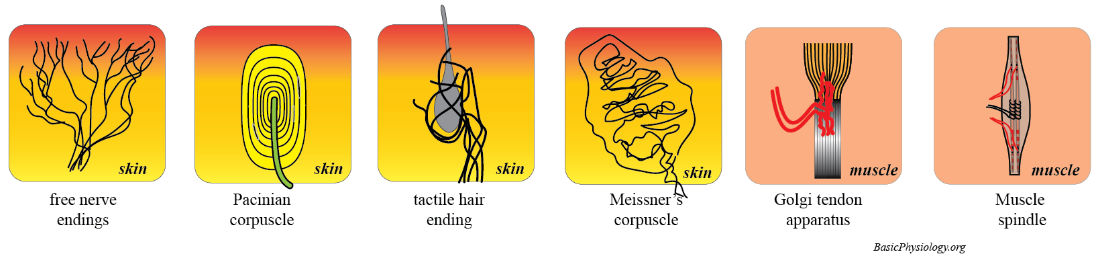
H.3.1. Sensory Receptors

A. Introduction:

1. The sensory system starts with the detection of sensory stimuli such as temperature, touch, pain, taste, etc.	2. For this we need sensory receptors which are specialized in detecting a specific stimulus.
3. These receptors will then 'translate' the strength of the stimuli into nerve signals that are transmitted through nerves to the central nervous system.	4. There is a HUGE number of sensory receptors in our body (*millions* …). These can be classified into the following categories: 1) mechanoreceptors 2) thermoreceptors 3) nociceptors (noci = pain) 4) electromagnetic receptors (eye vision) 5) chemoreceptors (taste, oxygen level)
5. Interestingly, a receptor will only detect a specific type of stimuli, for example touch, but no other stimuli such as temperature, taste, vision, etc.	6. In this chapter we will discuss the first three types of receptors while the electromagnetic (in the eye – vision) and the chemoreceptors (taste, oxygen level, etc) will be discussed in other chapters (*H.3.3. Special Senses*)
7. All these stimuli are 'translated' by their receptors into a string of action potentials which are then conducted to the brain.	8. But if all these sensory feelings are transmitted into the same type of action potentials, how does the brain know which feeling is which "feeling" (pain, cold, or a brush of air)?
9. That is because the nerve of every receptor goes to a **specific site** in the brain. Each site is dedicated to that particular "feeling".	10. If for some reason this specific site is stimulated in another way, by an external stimulus for example, then we would still feel that particular "feeling".

B. Types of receptors:

1. Because there are so many types of receptors, we will only discuss a few, hopefully the most important ones!	2. Many of these receptors are located in the skin, or in (skeletal) muscles but there are also sensors in other parts of the body such as pressure receptors in the blood circulation, oxygen receptors in the lungs, etc.



3.
We will start with the “**free nerve ending**” which is the most common receptor in the skin. These nerve endings detect “dangerous” signals which are most often perceived as pain (“ouch!”).

4.
Another ‘famous’ receptor is the **Pacinian corpuscle** (discovered by Pacini in 1835 and by other scientists) which detects pressure and vibrations. These receptors are located in the skin but also in internal organs such as the breast, genitalia, joints etc.

5.
Then we also have the **hair follicles** (= tactile hair ending) that can detect small movements along the skin such as soft touch, or a breath of air.

6.
The **Meissner corpuscle** (discovered by Meissner; very good!) detects pressure and vibrations when applied to the skin. There are especially many of them in the skin of our fingers.

7.
I have also added in this list two types of receptors located in skeletal muscles; the **muscle spindle** and the **Golgi tendon apparatus**.

8.
The functions of these receptors are discussed in *H.4. Motor System*.

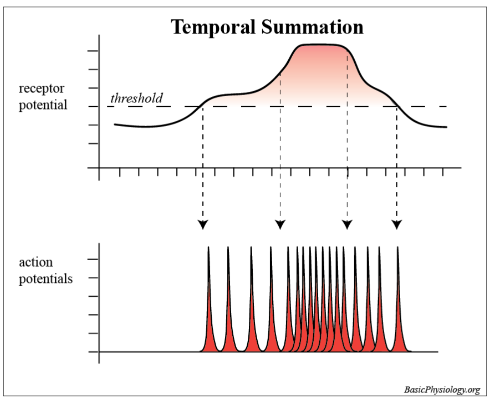
C. Temporal and Spatial Summation:

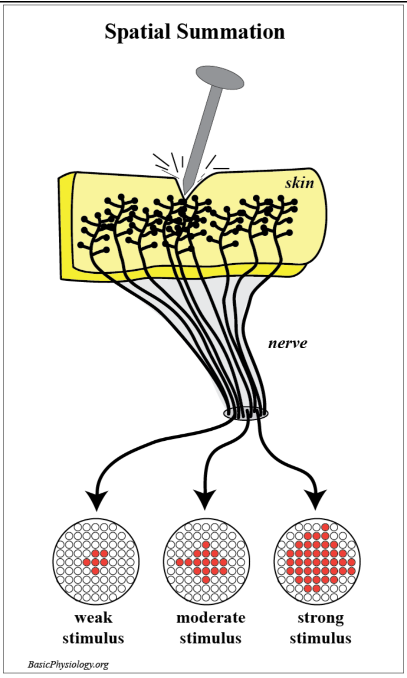
1.
As you have seen in panel A, sensory information is transmitted to the brain tissue by means of action potentials. That’s all, there is no other way.

2.
Interestingly, there are several ways in which these action potentials are transmitted to convey extra information to the brain about what the receptors are sensing.

3.
One way is to relate the strength of the stimulus to the number of action potentials transmitted; **temporal summation**.

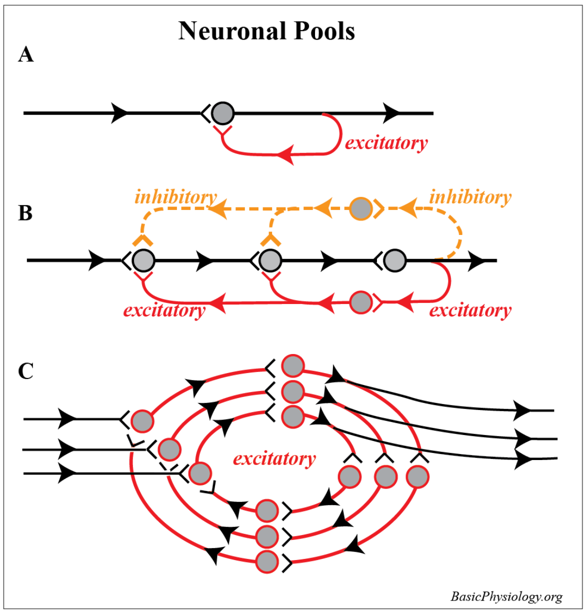
4.
In this mechanism, the strength of the stimulus is translated into a potential in that sensory organ. That receptor potential in turn can then, if it is higher than the threshold, initiate action potentials in the efferent nerve.



5. What is clever about this mechanism is that if the stimulus strength is increased, then the receptor potential also increases which, in turn, increases, the number of transmitted action potentials.	6. In this manner, the brain does not only know that a stimulus has been detected but also how strong it is!
7. Another way to transmit 'more' info to the brain is by **spatial summation**. 8. As shown in this diagram, a pin induces a 'painful' pressure in the skin which is perceived by the free nerve endings that serve as pain receptors. As there are many free nerve endings in the skin, each with their own axon, then a stronger stimulus, which induces a larger depression, will induce action potentials in more neighbouring axons. 9. And so, again, the brain gets more information with this spatial summation of active efferent nerves.	

D. Neuronal Pools:

1. But there are even more clever ways to relate more information to the brain. In a way, it seems we have micro-chips implanted in our nervous system!	2. In many parts in the brain, nerves connect together to form several kinds of "loops". This may for example increase the number of action potentials.
3. Diagram A shows the simplest example, a kind of a feed-back loop in which the axon of a nerve sends a loop back to its own cell body though a second synapse.	4. In the diagram, the synapse is labelled excitatory which means that the cell has become more excitable for future excitations.

5. But the synapse could also have been "inhibitory' which would make this cell temporarily less excitable.	
6. Diagram B shows a more complex set of neurons containing both excitatory loops and inhibitory loops.	
7. Diagram C shows an even more complex system in which a simple action potential may trigger a series of new action potentials.	
8. In other words, neuronal loops can be very complicated!	

E. Types of Senses:

1. Unfortunately, medical/physiological literature is sometimes confusing by using different terms to describe our sensory system.	2. In this chapter, we have used the following classification: a. mechanoreceptors b. thermoreceptors c. nociceptors d. electromagnetic receptors e. chemoreceptors
3. But here is another classification system: 1. **exteroreceptive** sensations – from the surface of the body 2. **proprioceptive** sensations – position sensations (from muscle and tendons), pressure sensations, equilibrium 3. **visceral** sensations; from the viscera of the body (internal organs) 4. **deep** sensation – deep tissues such as fasciae, muscles, bones	4. You may choose your own system!