

Exercise & Learning

aerobic activity may prepare your brain for learning

Katie L. Howe: Health Educator

Mark Fink: Assistant Fitness Director

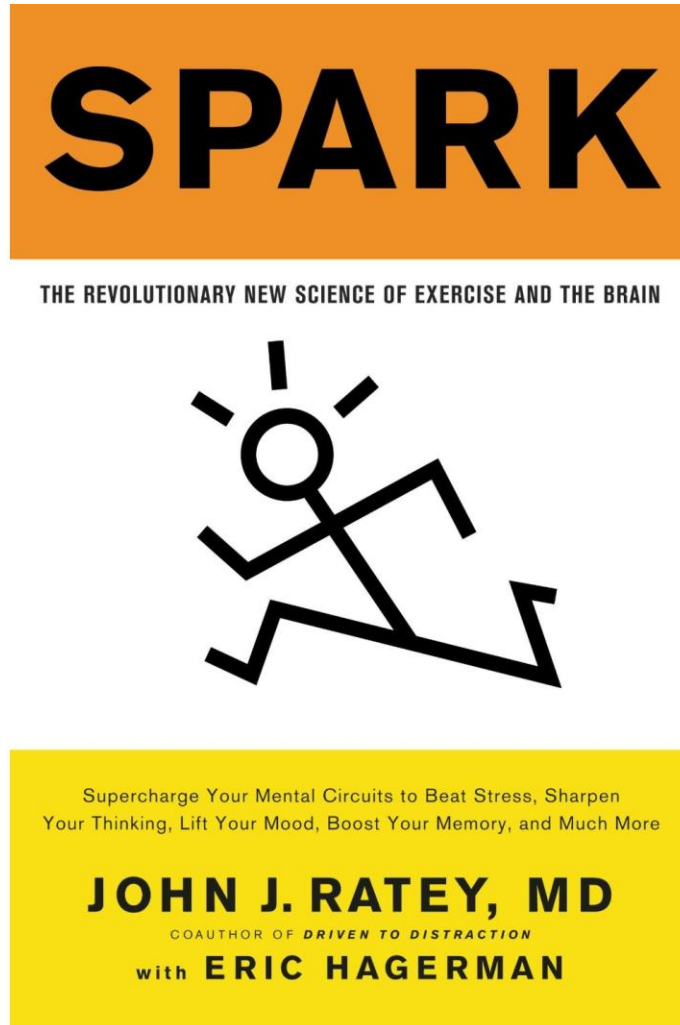
Thursday, February 20, 2014

Campus Life Center Quiet Room

12:00-12:30 p.m.

Suggested Reading

- ▶ Spark: The Revolutionary New Science of Exercise and the Brain
- ▶ John J. Ratey, MD



Basic Brain Cell Anatomy

▶ Neurons

- ▶ Dendrites
- ▶ Cell Body
- ▶ Axon
- ▶ Synapses

Information flow through neurons

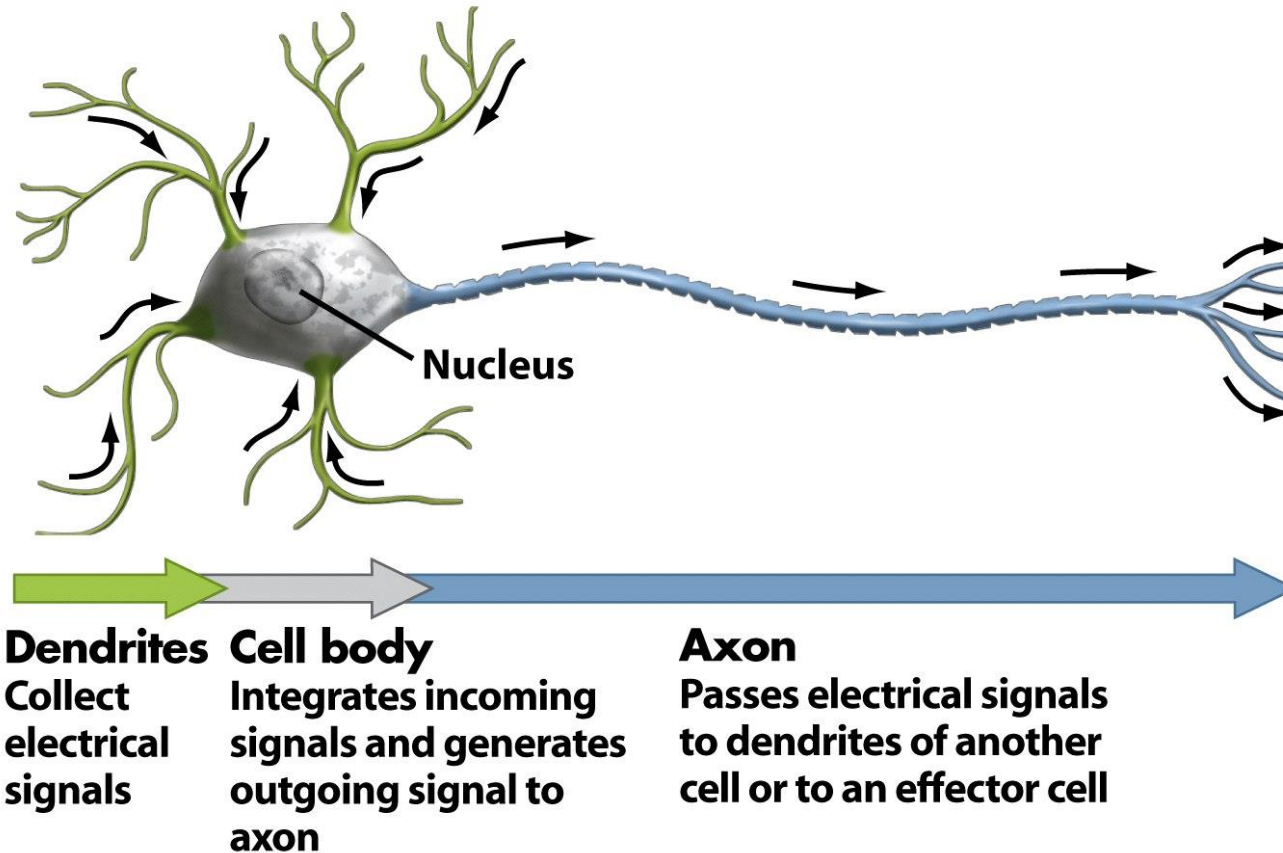


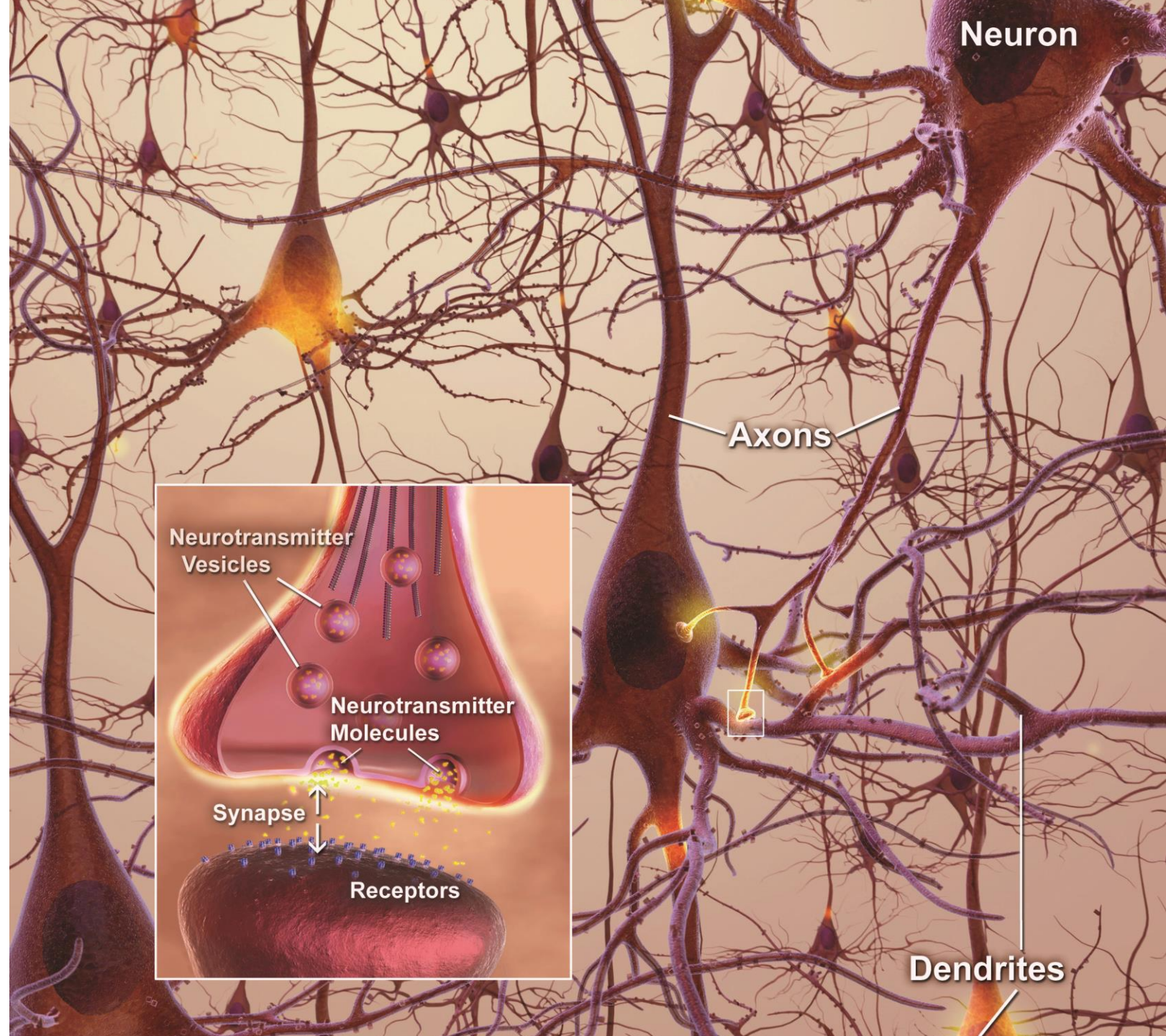
Figure 45-2b Biological Science, 2/e
© 2005 Pearson Prentice Hall, Inc.

Synapse

- ▶ Neurotransmitters
 - ▶ Excitatory
 - ▶ Inhibitory

Old Beliefs

- ▶ New connections/neurons made during development but in adulthood neurons become permanent and never regenerate
- ▶ Brain and body function independently



New Knowledge

- ▶ 1950's - Environmental Enrichment
 - ▶ Sensory and Social stimuli alter the function and structure of the brain
- ▶ Synaptic Plasticity: the experience-dependent change in connectivity between neurons that is believed to underlie learning and memory
 - ▶ Brain constantly rewiring
- ▶ Long Term Potentiation (LTP): activity induced sustained increase in synaptic strength; more often activated, the longer it stays and the easier it is to activate.
 - ▶ Use it or lose it
- ▶ 1998 - Proof that neurogenesis exists in the adult brain
 - ▶ Neurogenesis: Growth and development of nervous tissue
- ▶ Physical activity stimulates neurogenesis

Memory Storage

- ▶ The specific way memories are stored long term is not perfectly understood.
- ▶ The Stage Model of Memory
 - ▶ Sensory Memory: 0.5-4 sec
 - ▶ Short-Term Memory: 20-30 sec
 - ▶ Long-Term Memory: potential indefinite
- ▶ Areas of the brain (*simplified version*)
 - ▶ Hippocampus: Moves information from short-term memory to long-term memory.
 - ▶ Amygdala: Attaches emotional significance to the information the hippocampus transfers into long-term memory
 - ▶ Prefrontal Cortex: Tells the hippocampus which memories to store in long-term memory.

Physiology of Learning

- ▶ New memories = New neural connections
- ▶ Neurotransmitters
 - ▶ Serotonin: helps regulate mood, sleep, appetite, learning and memory.
 - ▶ Policeman of brain, keeps activity under control, regulates mood, impulsivity, anger, & aggressiveness
 - ▶ Norepinephrine: amplifies signals that influence attention, perception, motivation, & arousal
 - ▶ Dopamine: learning/reward, attention and movement
- ▶ “Brain Derived Neurotropic Factor (BDNF)”
 - ▶ “Nourishes neuron like fertilizer” → “Miracle-Gro for the brain.”
 - ▶ Kickstarts neurogenesis
 - ▶ New dendrites on current neurons
 - ▶ Builds LTP

BDNF Studies

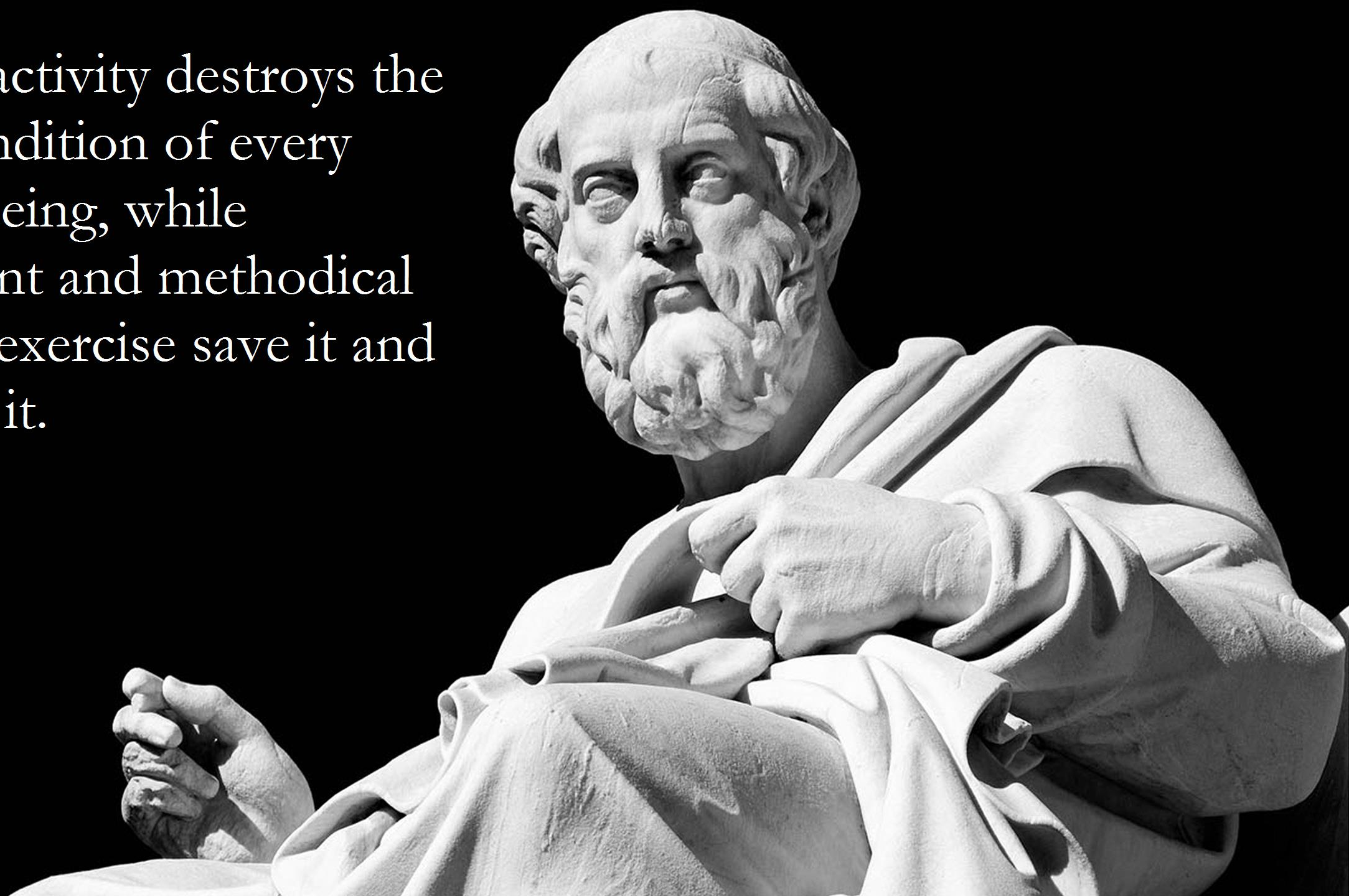
- ▶ BDNF increased in the hippocampus of rats following:
 - ▶ Morris water maze (Kesslak et al., 1998)
 - ▶ Radial arm maze (Mizuno et al., 2000)
 - ▶ Passive avoidance (Ma et al., 1998)
 - ▶ Contextual fear conditioning (Hall et al., 2000)
- ▶ BDNF in humans
 - ▶ People with gene variation that robs them of BDNF more likely to have learning deficiencies
 - ▶ Reduced BDNF levels have been detected in the brains of Alzheimer's disease (AD) patients
 - ▶ BDNF levels fluctuates according to AD severity

Exercise & BDNF

- ▶ Aerobic exercise increases BDNF → Kickstarts neurogenesis in the areas of the brain associated with learning
 - ▶ **Interesting Theory:** Learn → Find food → Energy required to learn where to find more food
- ▶ Stimulates other “Factors” (IGF1, VEGF, FGF2) through the blood-brain barrier
 - ▶ Increases BDNF receptors, builds capillaries to feed neurons, increases stem cell division
- ▶ Neurons and connections developed during exercise are better equipped to spark LTP
- ▶ Regulates neurotransmitters
 - ▶ “Going for a run is like taking a little bit of Prozac and a little bit of Ritalin because, like the drugs, exercise elevates these neurotransmitters. Exercise balances neurotransmitters – along with the rest of the neurochemicals in the brain.”

Lack of activity destroys the good condition of every human being, while movement and methodical physical exercise save it and preserve it.

– Plato



Exercise & Learning

▶ Animal studies

- ▶ Increasing aerobic activity increases the number of cells that develop. Same % die but brains starts with a larger pool. Environmental enrichment helps neurons survive.
- ▶ Morris water maze: exercisers (wheel) were quicker to remember the location of the platform
- ▶ Dissected exercisers' brains were heavier than non-exercisers

▶ Humans Studies

- ▶ 2007 German study learn vocabulary words 20% faster following exercise than before exercise.
 - ▶ Rate of learning correlated directly with levels with BDNF
- ▶ 2013 German Study: studying during light-moderate exercise better than studying following exercise
- ▶ ACSM Conference: reading while exercising vigorously

Exercise & Learning

- ▶ What we know for sure:
 - ▶ Acute physical activity has been repeatedly shown to improve various cognitive functions.
 - ▶ Can't learn difficult material while exercising at high intensity because blood is shunted away from the Prefrontal Cortex. This hampers executive function.
 - ▶ This effect lingers after high-intensity exercise
- ▶ What studies imply:
 - ▶ Timing (studying & recall) and intensity of exercise play roles in learning.
 - ▶ Studying after or during light-moderate physical activity seems best
 - ▶ Light-moderate intensity is:
 - ▶ 60-65% Estimated Max Heart Rate
 - ▶ 12 – “light-moderate” on a 20 point BORG scale

RPE	Description	Intensity Level
7	Easy	
8		
9	Very Light	
10		50% MHR
11	Fairly Light	
12		60% MHR
13	Somewhat Hard	
14		70% MHR
15		
16	Hard	80% MHR
17		
18	Very Hard	90% MHR
19	Very, Very Hard	
20		

Light-Moderate Activity

- ▶ Finding estimated Max Heart Rate (MHR)
 - ▶ $220 - (\text{Age}) = \text{MHR}$
- ▶ Finding your Light-Moderate (60-65%) heart rate zone
 - ▶ 30 year old: $220 - 30 = 190$
 - ▶ $190 \times 0.6 = 114$ beats per min
 - ▶ $190 \times 0.65 = 124$ beats per min
- ▶ Rate of Perceived Exertion (RPE)
 - ▶ Aerobic activities maintained at a 12 on BORG RPE scale
 - ▶ Verify with a 15 sec pulse check
 - ▶ $114 \div 4 = 28$ beats in 15 seconds
 - ▶ $124 \div 4 = 31$ beats in 15 seconds

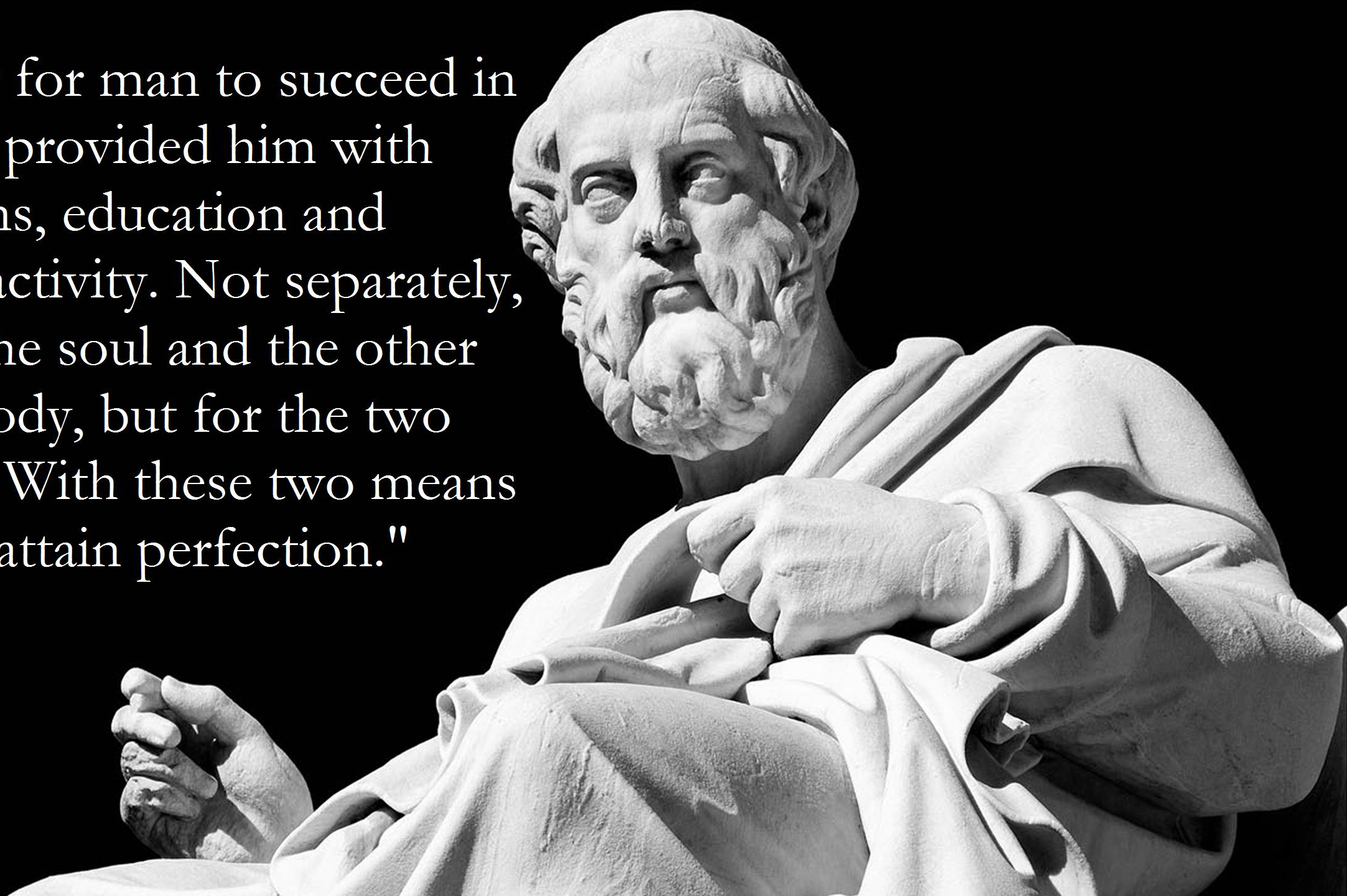
RPE	Description	Intensity Level
7	Easy	
8		
9	Very Light	
10		50% MHR
11	Fairly Light	
12		60% MHR
13	Somewhat Hard	
14		70% MHR
15		
16	Hard	80% MHR
17		
18	Very Hard	90% MHR
19	Very, Very Hard	
20		

Suggested Activities

- ▶ Anything that requires constant movement at light-moderate exertion
- ▶ Anything you enjoy!!
 - ▶ Brisk walking
 - ▶ Jogging
 - ▶ Hiking
 - ▶ Rock Climbing
 - ▶ Jumping Rope
 - ▶ Kayaking
 - ▶ Kickboxing
 - ▶ Biking
 - ▶ Team Sports
 - ▶ Zumba
 - ▶ Hula-Hooping
 - ▶ Geocaching
 - ▶ Dancing
 - ▶ Climbing Stairs
 - ▶ Elliptical
 - ▶ Indoor Cycling

"In order for man to succeed in life, God provided him with two means, education and physical activity. Not separately, one for the soul and the other for the body, but for the two together. With these two means man can attain perfection."

- Plato



Questions?



Brought to you by:



healtheducation



campusrecreation