Lecture 42: Final Review

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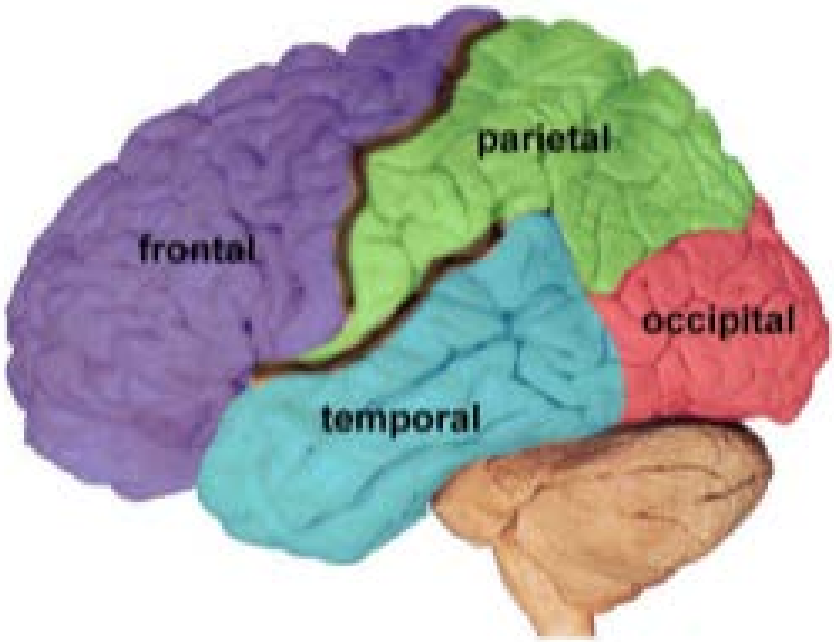
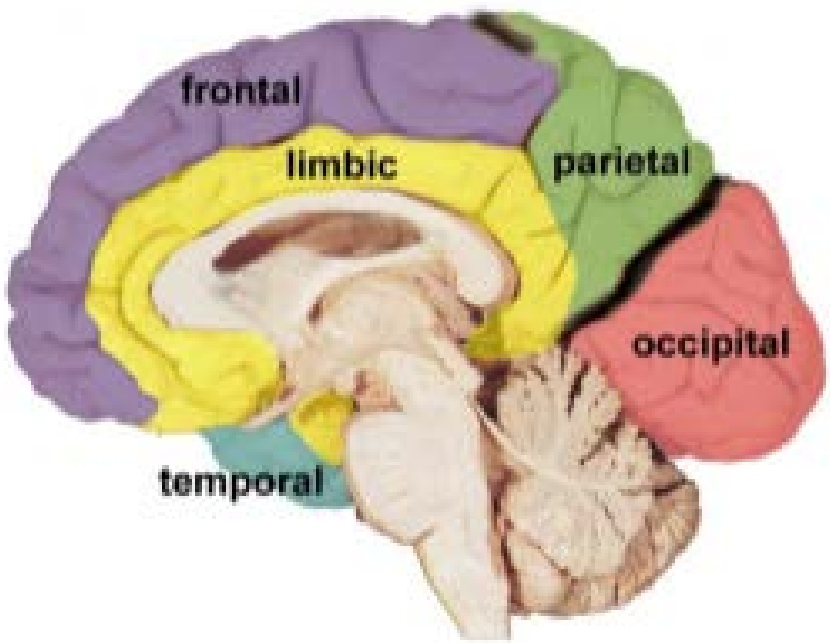
Lecture 33—cortex

Heilbronner

5 lobes of the cortex



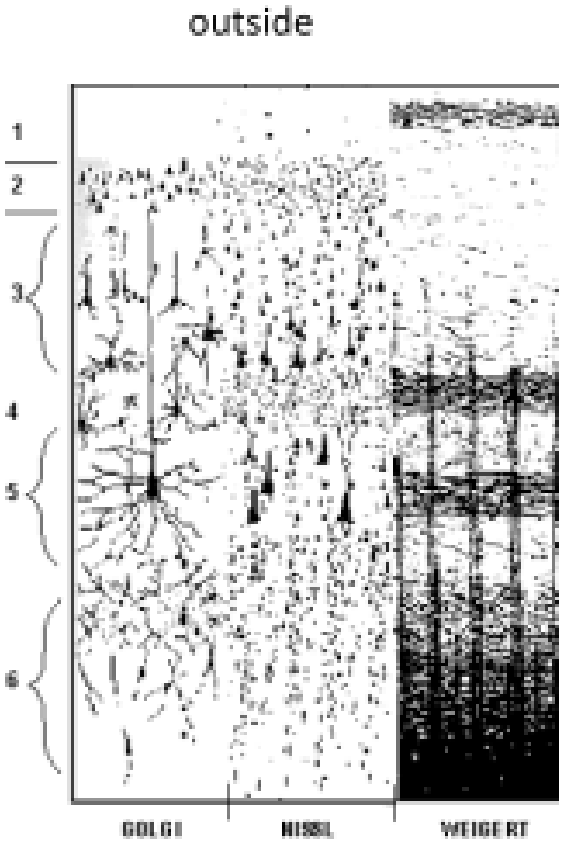
Lateral view (left side)



Mid-saggital view (right side)

Cellular organization of cortex

- Mammalian cortex has six layers.
- Layer 1 contains few cell bodies
- Layers 2/3 contain many pyramidal neurons that connect to other areas of the neocortex
- Layer 4 contains many neurons that receive sensory information from thalamus
- Layer 5 contains many large pyramidal neurons that connect to the brainstem & spinal cord
- Layer 6 contains many pyramidal neurons that project to the thalamus.



Adapted from Ranson & Clark (1959). The Anatomy of the Nervous System (10th ed). Philadelphia: Saunders.

White matter

- Corpus callosum and anterior commissure are the primary white matter bundles connecting the two hemispheres
- Uncinate fasciculus connects the frontal and temporal lobes
- Cingulum bundle and longitudinal fasciculi run rostral-caudal and connect the frontal, parietal, and occipital lobes
- Internal capsule connects cortical regions with thalamus, subthalamic nucleus, and brainstem

Lecture 34—Cortex 2

Heilbronner

Structural imaging

Detailed 3D (but static) anatomical images of the brain in a living human. Can examine the relationship between structural variance and function, including lesions.

- CT (X-ray computerized tomography)
- MRI (Magnetic resonance imaging)
- DTI (Diffusion tensor imaging)

Functional imaging

- PET
  - Radiotracer
  - Can show glucose use or receptor binding sites
  - Get a single time-point
- fMRI
  - Signal shows changes in blood flow (blood-oxygenation level dependent: BOLD)
  - Can observe changes during tasks

Cortical regions & modularity

- Association cortex: not directly connected to sensory or motor pathways

- Modularity: brain areas are specialized
  - Fusiform cortex: face recognition
  - R parietal cortex only activated by L visual field
  - Frontal cortex: character?
  - DAMAGE → DEFICITS

Lecture 35: Language & cortex

Heilbronner

Diseases of cerebral cortex

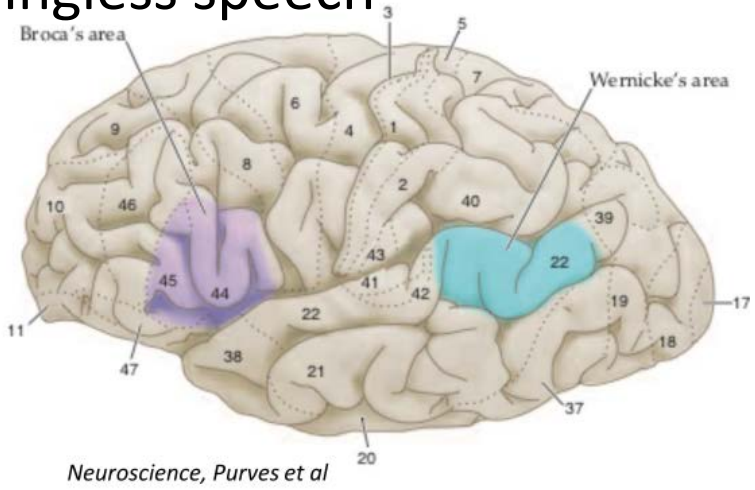
- Vascular
  - Stroke: ischemic vs. hemorrhagic
  - Arteries supplying cerebral cortex
    - Anterior, middle and posterior cerebral arteries
  - Treatment for ***ischemic*** stroke: tissue plasminogen activator (TPA)
    - ~3 hr time window
    - Contraindicated for hemorrhagic stroke

Cerebral cortex is involved in all mental illnesses

- OCD: increased activity in anterior cingulate gyrus
- Depression: reduced activity in dorsolateral prefrontal cortex

Cortex & language

- Language is generally localized to Broca's and Wernicke's areas in the left hemisphere
  - Loss of Broca's area: "Broca's aphasia"
    - Able to produce words but not fluently
    - Comprehension not affected
  - Loss of Wernicke's area: "Wernicke's aphasia"
    - Able to produce fluent but meaningless speech
    - Comprehension poor



Neuroscience, Purves et al

Lecture 36: Walking

- Rhythmic motor patterns created by central pattern generators
- These patterns can be chosen or modified by ascending & descending input

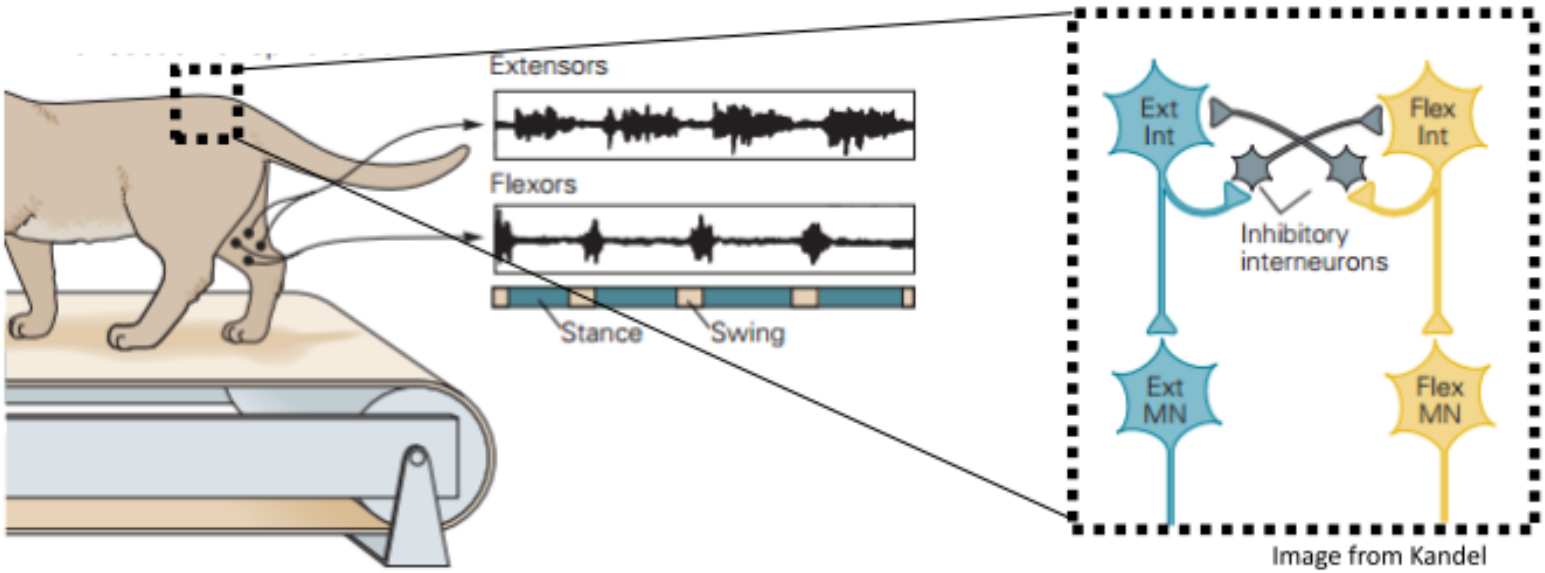


Image from Kandel

MN = Motor Neuron
Ext = Extensor muscle
Flex = Flexor muscle
Int = Internueron

Initiating walking: mesencephalic locomotor area

- Stimulation can initiate walking (via glutamate)
- Higher intensity → faster
- Cerebellum:
  - Ventral spinocerebellar tract: info from CPGs
  - Dorsal SCT: info from proprioceptors

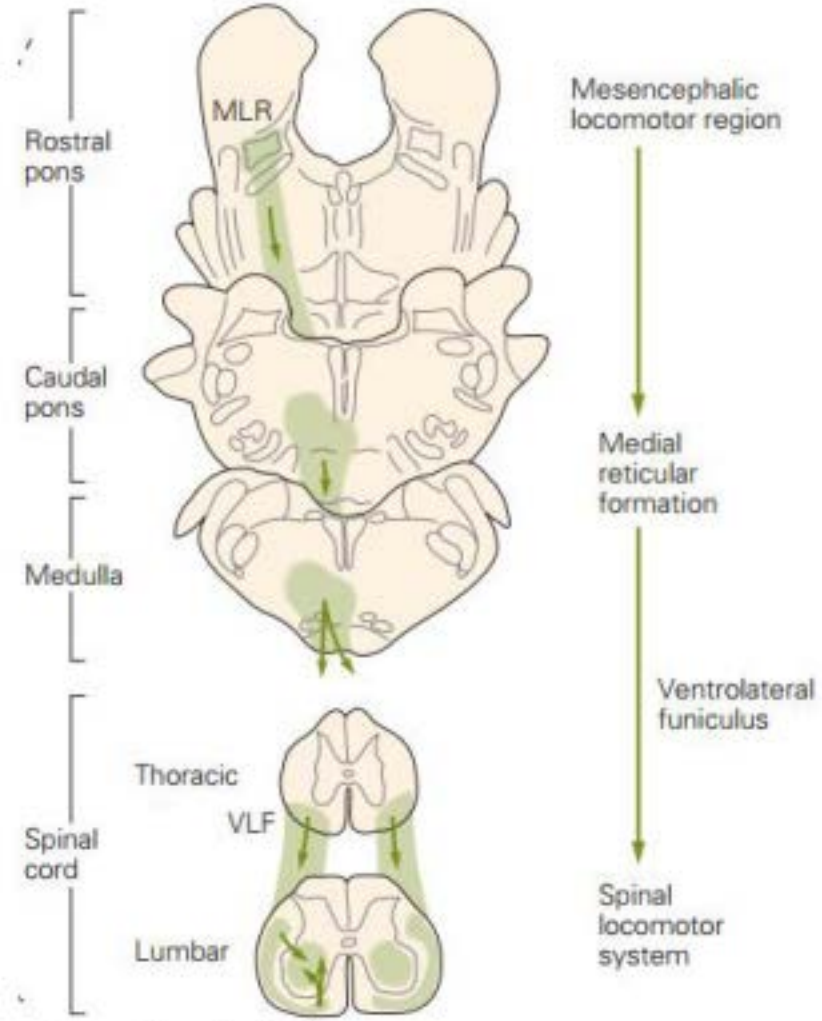
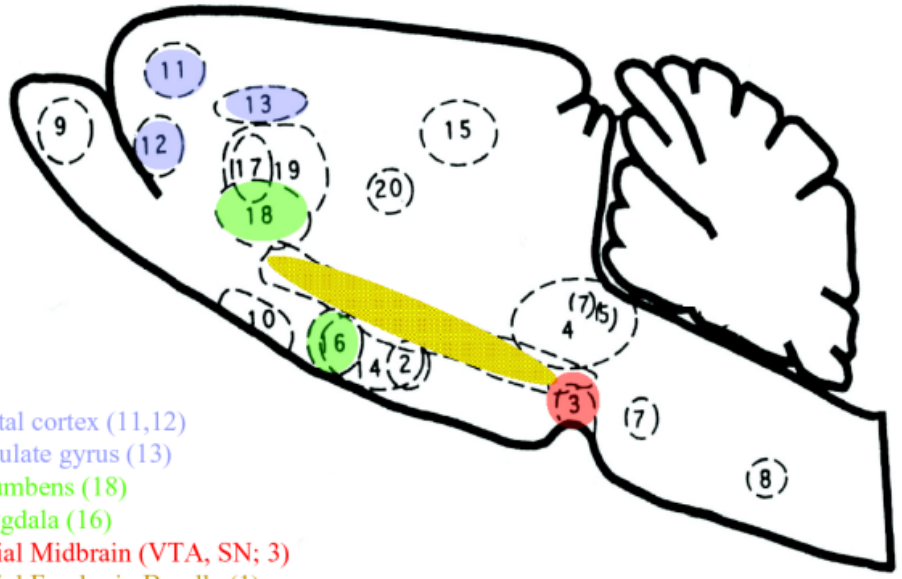


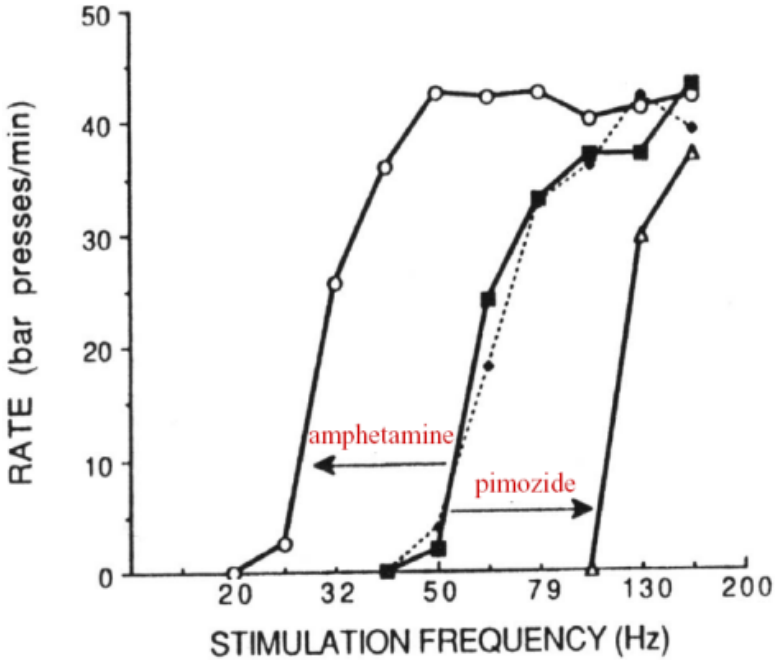
Image from Kandel

Lecture 37: Addiction

- Brain-stimulation reward enhanced by dopamine

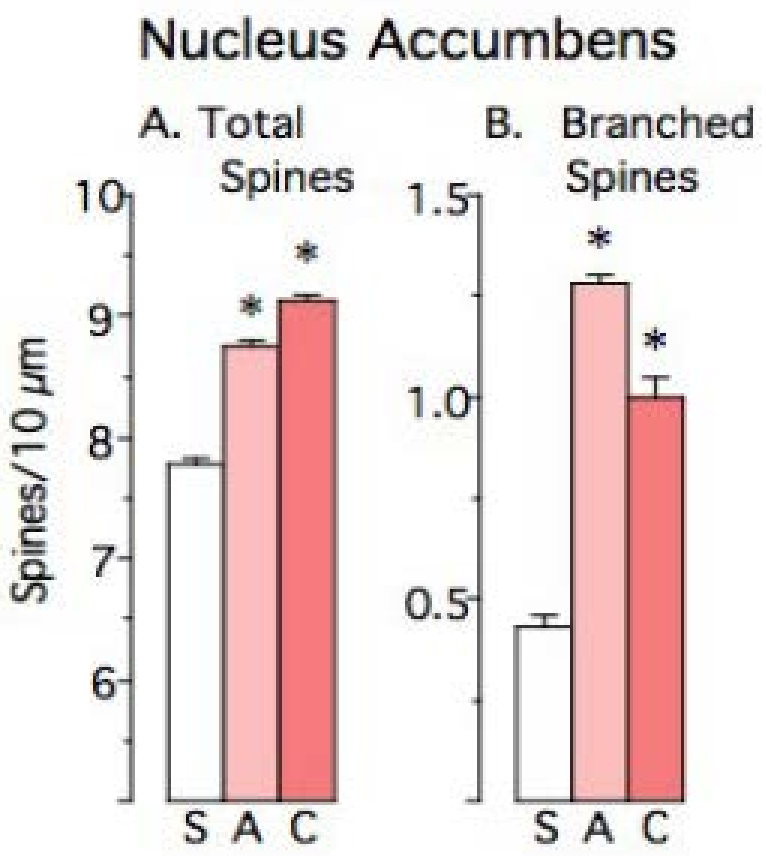


Frontal cortex (11,12)
Cingulate gyrus (13)
Accumbens (18)
Amygdala (16)
Medial Midbrain (VTA, SN; 3)
Medial Forebrain Bundle (1)



Brain changes with addiction

- Increased gene expression (cFOS, etc)
- Increased spines on medium spiny neurons in n. accumbens



Types of neurodegenerative diseases (Lecture 38)

- Cognitive (→ cerebral cortex)
  - Alzheimer's, frontotemporal dementia, Pick's disease
- Motor
  - Affecting motoneurons: ALS, spinal muscular atrophy
  - Affecting cerebellum: Friedreich ataxia, ataxia-telangiectasia
  - Affecting basal ganglia → rigidity: Parkinson's disease, Progressive supranuclear palsy
  - Affecting basal ganglia → hyperkinesis: Huntingdon's disease
- Sensory
  - Affecting vision: retinitis pigmentosa

- Mostly sporadic, increase with age, involve protein inclusions

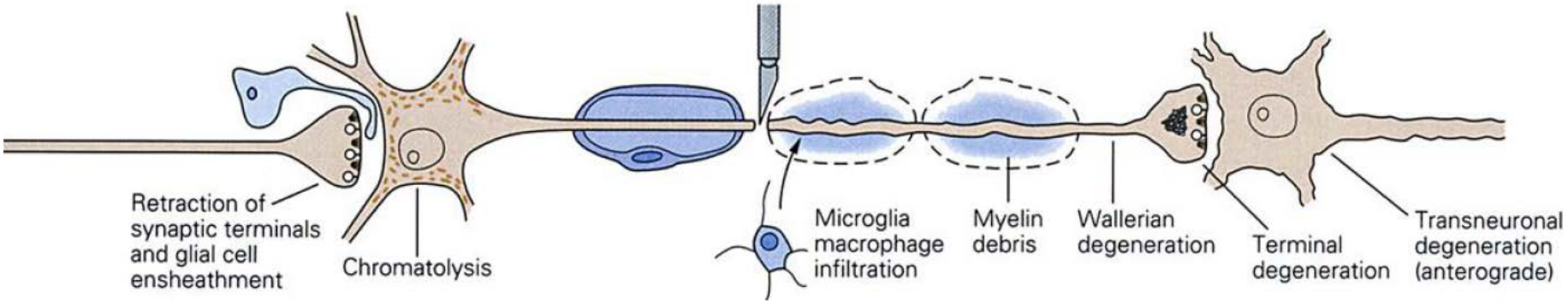
Neurodegenerative diseases

- AD: memory loss that interferes with everyday life. Amyloidβ plaques & tau tangles seen
- FTD: atrophy of frontal & temporal lobes usually prior to age 65. Extreme behavioral/ personality (language) changes. 25% familial.
- Parkinson's: Loss of substantia nigra; presence of Lewy bodies; tremor/rigidity/bradykinesia/ instability. Treatment: DOPA/DA agonists; DBS
- ALS: 10% familial (early-onset). Loss of both upper and lower motoneurons. Muscle atrophy, difficulty speaking, swallowing, & breathing.

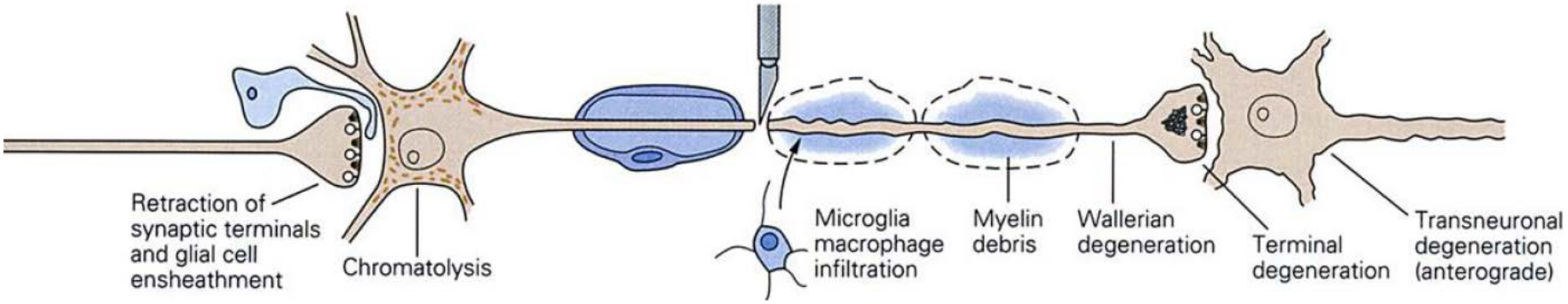
Neurodegenerative diseases caused by nucleotide repeats

- Genetic: due to repeated nucleotide sequences (often encoding glutamine)
- Increase # repeats → sooner onset
- Huntingdon's disease: loss of medium spiny neurons in striatum, progressing to cortex, thalamus, cerebellum
- ≤35 repeats: normal; 40 repeats → H. disease

Degeneration/ regeneration (lecture 39)



Degeneration/ regeneration



Neurogenesis (Lecture 40)

- Subventricular zone (SVZ) → olfactory bulb
  - No net growth: many cells die
  - Needed for odor discrimination
- Subgranular zone (SGZ) →
  - 700 cells/day produced; most die
  - ~2% of granule cells replaced/year.
  - 4-8 weeks to mature and be incorporated
  - Needed for memory
  - Fluoxetine (Prozac) increases cell division → antidepressant effect

Neural stem cells

- NSCs → neurons, astrocytes and oligodendrocytes.
  - Astrocytes & glia produced constantly @ low levels
- NSCs found in other areas but only generate neurons in SVZ & SGZ
- SVZ neurons can migrate into stroke infarct
- Olfactory receptor neurons reproduce and replace dying receptor neurons

Neurogenesis/gliogenesis

- Oligodendrocyte generation needed for learning motor task, but not for recall

Stem cells

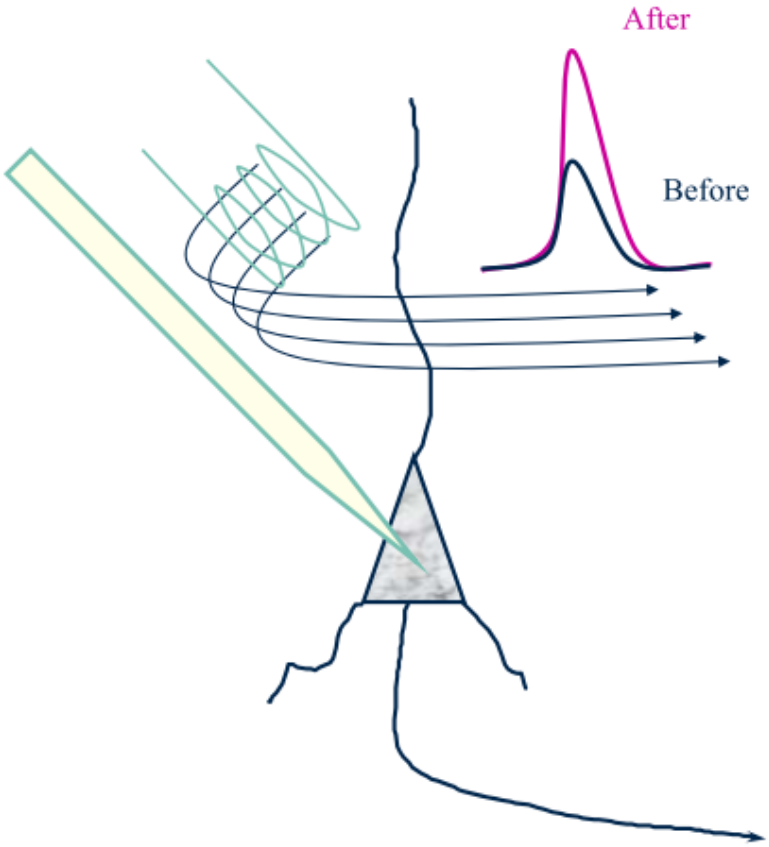
- Embryonic stem cells, fetal stem cells, inducible pluripotent stem cells
- Fetal SCs work best but require much tissue
- Embryonic stem cells may → teratomas

Lecture 41: memory & decision-making

***Long-term potentiation* = LTP**

- Found throughout the brain
  - hippocampus
  - cortex
  - nucleus accumbens
  - VTA
  - striatum
- Typically found by injecting bursts of current along pathways which depolarizes post-synaptic neurons

CELLULAR MEMORY



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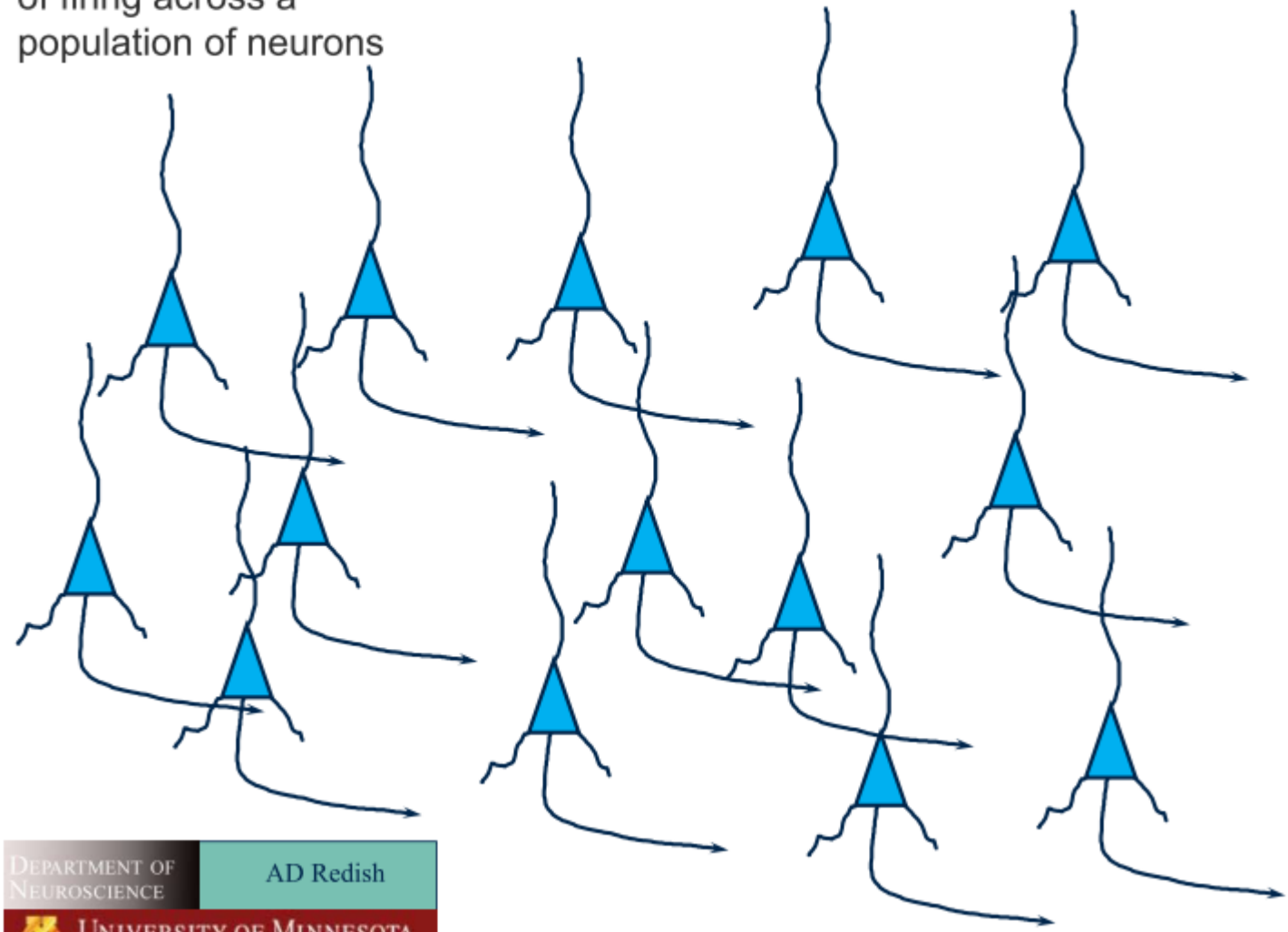
A memory is a pattern of firing across a population of neurons

CONTENT-ADDRESSABLE MEMORY



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Multiple decision-making systems

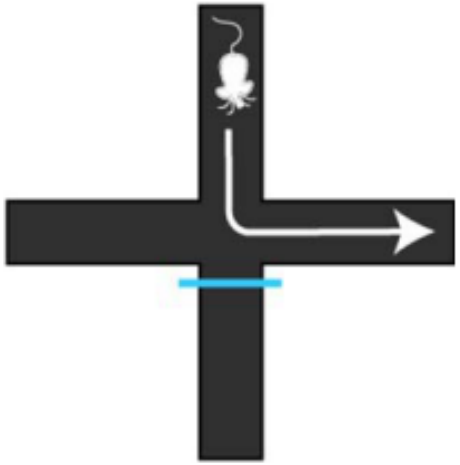
Designing probe trials right reveals decision processes.

Training
4x/day, 7 days

Probe trials

Place-strategy
(return to same location by taking a different action)

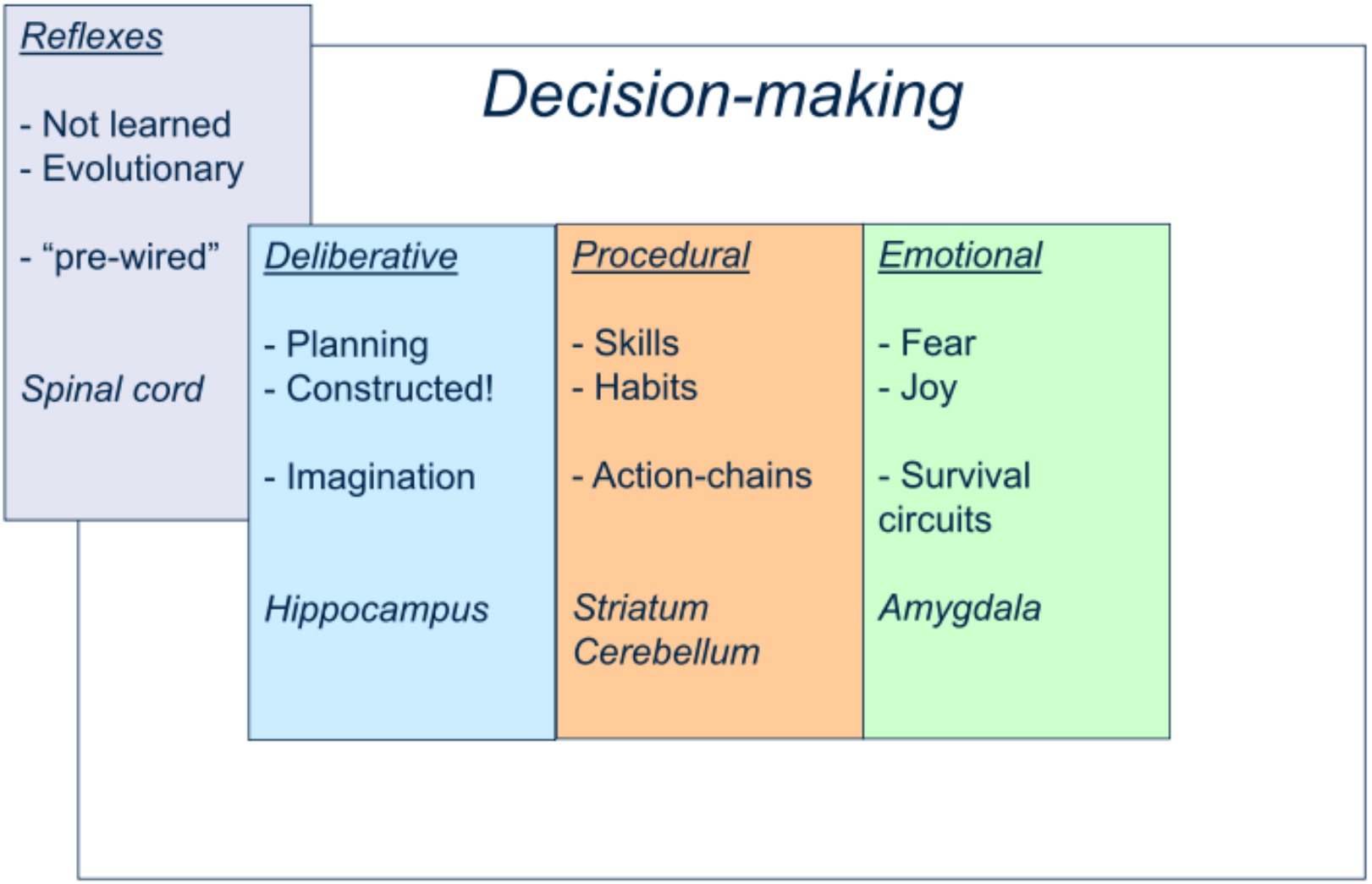
Dependent on hippocampal function



Response-strategy
(turn in same direction but reach a different goal)

Dependent on dorsolateral striatal function

Kinds of decisions



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