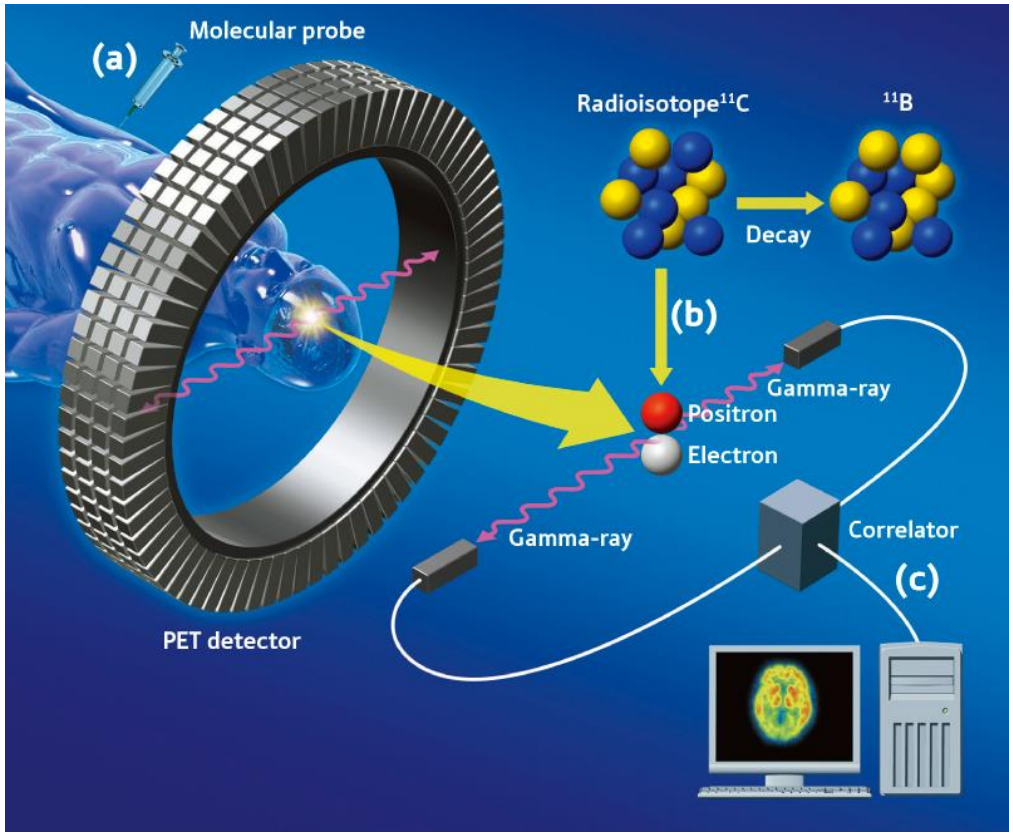
Basic Glucose Metabolism





Metabolism based Neural Imaging – PET Scan (positron emission tomography)

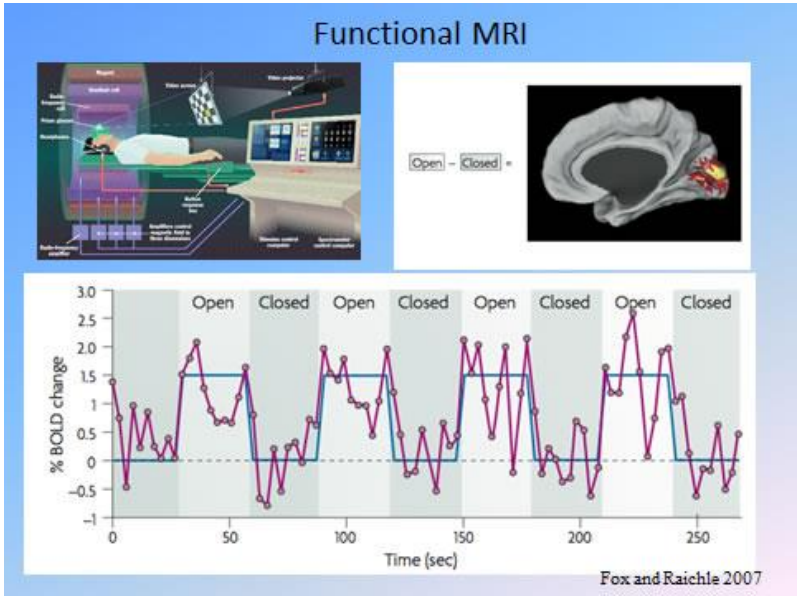
invasive



Radioactive labelled tracer is injected
Tracer accumulates in tissue of choice
Decay produces positron that is annihilated under gamma ray emission when encountering an electron

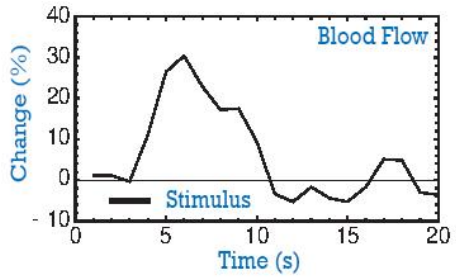
$^{15}O_2$ – blood flow
F2-deoxyglucose – glucose consumption

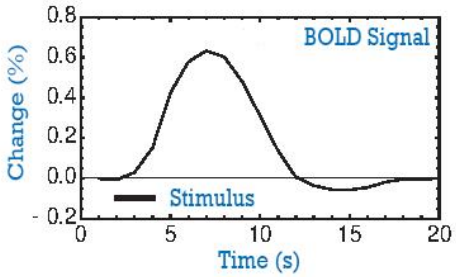
Metabolism based Neural Imaging – fMRI (magnetic resonance imaging)

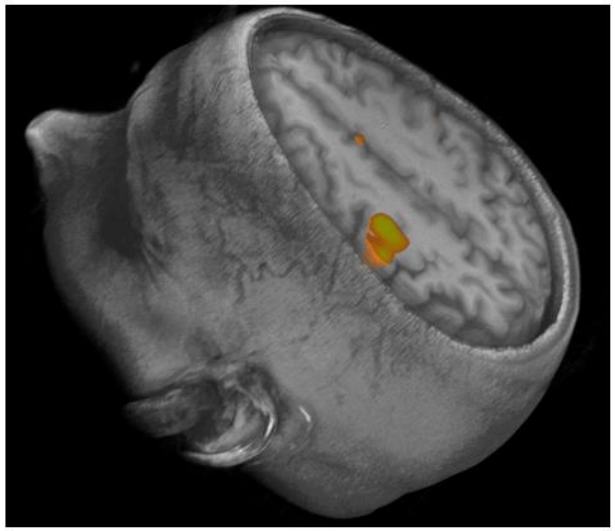


non-invasive

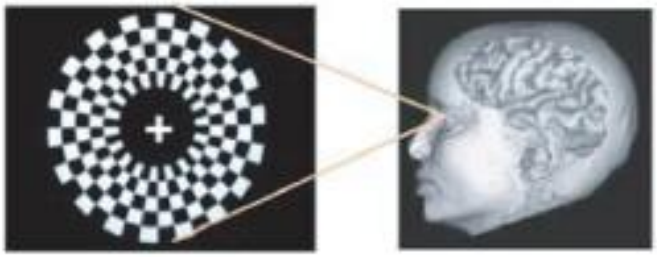
BOLD (blood-oxygen dependent) contrast
by complex alignment of paramagnetic atoms





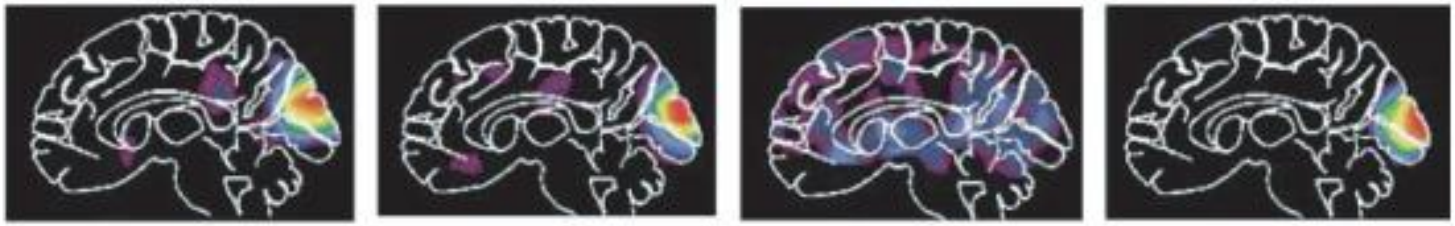


Neurovascular and Neurometabolic Coupling

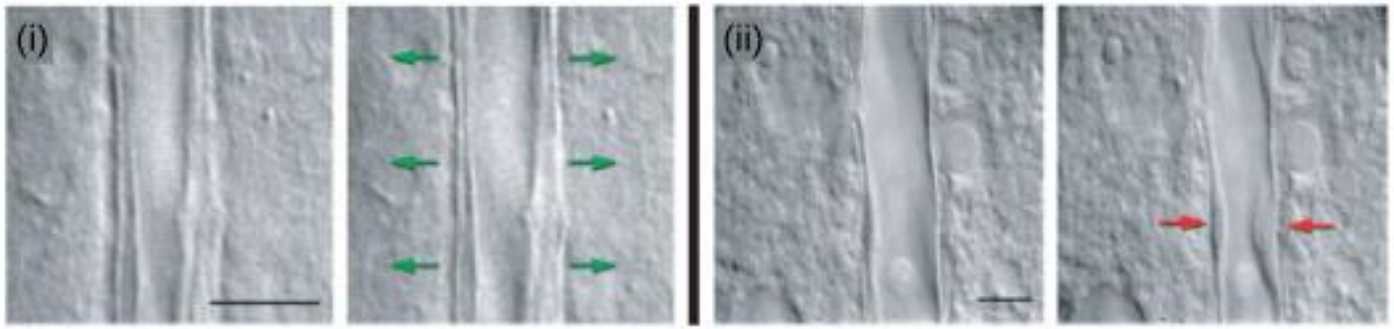


O"-independence of immediate neuron activation

(ii)

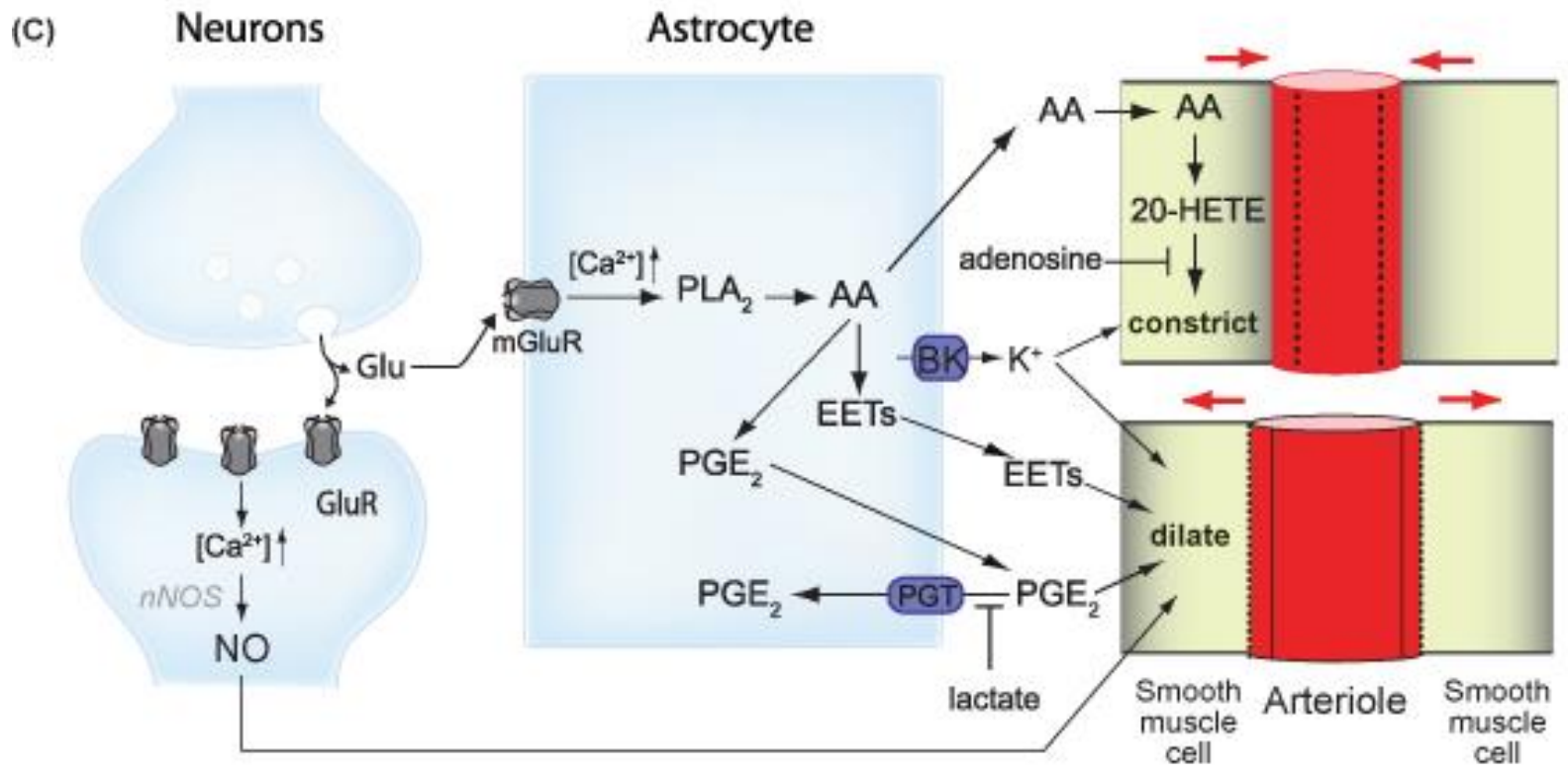


(B)



Metabolic needs to increased neuronal activity are met by glycolysis

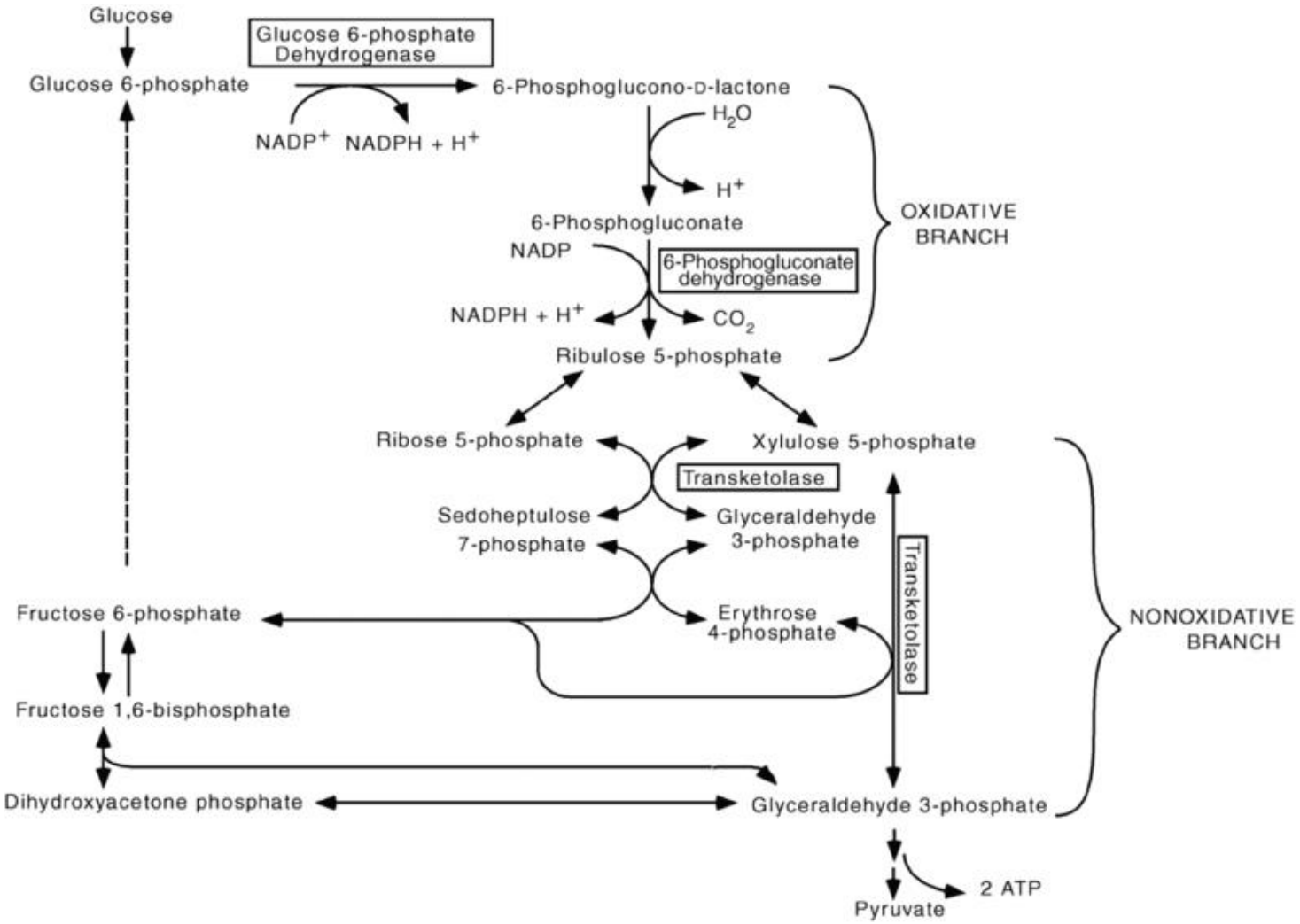
Glutamate Dependent Regulation of Cerebral Blood Flow



this is an activity dependent system that releases glutamate for activation. Postsyn neuron releases NO which is a dilator (arterioles open up). NO is diffusible and short-lived in tissue.

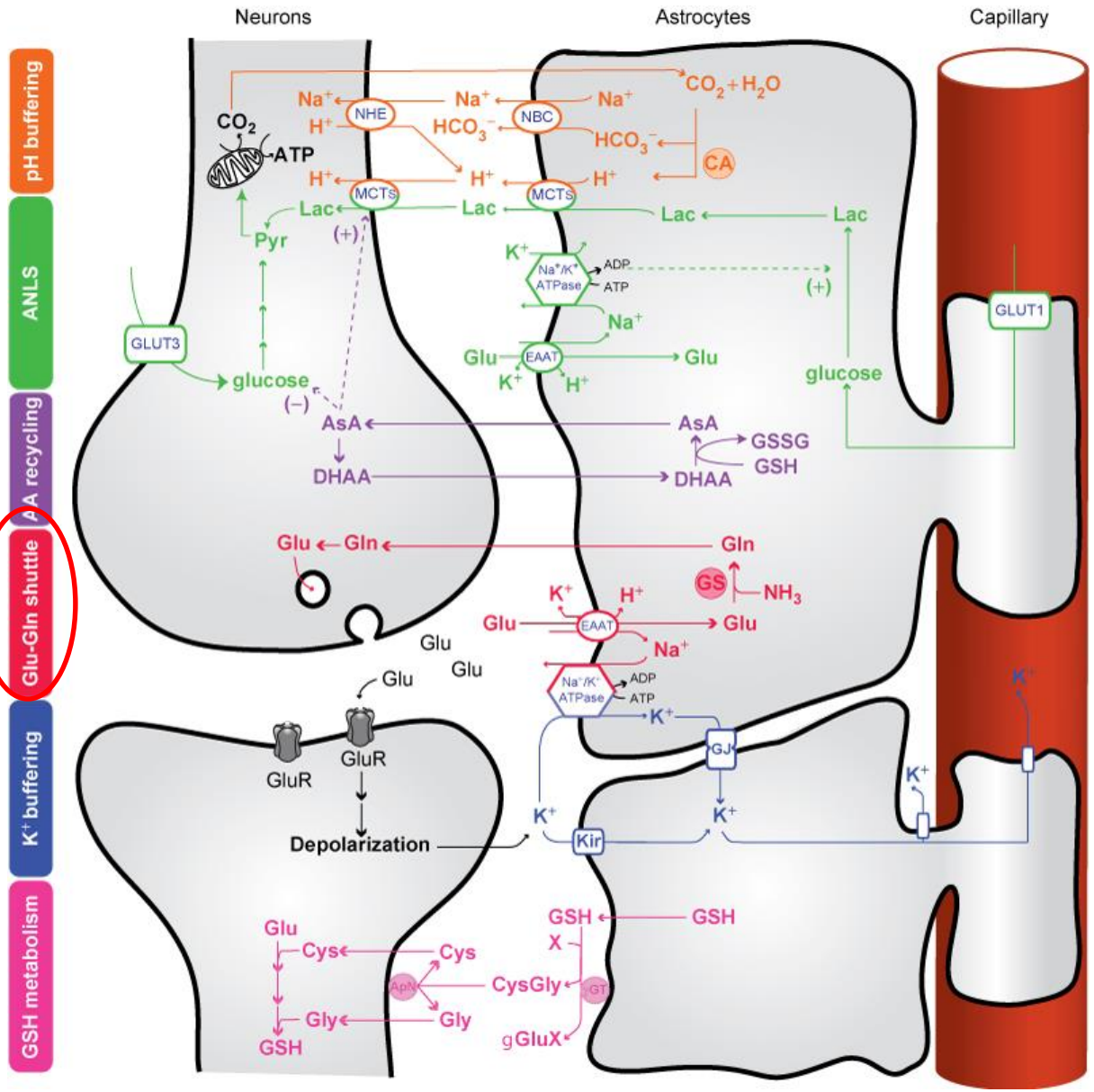
but glut is also sensed by astrocytes, which increases intracell Ca2+ levels => AA which constricts the vessels (and it can be metabolized into other things that are dilators). Astrocytes are intermediates that enhance the activation of the neurons by controlling the vessels.

Anabolic Use of Glucose

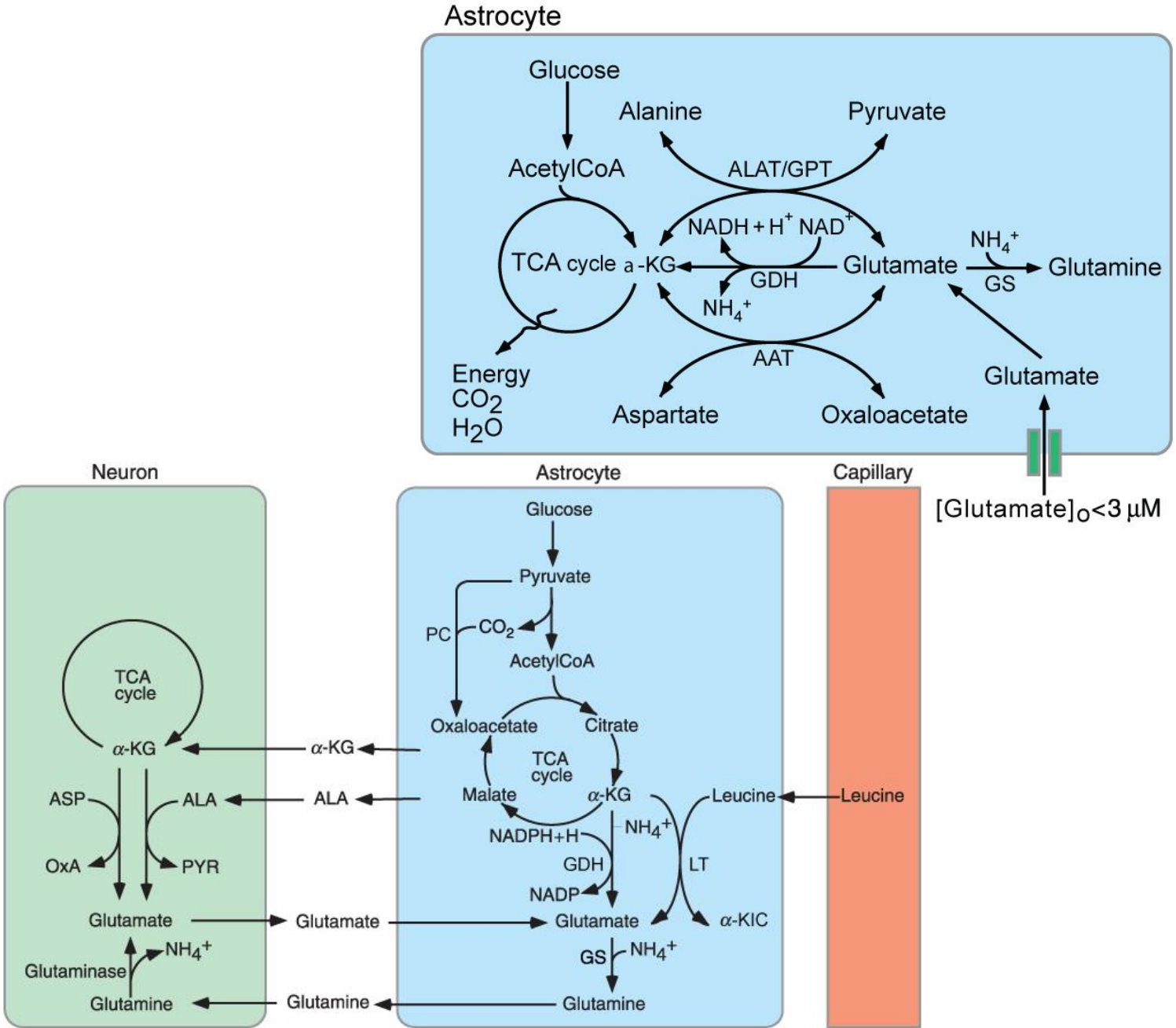


Astrocytes and Brain Homeostasis

death of postsyn neuron through hyperexcitation (too much glut) = excitotoxicity

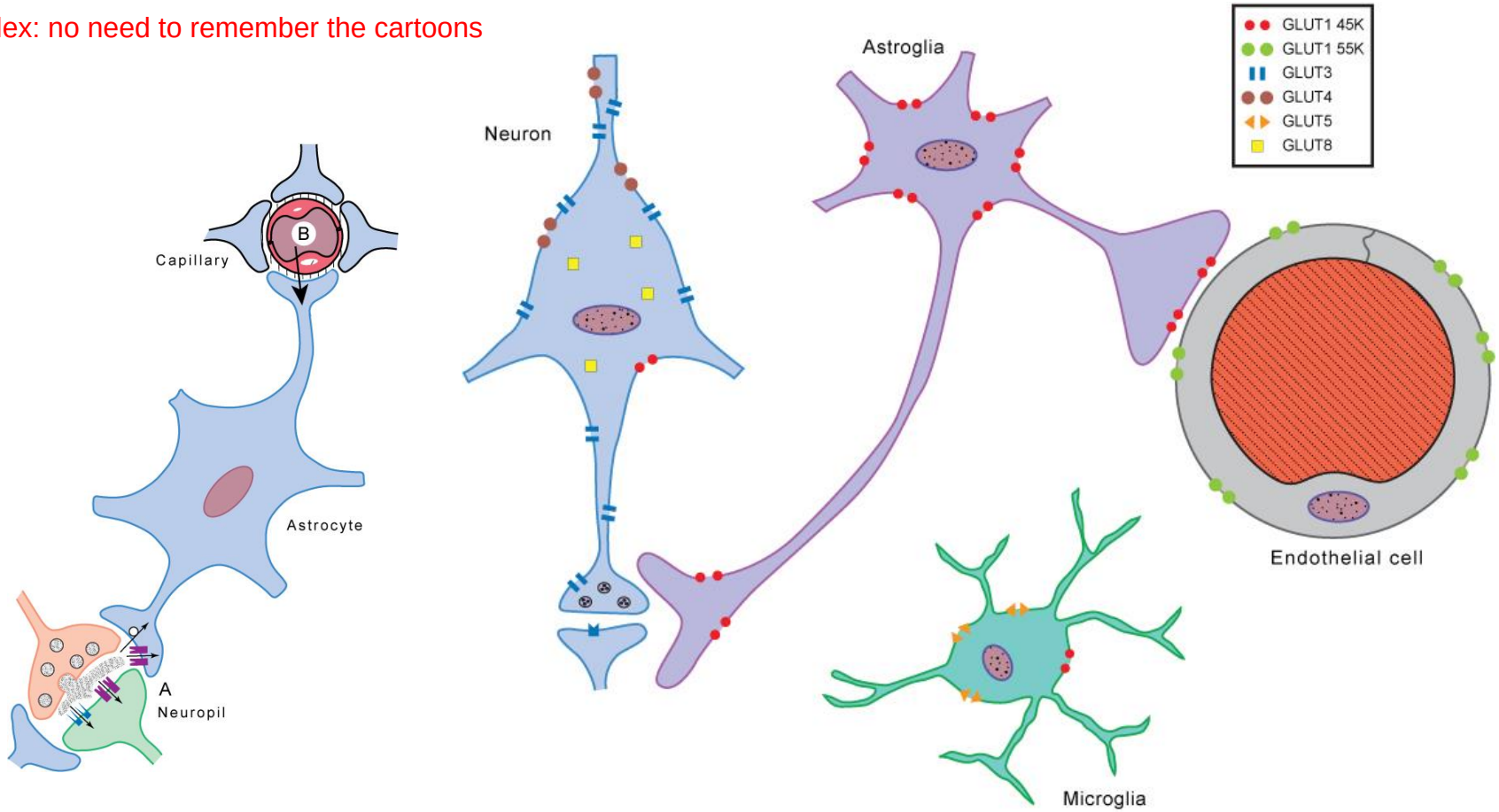


Glutamate Metabolism

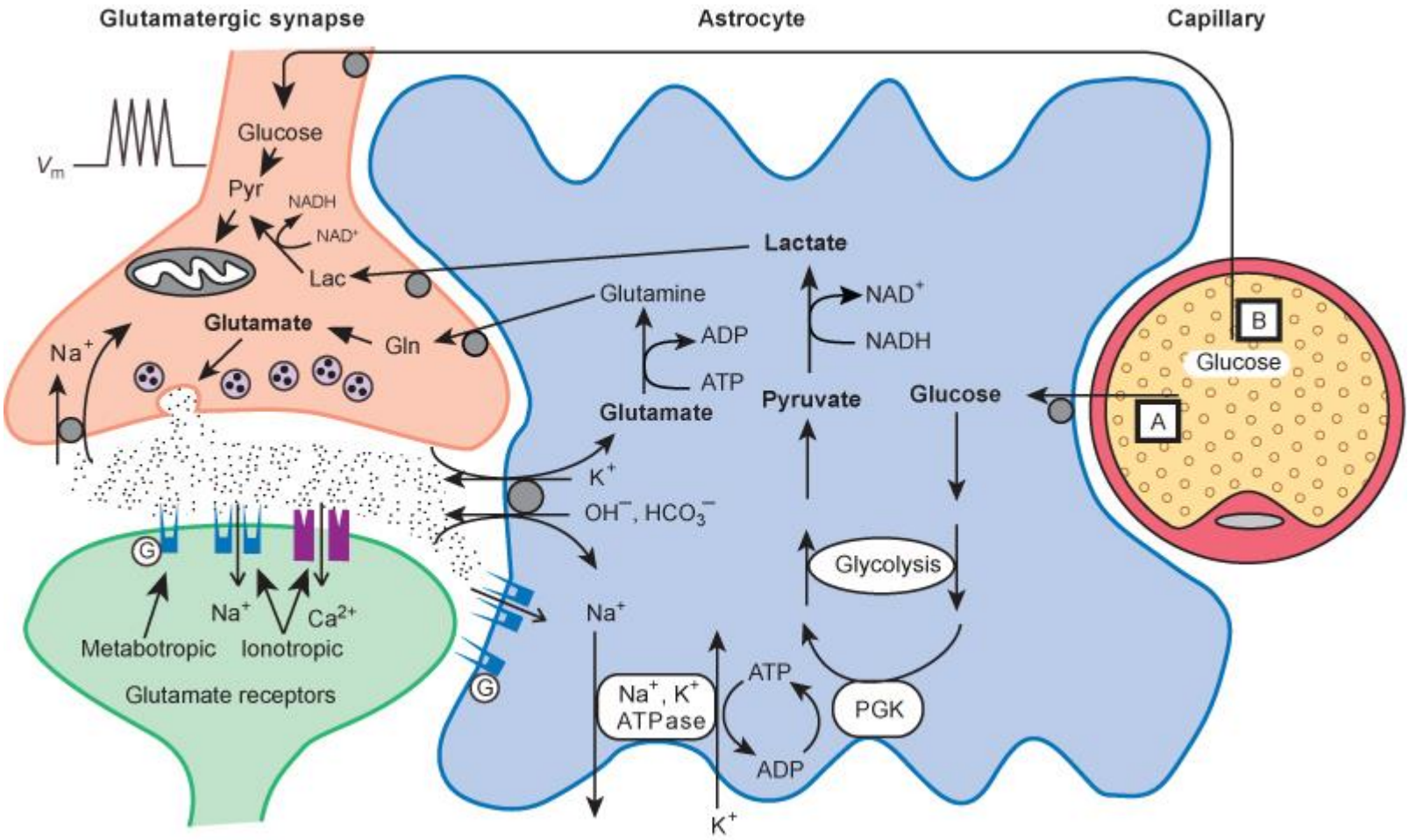


Cellular Distribution of Glucose Transporters

lex: no need to remember the cartoons

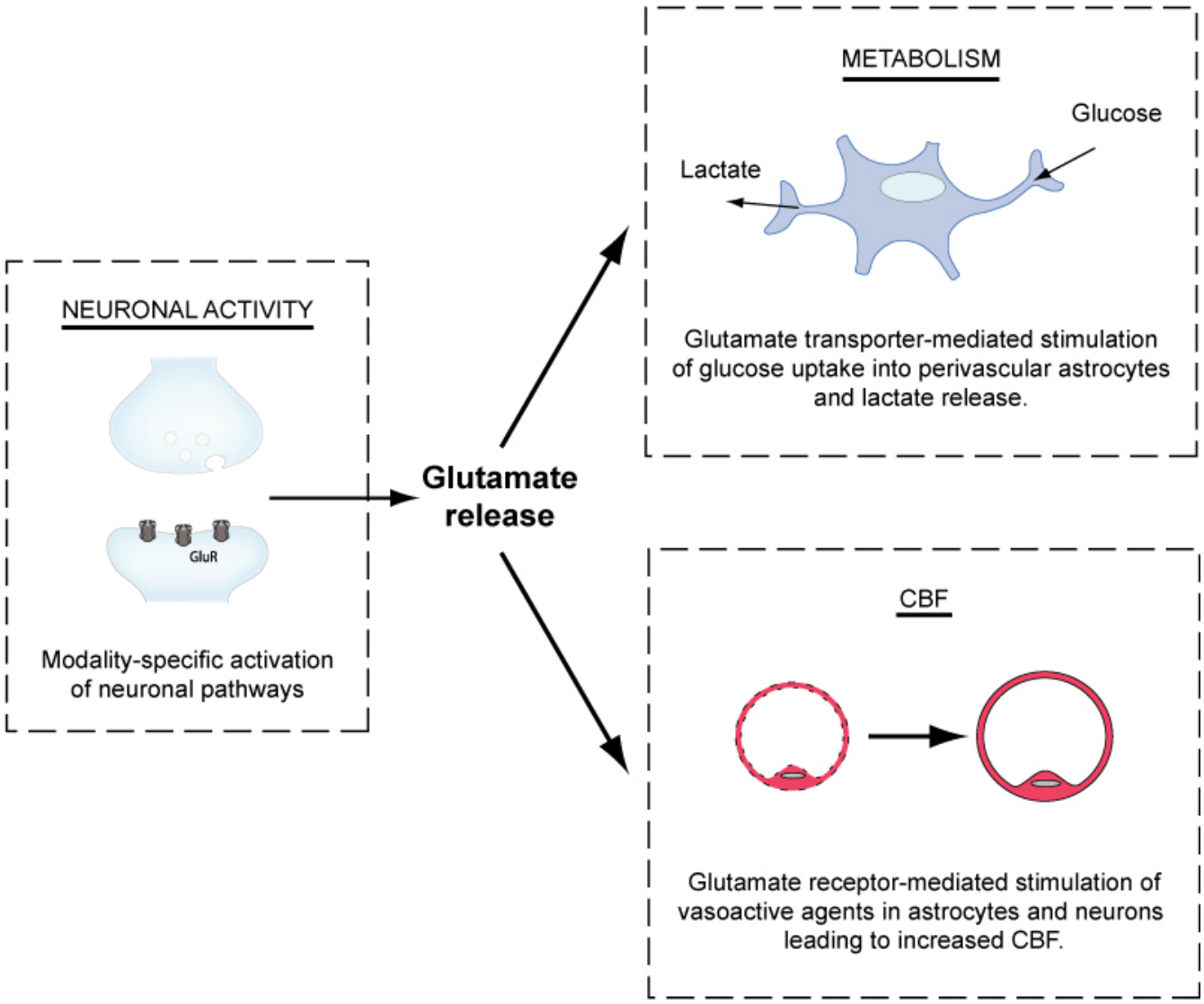


Glycolysis Regulation by Glutamate Uptake



Glycogen Storage in Astrocytes is regulated by Neuronal Activity

Take Home Message



Astrocyte – Neuron Metabolic Unit