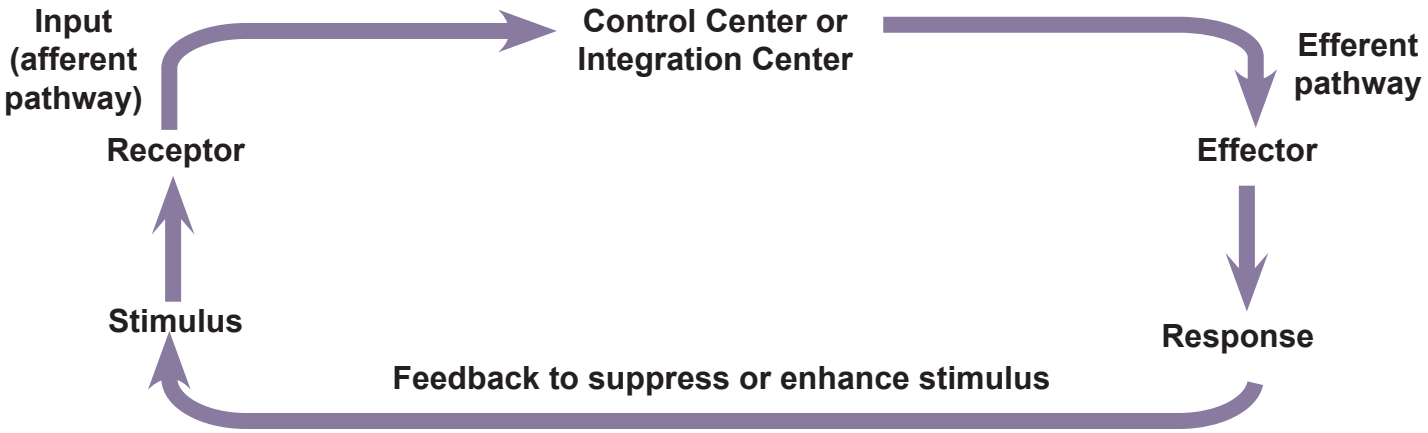
# Feedback Mechanisms Maintain Living Systems

The body's goal of **homeostasis** – keeping a relatively stable internal environment despite changing external conditions, is vital. The body is not unchanging or static. In fact, to maintain homeostasis, every organ system is constantly working and interacting to balance the body's optimum chemical, thermal, and neural conditions. The basic mechanism to maintain homeostasis involves **receptors** that monitor changes to the environment. When there is a **stimulus**, they send that information to the **control center (integrating center)** which interprets what the body needs and triggers a response with an **effector.** The effector elicits a feedback response to the stimulus. The feedback can influence the stimulus by depressing it with **negative feedback** or enhancing it with **positive feedback**.

This communication of stimulus and response is mainly between the **nervous system** and the **endocrine system**. The nervous system uses electrical impulses and the endocrine system uses hormones released into the blood to get their messages to where they need to go.

Most responses to stimuli for maintaining homeostasis are **negative feedback** to counter the stimuli and reduce its effect – protect the body from sudden severe changes. This is how the body maintains its temperature, heart rate, blood pressure, blood sugar levels, etc. This is by far the more common way to regulate and maintain homeostasis.

**Positive feedback** in the body is a way to respond to a stimuli by increasing it. This is much rarer than negative feedback, but is a powerful, rare response (cascade effect) when needed. An important example of this is blood clotting.

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These resources, through reading, illustrated diagrams, investigations, and critical thinking activities will help students with the following Next Generation Science Standard:

**Performance Expectations:** Students who demonstrate understanding can:

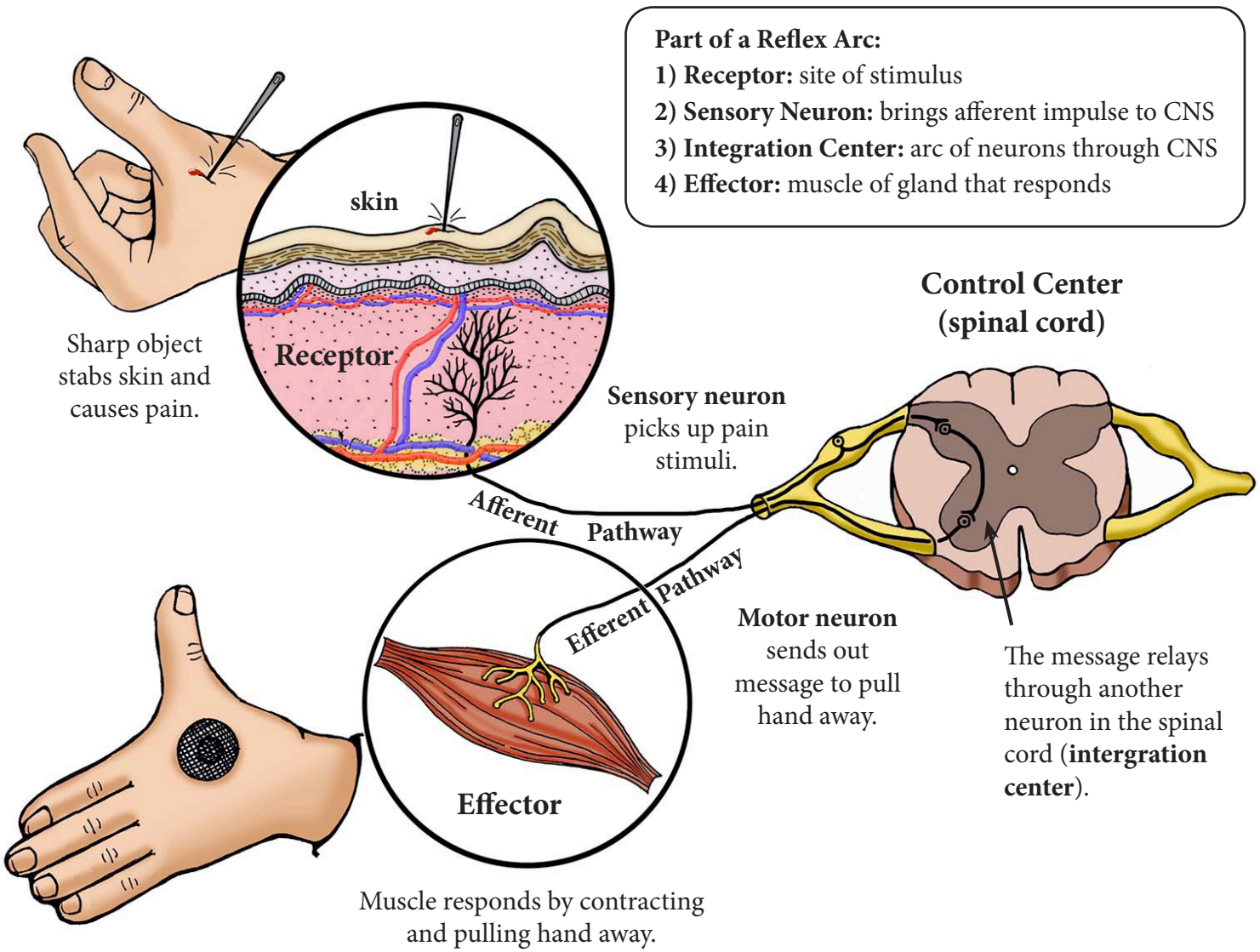
**HS-LS1-3. Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.** *[Clarification Statement: Examples of investigations could include heart rate response to exercise, stomate response to moisture and temperature, and root development in response to water levels.]*

# Feedback Response - Withdrawal Reflexes

Sometimes messages coming into the nervous system need a very quick feedback response. A **reflex** is a rapid, predictable motor response to a stimulus. It is **involuntary**. You do not have to learn how to do it or think about it. It is a message that doesn't reach your brain before you act. Think about how fast you move when you touch a hot stove. The stimuli flies through the spinal cord and back out to give a quicker motor response. This is called a ***spinal reflex*** or a ***simple reflex arc***. This is an important feedback response to an emergency moment when your body needs to respond quicker than the brain can act.

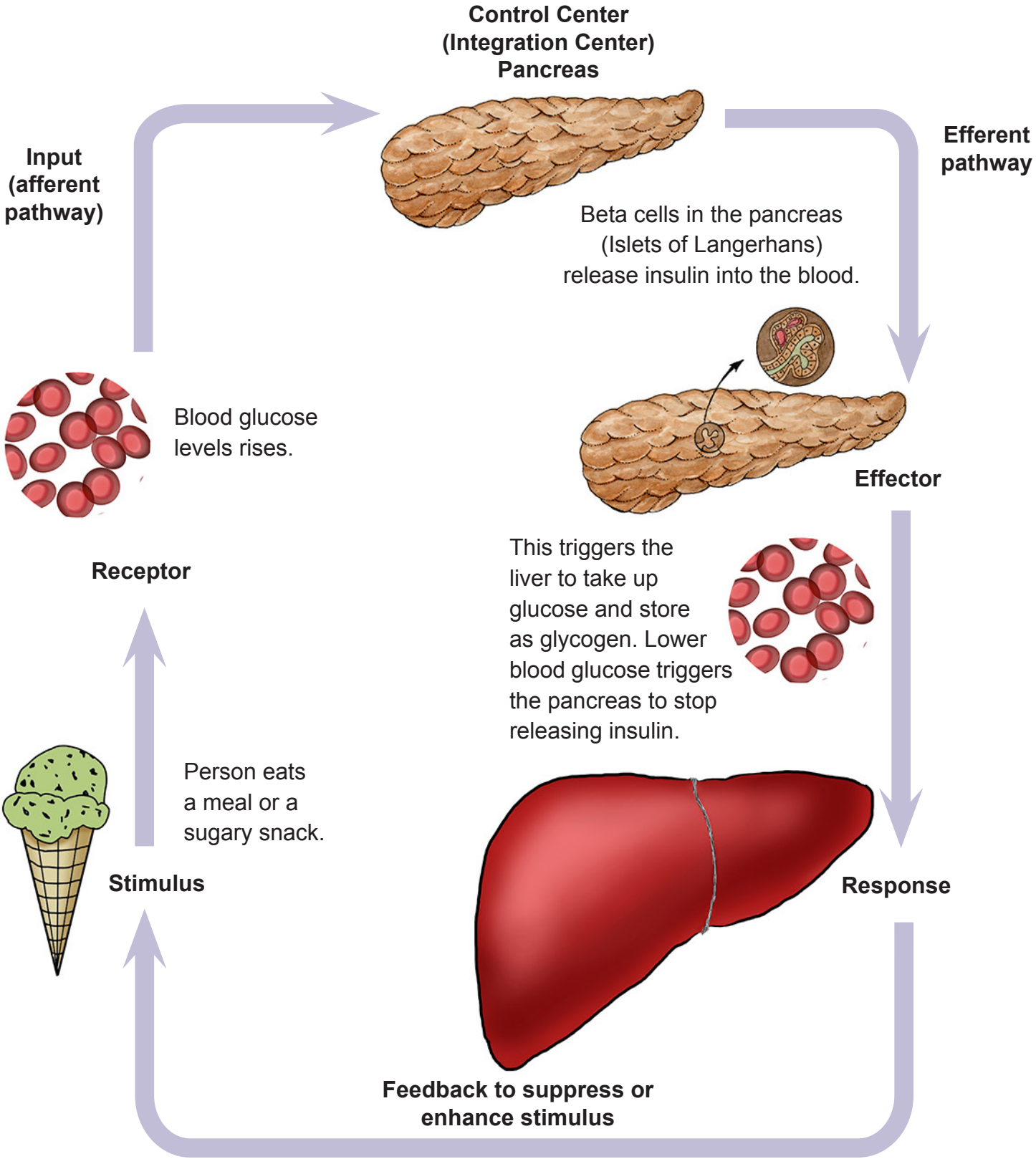
Some reflexes do develop from practice. They are acquired reflex responses. They include situations where you can react quickly because of repetitive practice. Some examples of this are handling a sailboat in high winds, driving a car, and even playing tennis.

## Spinal Reflex (Simple Reflex Arc)



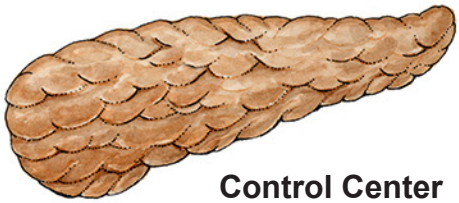
# Feedback Mechanisms that Lowers Blood Sugar (Glucose)

When the glucose levels in the blood rise, receptors in the blood sense the change. This triggers the pancreas to release of insulin from specialized beta cells (Islets of Langerhans). Once in the blood, insulin trigger the liver to take up glucose and store it as glycogen. This  lowers the blood sugar and triggers the pancreas to stop releasing insulin.



# Feedback Mechanisms that Raises Blood Sugar (Glucose)

When the glucose levels in the blood fall, receptors in the blood sense the change. This triggers the pancreas to release glucagon from its alpha cells. Once in the blood, glucagon triggers the liver to break down glycogen and release it as glucose into the blood. As glucose levels rise to normal (set point for homeostasis), it triggers the pancreas to stop releasing glucagon and the liver to stop breaking down glycogen.

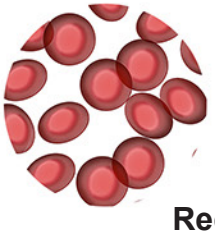


**Input (afferent pathway)**

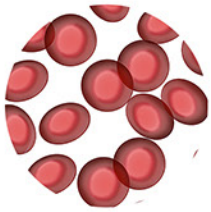
**Control Center (Integration Center) Pancreas**

**Efferent pathway**

Triggers alpha cells in the pancreas to release glucagon into the blood.



Blood detects low glucose levels.



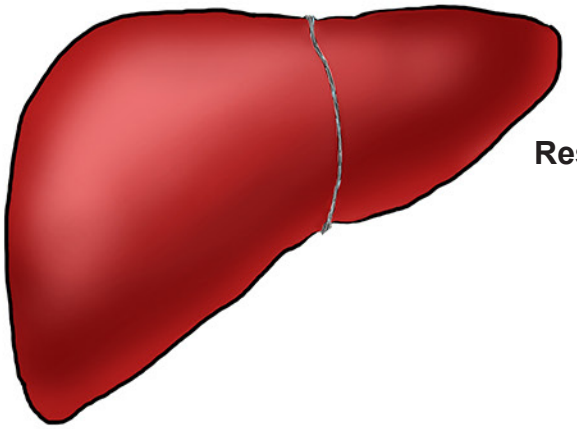
**Receptor**

**Effector**

This triggers the liver to break down glycogen and release it as glucose into the blood. When the set point for glucose is reached, both the pancreas and liver stop their response.

You go for a long time without eating. Hungry!

**Stimulus**

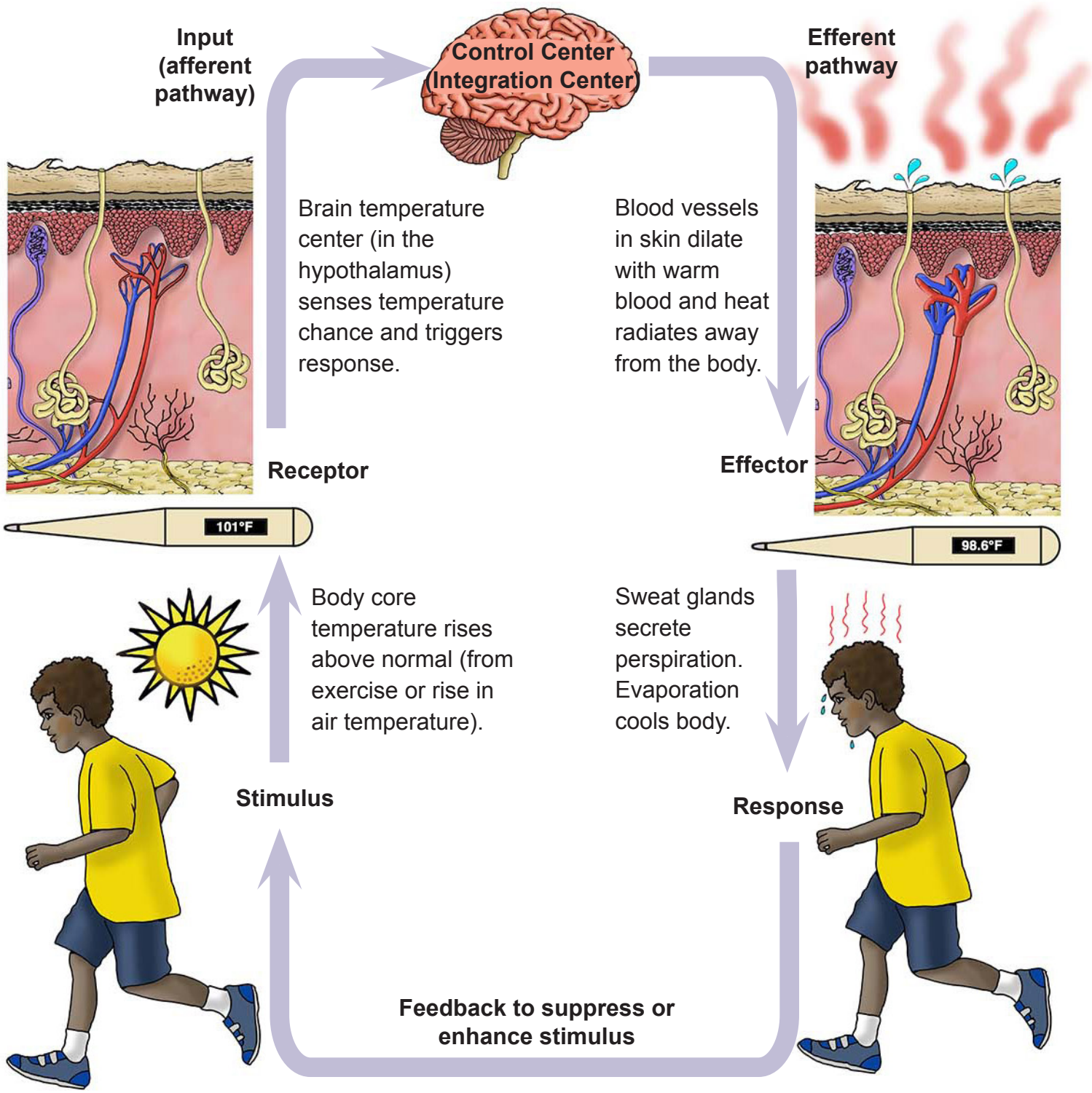


**Response**

**Feedback to suppress or enhance stimulus**

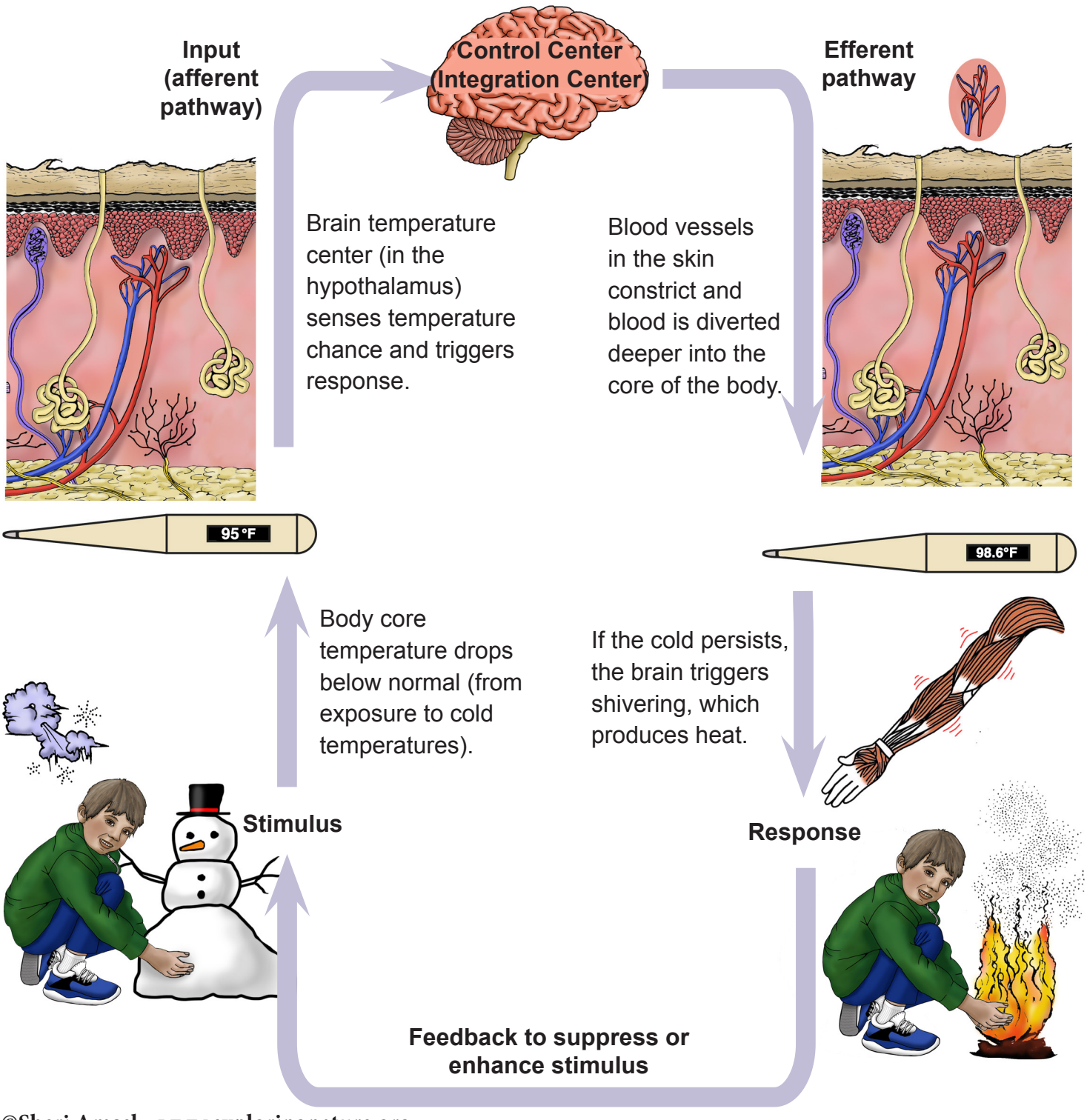
# Feedback Mechanisms that Promote Body Cooling

When the body core temperature rises above normal, the brain triggers several physiological changes to keep the body core at about 98.6°F (37°C). Blood vessels (capillaries) in the skin dilate and flood with warm blood. Brought to the surface, as such, the heat radiates away from the body (via conduction and convection). Nerve fibers also trigger sweat glands in the skin to secrete perspiration. Evaporation of perspiration cools the body. If the humidity is high and perspiration won't evaporate, the body becomes very uncomfortable and we are motivated to take voluntary action: move into the shade, fan the skin, submerge in cool water, etc.

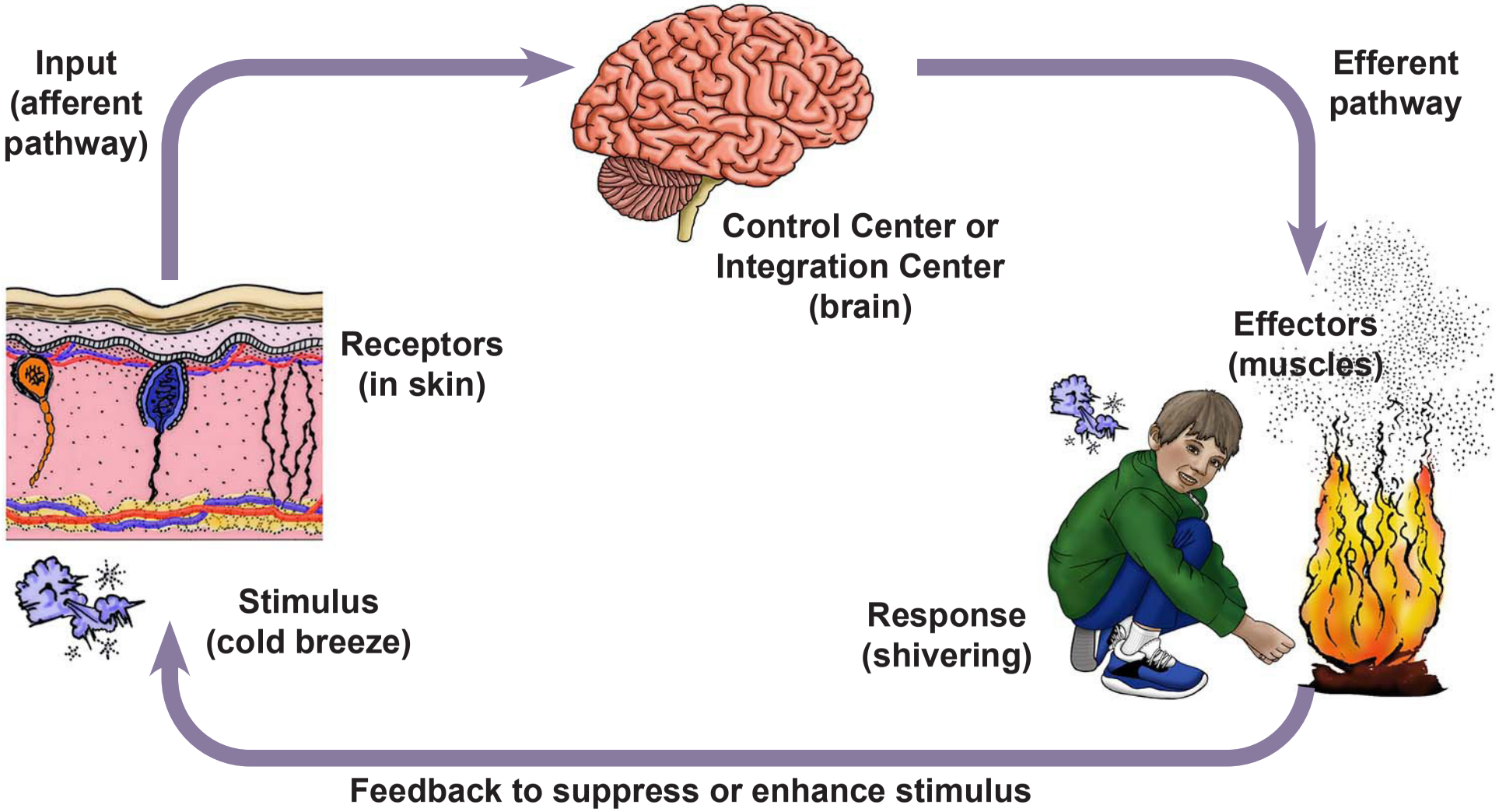


# Feedback Mechanisms that Promote Preserving Body Heat

When the temperature around us (environmental temperature) drops, the brain triggers several physiological changes to keep the body core at about 98.6°F (37°C). Blood vessels (capillaries) in the skin constrict and the blood is diverted deeper into the core of the body. If the cold persists, the brain triggers shivering, which produces heat. We also are motivated to take voluntary action: putting on a coat, drinking hot cocoa, jumping up and down, finding a heat source (fire, heater, go inside!), etc.



# Feedback Mechanisms Maintain Living Systems




**LS3.A: Structure and Function** - Feedback mechanisms maintain a living system's internal conditions within certain limits and mediate behaviors, allowing it to remain alive and functional even as external conditions change within some range. Feedback mechanisms can encourage (through positive feedback) or discourage (negative feedback) what is going on inside the living system.