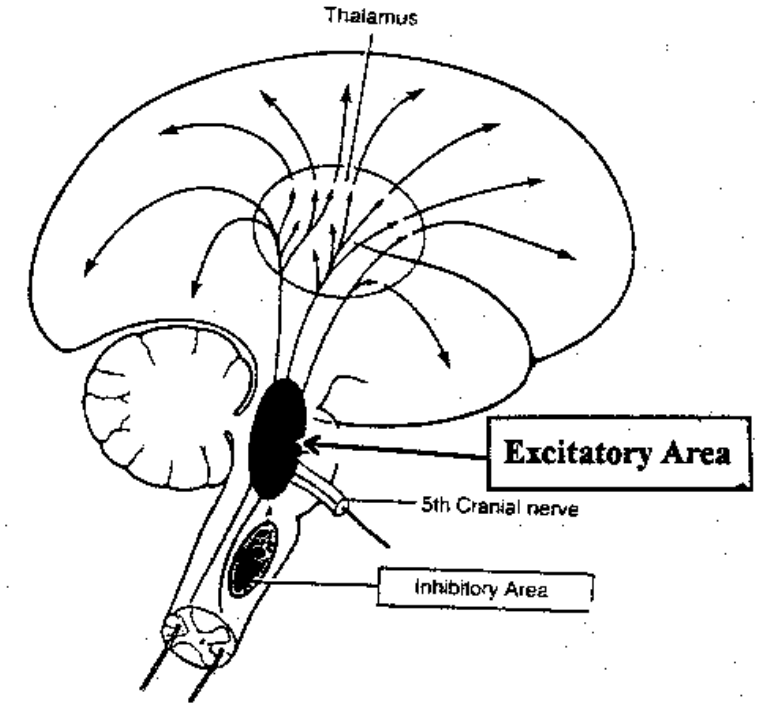
LECTURE 7 Higher Cortical Function 3240 2004

Tortora and Grabowski 517-520, 471-476

THE RETICULAR ACTIVATION SYSTEM

Activity of the cerebral cortex is dependent upon both specific sensory input and nonspecific activating impulses from the brain stem. The source of these activating impulses is the reticular formation of the brainstem and basal forebrain. The reticular formation is a nondestinct nucleus in the brainstem core, known as the tegmentum and in the forebrain consists of the septum and diagonal band.

The reticular formation not only contributes to the activation of the cortex and thalmus, but is important for maintaining muscle tone of "antigravity muscles" as we described in the motor lectures.



These systems are cholinergic (that means they use acetylcholine as their neurotransmitter).

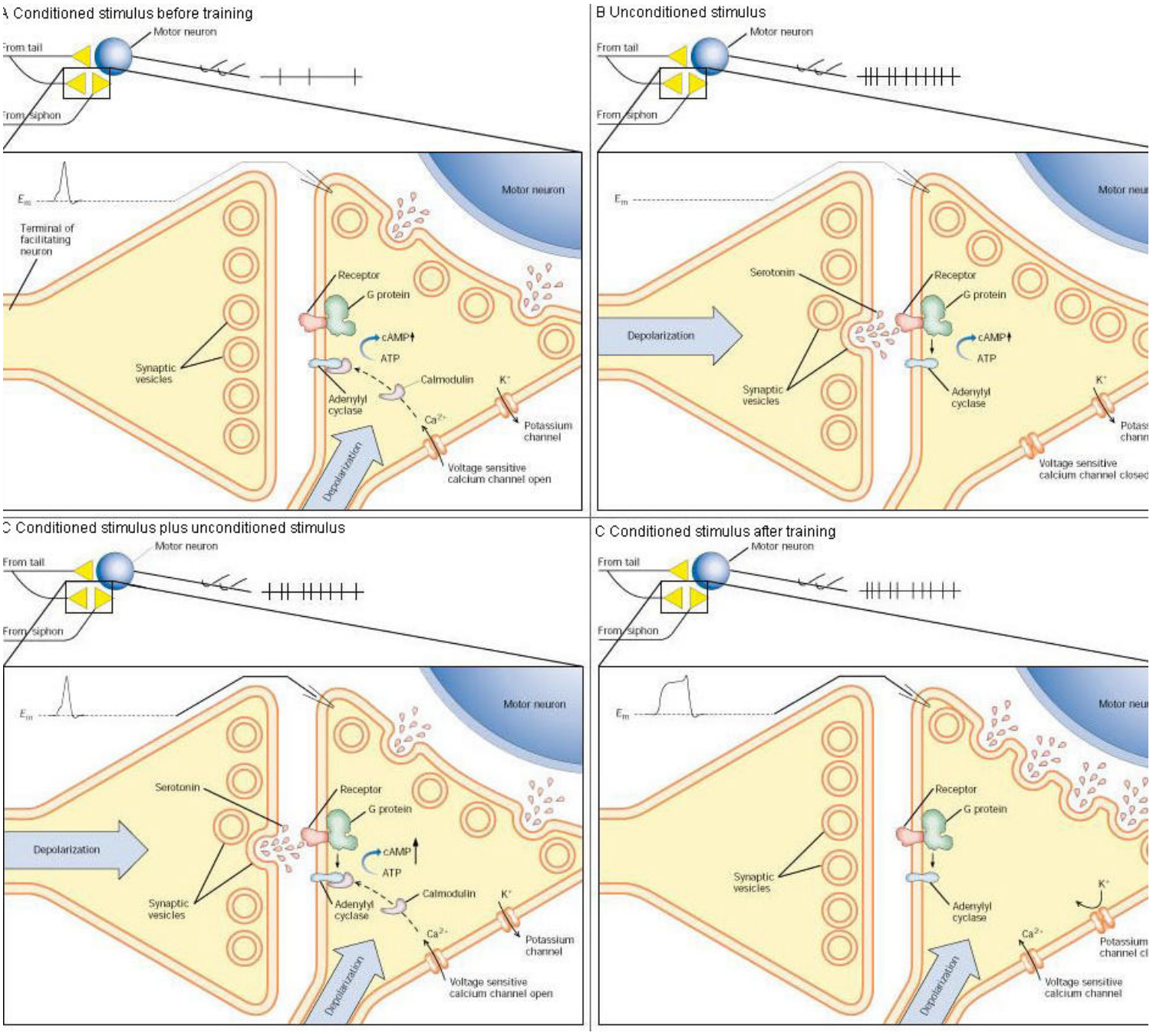
The cholinergic innervation of the cortex maintains cortical activity (like an on and off switch). In part, imparement of this system leads to the dementia of Alzheimer's disease and the iatrogenic dementia (An iatrogenic complication is an unfavorable response to medical treatment.) of some drug combinations in the elderly.

The innervation of the cortex and the hippocampus comes from forebrain parts of the cholinergic reticular activating system – the septum and basal forebrain. Damage to - or drug inhibition of - these systems leads to dementia (the cortex is not tuned on, reduced to birdbrain activities).

The innervation of the the thalamus comes from brainstem parts of the cholinergic reticular activating system. Damage to these systems leads to coma (the forebrain is not turned on, even birdbrain activities not accessible). The figure above is relevant for this section – note that a midbrain compression will inactivate the excitatory area and impare consciousness, resulting in coma.

Review the function of the synapse, neurotranmitter release is a fairly even most of the time - the amount of neurotransmitter released is roughly the same each time. The strength of the synaptic current can be changed by varying degree of excitatory vs inhibitory neurotransmitter release - or by temporal and spatial summation. Another important way that synpatic strength can be varied is by **potentiation.**

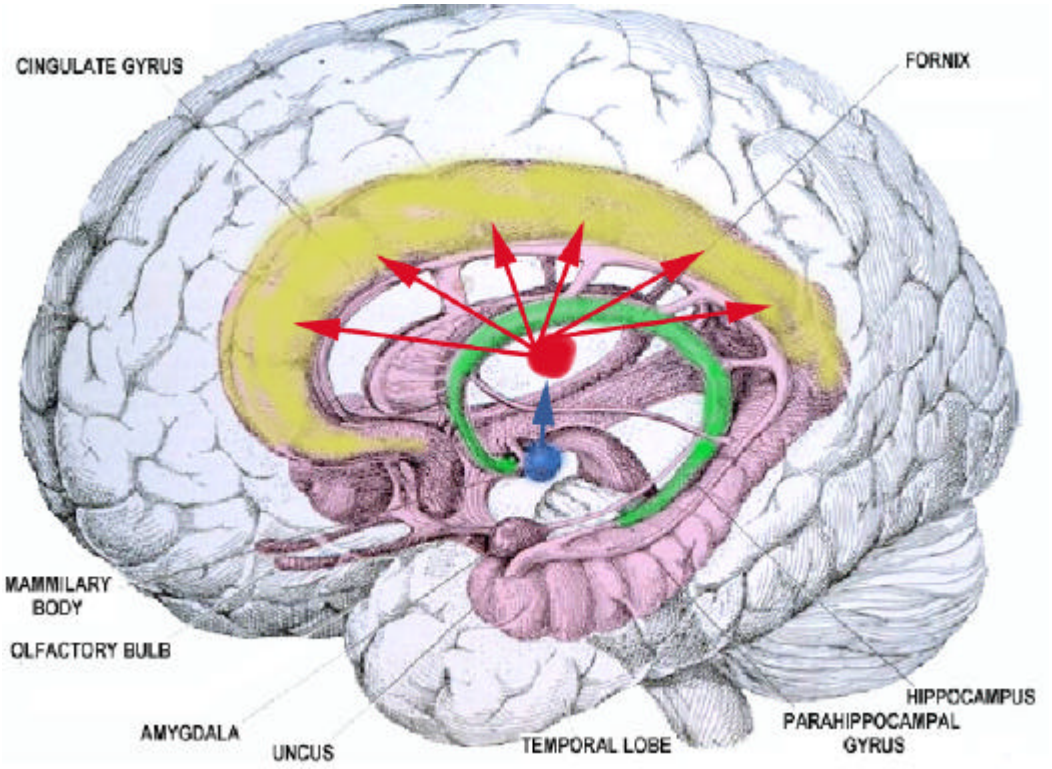
Learning arises out of the capacity for change within neural circuits. The molecular basis is potentiation of synapses. Memory arises out of both short term and long term changes in the properties of synapses (short term and long term memory). There are differerent types of memory declarative, associative and procedural.



THE LIMBIC SYSTEM Limbic means “border” - the limbic system lies at the border of the telencephalon encircling the diencephalon. Details of the anatomical organisation of this system are much too complex for us to go into any depth on that subject here. Suffice it to say that this system receives inputs from the olfactory system, and the cortex, and these higher cortical centers communicate with the hypothalamus via the limbic system.

According to classical concepts, the limbic system is believed to be the anatomical substrate of emotions and motivation, while the hypothalamus (together with the amygdala) seems to be involved in the expression of these emotions (e.g. feeding, sexual behaviour).

One part of the limbic system, the hippocampus, plays an important role in memory. This is carried out by the circuit of **cingulate cortex to parahippocampal cortex to hippocampus to mammillary bodies to anterior thalamic nucleus and then back to the cingulate cortex.** Damage to any part of this cuircuit can impare the abilities to form new memories.



CIRCADIAN RHYTHM - SLEEP

In animals, light/dark impulses from the eyes are sent to the suprachiasmatic nucleus and entrain its circadian activity. Lesions here can disrupt the circadian rhythm in some animals. In humans, these mechanisms still exist and may influence the circadian rhythm of some hormones (cortisol) and temperature (our body temperature oscillates around 35.6(C with a minimum around 3 a.m.; Cortisol has its maximum at around 8 a.m.). In humans, factors other than light/dark become more important, e.g. social contacts and duties.

The suprachiasmatic nucleus activity regulates circadian rythym, sleep wake cycle and is an innate property of the brain circuits which becomes entrained to light due to inputs from the visual system (dark light cycle). The reticular activating system regulates arousal (consciousness) and its activity varies with the circandian rythym, interest, pain, fear, drugs etc. Arousal from the reticular activating system maintains consiousness. The key neurotransmitter in the reticular activating system is acetylcholine. Acetylcholine activation of the brainstem maintains basic lower brain functions (control of respiration), acetylcholine activation of the thalamus maintains conciousness (coma), acetylcholine activation of the hippocampus maintains memory function (memory deficits), acetylcholine activation of the cerebral cortex maintains mental ability (dementia).

Adenosine is an important neurotransmitter in this system and that caffeine and theophyline block its action