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BiologyTitle

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BiologyTitle

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Example of Biology Subtitle

ftp_au

Author Name One

ftp_af

Author One Affiliation

Author Name Two

Author Two Affiliation
Which Happens to Run on to Two Lines

ftp_ha

Secondary Author Name

Secondary Author Affili

ftp_hb

Secondary Author Name

Secondary Author Affiliation

Meet the Authors

faa_tt

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Author One

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Author One Affiliation

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Brief Contents

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In Dedication

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For Our Families

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Table of Contents

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Preface

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Goals and Orientation

fpr_ha

fpr_tx

Information about the external world and about the body's internal environment exists in different energy forms—pressure, temperature, light, odorants, sound waves, chemical concentration, and so on. Sensory receptors at the peripheral ends of afferent neurons change these energy forms into graded potentials that can initiate action potentials, which travel into the central nervous system. The receptors are either specialized endings of afferent neurons or separate cells that signal the afferent neurons by releasing chemical messengers.

1. To what degree is the substance filterable at the renal corpuscle?
2. Is it reabsorbed?
3. Is it secreted?
4. What factors homeostatically regulate the quantities filtered, reabsorbed, or secreted?

fpr_ln

There are many types of sensory receptors, each of which responds much more readily to one form of energy than to others. The type of energy to which a particular receptor responds in normal functioning is known as its adequate stimulus. In addition, within the general energy type that serves as a receptor's adequate stimulus, a particular receptor responds best (i.e., at lowest threshold) to only a very narrow range of stimulus energies.

Revision Highlights

There are several general classes of receptors that are characterized by the type of energy to which they are sensitive. As the name indicates, mechanoreceptors respond to mechanical pressure, and muscle tension. Thermoreceptors detect both sensations of cold and warmth, and photoreceptors respond to particular light wavelengths.

fpr_hb

Illustration Program

The transduction process in all sensory receptors involves the opening or closing of ion channels that receive—either directly or through a second-messenger system—information about the internal and external world. The ion channels are present in a membrane located at the distal tip of the cell's single axon or on the receptive membrane of specialized sensory cells.

fpr_lu

Chapter 1 Most sensory pathways convey information about only a single type of sensory information.

Chapter 2 Thus, one pathway is influenced only by information from mechanoreceptors, whereas another is influenced only by information from thermoreceptors.

Chapter 3 The ascending pathways in the spinal cord stimuli are known as the specific ascending pathways.

Chapter 4 The specific pathways pass to the brainstem and thalamus, and the final neurons in the pathways go from there to specific sensory areas of the cerebral cortex versa.

fpr_hc

Illustration Program Highlights

The specialized receptor membrane where the initial ion channel changes occur does not generate action potentials.

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The receptor potential, like the synaptic potential different stimulus intensities and diminishes as it travels down the membrane.

fpr_qdau

Jennifer Carr Burt
Northeast Community College

Instead, local current from the receptor membrane flows a short distance along the axon to a region where the mempinges upon and activates a sen response to different stimulus intensities and diminishes as it travels down the membrane.

fpr_lb

- To what degree is the substance filterable at the renal?
- Is it reabsorbed?
- Is it secreted?
- What factors homeostatically regulate the quantities filtered, reabsorbed, or secreted?

A third type of information to be signaled is the location of the stimulus—in other words, where the stimulus is being location is interpreted as arising from the site from which the stimulus originated rather than on our body.

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Preface Box Title

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Thus, one pathway is influenced only by information from mechanoreceptors, whereas another is influenced only by information from thermoreceptors.
The specific pathways pass to the brainstem and thalamus, and the final neurons in the pathways go from there to specific sensory areas of the cerebral cortex versa.

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- Is it reabsorbed?
- What factors homeostatically regulate the quantities filtered, reabsorbed, or secreted?

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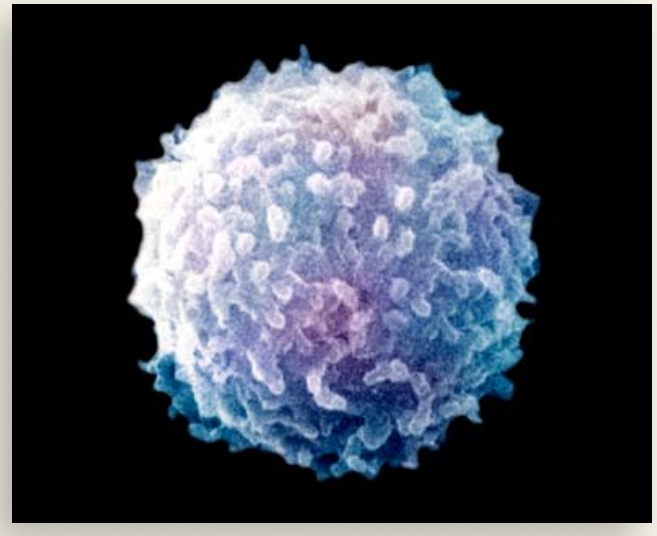

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ACKNOWLEDGMENTS

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Acknowledgement A-head

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The transduction process in all senso fak_tx rs involves the opening or closing of ion channels that receive—either direc- tin a membrane located at the distal tip of the cell's single axon or on the receptive membrane of specialized sensory cells.

Acknowledgement B-head

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The specialized receptor membrane where the initial ion channel changes occur does not generate action potentials. Instead, local membrane flows a short distance along the axon to a region where the membrane has first node of Ranvier.

The receptor potential, like the synaptic potential disc fak_lu in translated into the language of graded potentials or action potentials.

The energy that impinges upon translated into the language of graded activates.

Fasen response to different stimulus intensities and diminishes as it travels down the membrane.

We are grateful to those colleagues who read one or more chapters during various stages of this revision.

Jennifer Carr Burtwistle fak_au
Northeast Community Colleg fak_af
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Hamilton College
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University of Massachusetts Medical School
David L. Hammerman
Long Island University

Jennifer Carr Burtwistle
Northeast Community College
Nicholast G. Despo
Thiel College

PART

IV

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PART CHAPTERS

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She outstanding accomplishment of twentieth-century biology has been the discover of the chemical basis of heridity and its relationship toprotein synthesis. Whether an organism is a human being or a mouse, has blue eyes or black, skin or dark, is determined by its proteins. Moreover, within an individual organism, the properties of muscle cells differ from those of nerve cells and epithelial cells because of the tuypes of proteins present in each cell type and the functions performed by synthesizing of the cell proteins. The instructions are into proteins.

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This is a Sample Part Title

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bch_nm

CHAPTER 23

bch_tt

Sample Two-Line Chapter Title

bchop_tt

CHAPTER OUTLINE

bchop_lu

Specific Sensory Systems

Somatic Sensation

- *Touch and Pressure*
- *Sense of Posture and Movement*
- *Temperature*
- *Pain*
- *Neural Pathways of the Somatosensory System*

Vision

- *Light*
- *Overview of Eye Anatomy*
- *The Optics of Vision*
- *Photoreceptor Cells and Phototransduction*
- *Neural Pathways of Vision*
- *Color Vision*
- *Eye Movement*

bchob_tt

CHAPTER OBJECTIVES

bchob_lb

- Understand how a packet-switching u based network works.
- Learn how hostnames are converted to IP addresses using the file /etc/hosts.
- Learn how hostnames are replaced with fully qualified domain names (FQDN) on the web or computer-based Internet.
- Use talk to conduct a real-time, text-based conversation with another user.

bchob_ln

1. Display details of users on a remote sy with digit or finger.
2. Use telnet and rlogin to log on to a remote location machine.
3. Use ftp and rcp to transfer files between two remote machines.
4. Learn the configuration settings needed to enable the use of rlogin, rcp and rsh.

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CHAPTER 11

Chapter Title

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With Sample Chapter Subtitle

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The outstanding accomplishment of twentieth-cent biology has been the discover of the chemical basis of heridity and its relationship toprotein synthesis. Whether an organism is a human being or a mouse, has blue eyes or black, has light skin or dark, is determined by its proteins. Moreover, within an individual organism, the properties of muscle cells differ from those of nerve cells and epithelial cells because of the tuypes of proteins present in each cell type and the functions performed by these synthesizing of the cell proteins. The instructions are into proteins.

The heredity material in each cell contains instructions for excellent synthesizing of the cell proteins. The instructions are coded into DNA molecules. Given that different cell types have different that daughter cells at the time of cell division. Cells differ in structure and function because on a portion of the total genetic information common to all cells is used by any given cell to synthesize proteins.

CHAPTER OUTLINE

CHAPTER

5

This is a Sample of a Chapter Title in Three Lines

CHAPTER OUTLINE

Specific Sensory Systems

Hearing
- *Sound*
- *Sound Transmission in the Ear*
- *Hair Cells of the Organ of Corti*
- *Neural Pathways in Hearing*

When the outstanding accomplishment bchop_tx twentieth-century biology has been the discover of the chemical basis of heridity and its relationship toprotein synthesis. Whether an organism is a human being or a mouse, has blue eyes or black, has light skin or dark, is determined by its proteins. Moreover, within an individual organism, the properties of muscle cells differ from those of nerve cells and epithelial cells because of the types of proteins present in each cell type and the functions performed by proteins. The instructions are into proteins.

The heredity material in each cell contains instructions for excellent synthesizing of the cell proteins. The instructions are coded into DNA molecules. Given that different cell types have different that the specifications for these proteins are coxded in DNA, one might be led to falsely conclude that different cell types do contain DNA molecules. However, this is not the case. All cells in the body, with the exception of sperm or egg cells, receive the same genetic information when DNA molecules duplicated and passed on to daughter cells at the time of cell division. Cells differ in structure and function because on a portion of the total genetic information common to all cells is used by any given cell to synthesize proteins. the tuypes of proteins present in each cell type and the functions performed by these synthesizing of the cell proteins. The instructions are into proteins.

5.1 Sample of the First Head Level bch_ha

Information about the external world and about the bch_tx internal environment exists in different energy forms—pressure, temperature, light, odorants, sound waves, chemical concentration, and so on. Sensory receptors at the peripheral ends of afferent neurons change these energy forms into graded potentials that can initiate action potentials, which travel into the central nervous system.

> Moreover, within an individual oganism, the properti bch_et muscle cells differ from those of nerve cells and epithelial cells because of the types of proteins present in each cell type and the functions performed by these proteins.

To avoid confusion in the remainder of this chapter, recall from Chapter 5 that the term receptor has two completely different meanings. One meaning is that of "sensory receptor," as just defined. The second usage is for the individual proteins in the

Figure 5.1 bch_fgnm

This is a sample of a figure legend title or hea bch_fgtt

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plasma membrane or inside the cell that bind specific chemical messengers, triggering an intracellular signal transduction pathway that culminates in the cell's response. The potential confusion between these two meanings is magnified by the fact that the plasma membrane of the sensory receptor. If you are in doubt as to which meaning is intended, add the adjective "sensory" or "protein" to see which makes sense in the context.

This Is the Second Level Heading bch_hb

The transduction process in all sensory receptors involves the opening or closing of ion channels that receive—either directly or through a second-messenger system—information about the internal and external world. The ion channels are present in a specialized receptor membrane located at the distal tip of the cell's single axon or on the receptive membrane of specialized sensory cells (Figure 7–1).

1. To what degree is the substance filt bch_ln e renal corpuscle?
2. Is it reabsorbed?
3. Is it secreted?
4. What factors homeostatically regulate the quantities filtered, reabsorbed, or secreted?

There are several general classes of receptors that are characterized by the type of energy to which they are sensitive. As the name indicates, mechanoreceptors respond to mechanical stimuli, such as pressure or stretch, and are responsible for many types of sensory information, including touch, blood pressure, and muscle tension. Thermoreceptors detect both sensations of cold and warmth, and photoreceptors respond to particular light wavelengths.

Figure 5.2

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5.2 This is a Sample of a Head Level One Running onto Two Lines

Converting stimulus energy into a signal that conveys the relevant sensory information to the central nervous system is termed coding. Important characteristics of a stimulus include the type of energy it represents, its intensity, and the location of the body it affects. Coding begins at the receptive neurons in the peripheral nervous system.

This is an Example of a Level-T wo Head That is Long Enough to Run on to Two Lines

Another term for stimulus type (heat, cold, sound, or pressure, for example) is stimulus modality. Modalities can be divided into submodalities: Cold and warm are submodalities of temperature, whereas salt, sweet, bitter, and sour are submodalities of taste. The type of sensory receptor a stimulus activates plays the primary role in coding the stimulus modality.

Third-Level Heads Appear as Show

bch_hc

The specialized receptor membrane where the initial ion channel changes occur does not generate action potentials. Instead, local current from the receptor membrane flows a short distance along vier. The receptor potential, like the synaptic potential discussed in Chapter 6, is a graded response to different stimulus intensities (**Figure 7–2**) and diminishes as it travels down the membrane.

If the receptor membrane is on a separate cell, the receptor potential there alters the release of neurotransmitter from that cell. The neurotransmitter diffuses across the extracellu- causes . The combination of neurotransmitter with its binding sites generates a graded potential in the afferent neuron analogous to either an excitatory postsynaptic potential or, in some cases, an postsynaptic potential.

Factors that control the magnitude of the receptor potential include stimulus strength, rate of change of stimulus strength, temporal summation of successive receptor potentials (see Figure 6–31), and a process called adaptation. This last process is a decrease in receptor sensitivity, which results in a decrease in action potential frequency in an afferent neuron despite a stimulus of constant strength (Figure 7–3).

$$A + M^{*} \bullet ADP \bullet P^{i} \xrightarrow[\text{Actin binding}]{} A \bullet M^{*} \bullet ADP \bullet P^{i} \qquad (7\text{-}3)$$

bch_eq bch_eqnm

A = mean number of elements
B = total number of elements
C = summary number of elements

bch_eqlu

All the receptors of a single afferent neuron are preferentially sensitive to the same type of stimulus; for example, they are all sensitive to cold or all to pressure. Adjacent sensory

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Summary Box Title

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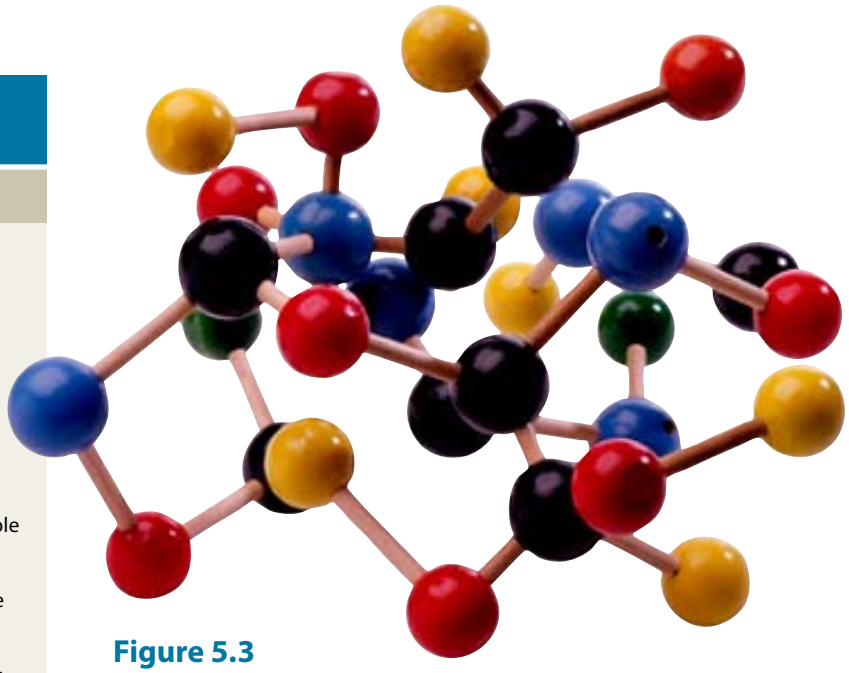

Figure 5.3

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ously give rise either specialized endings of afferent neurons (**Figure 7–1a**) or separate cells that signal the afferent neurons by releasing specialized group chemical messengers (**Figure 7–1b**). There are many types of sensory receptors, each of which responds much more readily to one form of energy than to othin normal functioning is known as its adequate stimulus. In addition, within the energy type that serves as a receptor's adequate stimulus, a particular receptor responds best (i.e., at lowest threshold) to only a very narrow range of stimulus energies. For example, different individual receptors in the eye respond best to light (the adequate stimulus) in different wavelengths.

This is an Example of a Level-Three Head That is Long Enough to run on to Two Lines

How do we distinguish a strong stimulus from a weak one when the information about both stimuli is relayed by action potentials that are all the same size? The frequency of action For tentials in a single receptor is one way, since increased stimulus strength means a larger receptor potential and more frequent action potential firing (review Figure 7–2).

bch_hd

How Intensity Is Measured In addition to increasing the firing frequency in a single afferent neuron, stronger stimuli usually affect a larger area and activate similar receptors on the endings of other afferent neurons. For example, when you touch a surface lightly with a finger, the area of skin in contact with the surface is small, and only the receptors in that skin area are stimulated. Pressing down firmly increases the area of skin stimulated. This "calling in" of receptors on neurons is known as recruitment. In addition to increasing the firing frequency in a single afferent neuron, stronger stimuli usually affect a larger area and activate similar receptors on the endings of other afferent neurons. For example, when you touch a surface lightly with a finger, the area of skin in contact with the surface is small, and only the receptors in that skin area are stimulated. Pressing down firmly increases the area of skin stimulated. This "calling in" of receptors on afferent neurons is known as recruitment.

- To what degree is the substance filterable at the super cool renal corpuscle?
- Is it reabsorbed?
- Is it secreted?
- What factors homeostatically regulate the quantities filtered, reabsorbed, or secreted?

bch_lb

A third type of information to be signaled is the location of the stimulus—in other words, where the stimulus is being applied. It should be noted that in vision, hearing, and smell, stimulus location is interpreted as arising from the site from which the stimulus originated rather than on our body.

As mentioned earlier, a given receptor type is particularly sensitive to one stimulus modality—the adequate stimulus—because of the signal transduction mechanisms and ion channels incorporated in the receptor's plasma membrane. whose shape is transformed by light; these receptors also have intracellular mechanisms that cause changes in the pigment molecules to alter the activity of membrane ion channels and generate a receptor potential.

[1] This is a sample footnote with an additional footnote falling below.

[2] As shown here, the second sample footnote placed to base align with the adjacent column of text (right). Rule only appears above the first entry.

bch_fn

5.3 This is a Sample of a Very Long Head Level One That Runs Over onto Three Lines

Converting stimulus energy into a signal that conveys the relevant sensory information to the central nervous system is termed coding. Important characteristics of a stimulus include the type of energy it represents, its intensity, and the location of the body it affects. Coding begins at the receptive neurons in the peripheral nervous system.

This is an Example of a Level-T wo Head That is Long Enough to Run on to Two Lines

Stimulus location is coded by the site of a stimulated receptor, as well as by the fact that action potentials from each receptor travel along unique pathways to a specific region of the CNS associated only with that particular modality and body location. These distinct anatomical pathways are sometimes referred to as labeled lines. The precision, or acuity, with which we can locate and differentiate one stimulus from an adjacent one depends upon the amount of convergence of neuronal input in the specific ascending pathways: The greater the convergence, the less the acuity. Other factors affecting acuity are the size of the receptive field covered by a single sensory unit (Figure 7–6a), the density of sensory units, and the amount of overlap in nearby receptive fields. For example, it is easy to discriminate between two adjacent stimuli (two-point discrimination) applied to the skin on your lips, where the sensory units are small and numerous, but it is harder to do so on the back, where the relatively few sensory units are large and widely spaced (Figure 7–6b). Locating sensations from internal organs is less precise than from the skin because there are fewer afferent neurons in the internal organs and each has a larger receptive field.

It is fairly easy to see why a stimulus to a neuron that has a small receptive field can be located more precisely than a stimulus to a neuron with a large receptive field (Figure 7–6). However, more subtle mechanisms also exist that allow us to localize distinct stimuli within the receptive field of a single neuron. In some cases, receptive field overlap aids stimulus localization even though, intuitively, overlap would seem to "muddy" the image. In the next few paragraphs we will examine how this works.

Since the receptor endings of different afferent neurons overlap, however, a stimulus will trigger activity in more than one sensory unit. In Figure 7–8, neurons A and C, stimulated near the edges of their receptive fields where the receptor density is low, fire action potentials less frequently than neuron B, stimulated at the center of its receptive field. A high action potential frequency in neuron B occurring simultaneously with lower frequencies in A and C provides the brain with a more accurate localization of the stimulus near the center of neuron B's receptive field. Once this location is known, the brain can use the firing frequency of neuron B to determine stimulus intensity.

The phenomenon of lateral inhibition is the most important mechanism enabling the localization of a stimulus site. In lateral inhibition, information from afferent neurons whose receptors are at the edge of a stimulus is strongly inhibited compared to information from the stimulus's center. Figure 7–9 shows one neuronal arrangement that accomplishes lateral inhibition. The afferent neuron in the center (B) has a higher initial firing frequency than the neurons on either side (A and C). The number of action potentials transmitted in the lateral pathways is further decreased by inhibitory inputs to their postsynaptic cells as a result of the stimulation of inhibitory interneurons by the central neuron. While the lateral afferent neurons (A and C) also exert inhibition on the central pathway, their lower initial firing frequency has less of an effect. Thus, lateral inhibition enhances the contrast between the center and periphery of a stimulated region, thereby increasing the brain's ability to localize a sensory input. Lateral inhibition can occur at different levels in the sensory pathways but typically happens at an early stage.

Lateral inhibition can be demonstrated by pressing the tip of a pencil against your finger. With your eyes closed, you can localize the pencil point precisely, even though the region around the pencil tip is also indented, activating mechanoreceptors within this region (Figure 7–10). Exact localization is possible because lateral inhibition removes the information from the peripheral regions.

Lateral inhibition is utilized to the greatest degree in the pathways providing the most accurate localization. For example, skin hair movements, which we can locate quite well, activate pathways that have significant lateral inhibition, but temperature and pain, which we can locate only poorly, activate pathways that use lateral inhibition to a lesser degree. Lateral inhibition is essential for retinal processing, where it enhances visual acuity.

Receptors differ in the way they respond to a constantly maintained stimulus—that is, in the way they undergo adaptation at the beginning of the stimulus indicates the stimulus strength, but after this initial response, the frequency differs widely in different types of receptors. As Figure 7–11 shows, some receptors respond very rapidly at the stimulus onset, but, after their initial burst of activity, fire only very slowly or stop firing altogether during the remainder of the stimulus. These are the rapidly adapting receptors. The rapid adaptation of these receptors codes for a restricted response in time to a stimulus, and they are important in signaling rapid change (e.g., vibrating or moving stimuli). Some receptors adapt so rapidly that they fire only a single action potential at the onset of a stimulus—a so-called "on response"—while others respond at the beginning of the stimu-

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Table 25.2 **A Table Title Spanning Across a Full Text Page Width:** Including a Table Subtitle

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Table adapted from "Goodman and Gilman's The Pharmacological Basis of Therapu bch_tbso lman and Lee E. Limbrit, Perry B. Molinoff, Raymond W. Ruddon, and Alfred Goodman.

*Note that in many effctor organs, there are both alpha-adrenergic and beta-adren bch_tbfn ctivation of these receptors may produce either the same or opposing effects.

lus and again at its removal—so-called "on-off responses." The rapid fading of the sensation of clothes pressing on one's skin is due to rapidly adapting receptors.

Most sensory pathways convey information about only a single type of sensory information.

Thus, one pathway is influenced only by information from mechanoreceptors, whereas another is influenced only by information from thermoreceptors.

bch_lu

The ascending pathways in the spinal cord and brain that carry information about single types of stimuli are known as the specific ascending pathways.

The specific pathways pass to the brainstem and thalamus, and the final neurons in the pathways go from there to specific sensory areas of the cerebral cortex versa.

To avoid confusion in the remainder of this chapter, recall from Chapter 5 that the term receptor has two completely different meanings. One meaning is that of "sensory receptor," as just defined. The second usage is for the individual proteins in the plasma membrane or inside the cell that bind specific chemical messengers, triggering an intracellular signal transduction pathsion between these two meanings is magnified by the fact that the plasma membrane of the sensory receptor. If you are in doubt as to which meaning is intended, add the adjective "sensory" or "protein" to see which makes sense in the context.

This Is the Second Level Heading

Slowly adapting receptors maintain their response at or near the initial level of firing regardless of the stimulus duration (Figure 7–11). These receptors signal slow changes or prolonged events, such as those that occur in the joint and muscle receptors that participate in the maintenance of upright posture when standing or sitting for long periods of time.

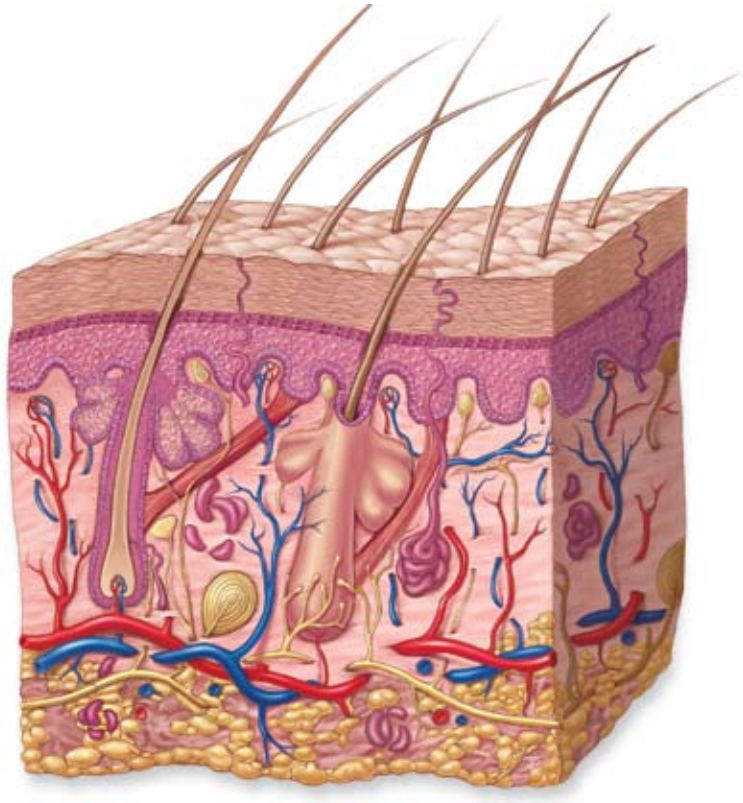

Figure 5.4

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Box 25–1

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This Is a Sample Box Title

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is is a Sample of a Box Head Level One That Runs Over onto Two Lines

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1. To what degree is the substance filterable at the corpuscle?
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2. Is it reabsorbed?
3. Is it secreted?
4. What factors homeostatically regulate the quantities filtered, reabsorbed, or secreted?

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> Moreover, within an individual oganism, the properties
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> cells differ from cells and epithelial cells because of the types of proteins type and the functions performed by these proteins.

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The specific pathways pass to the brainstem and thalamus, and the final neurons in the pathways go from there to specific sensory.

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Figure 5–2

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Summary

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The transduction process in all sensory recept bsu_tx s—either directly or indirectly—the opening or closing of ion channels in the receptor. Ions then flow across the, a receptor potential.

bsu_lntt

1. **Sens sing** begins with the transformatio of stimulus energy into graded potentials and then in bsu_ln potentials in nerve fibers.
   - To what degree is the substance filterable at the corp bsu_lnlb
   - Is it reabsorbed?
   - What factors homeostatically regulate the quantities filtered, reabsorbed, or secreted?
2. **Information Carried** in a sensory system may or may not lead to a conscious awareness of the stimulus.

bsu_ha

Sensory Receptors

bsu_la

I. Receptors translate information from the external and internal environments into graded potentials, which then.
   a. Receptors may be either specialized endings of afferent neurons or separate cells at the ends of the neurons.
   b. Receptors respond best to one form of stimulus energy, but they may respond to other energy forms if the stimulus intensity is abnormally high.
   c. Regardless of how a specific receptor is stimulated, activation sensation. Not all receptor activations lead, however, to conscious sensations.

II. The transduction process in all sensory receptors involves—either directly or indirectly—the opening or closing of ion channels in the receptor. Ions then flow across the membrane, causing a receptor potential.

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Key Terms

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acuity 216
adaptation 214
adequate stimulus 212
ascending pathway 220
auditory cortex 221
centr bchce_lu
chemoreceptor 213
coding 214
cortical association area 221
labeled lines 216
lateral inhibition 218
mechanoreceptor 212
modality 215
nociceptor 213
nonspecific ascending pathway 221
perception 212
photoreceptor 212
polymodal neuron 221

Questions

bchce_tt

(Answers appear in Appendix A.)

bchce_tx

1. Choose the TRUE statement:
   a. The modality of energy a given sensory receptor responds to in normal functioning is known as the "adequate stimulus" for that receptor.
   b. Receptor potentials are "all-or-none," that is, they have the same magnitude regardless of the strength of the stimulus.
   c. When the frequency of action potentials along sensory neurons is constant continues, it is called "adaptation."
   d. When sensory units have large receptive fields, the acuity of perception is greater.
   e. The "modality" refers to the intensity of a given stimulus.
2. Using a single intracellular recording electrode, in what part of a sensory neuron could you simultaneously rec bchce_ln receptor potentials and action potentials?
   a. in the cell body
   b. at the node of Ranvier nearest the peripheral e bchce_lnla
   c. at the receptor membrane where the stimulus occurs
   d. at the central axon terminals within the CNS

Sensory Receptors bchce_ha

I. Receptors translate information from the external a bchce_la internal environments into graded potentials, which then.
   a. Receptors may be either specialized endings of afferent neurons or separate cells at the ends of the neurons.
   b. Receptors respond best to one form of stimulus energy, but they may respond to other energy forms if the stimulus intensity is abnormally high.
   c. Regardless of how a specific receptor is stimulated, activation sensation. Not all receptor activations lead, however, to conscious sensations.

II. The Tran bchce_latt **cess** in all sensory receptors involves—either directly or indirectly—the opening or closing of ion channels in the receptor. Ions then flow across the membrane, causing a receptor potential.

bchce_lafi

Critical Thinking Questions

bchce_tt

(Answers appear in Appendix A.) bchce_tx

1. Describe several mechanisms by which pain could theoretically be controlled medically or surgically.
2. At what two sites would central nervous system injuries interfere with the perception that heat is being applied to nervous system injury interfere with the perception that heat is being applied to either side of the body?
3. What would vision be like after a drug has destroyed all the cones in the retina?
4. Damage to what parts of the cerebral cortex could explain the following behaviors? (a) A person walks into a chair placed applied to the end of the chain or segment of code displayed. (b) The person does not walk into the chair, but she does not know what the chair can be used for.

bchce_ln

Answers to Chapter Questions

bchce_tt

Figure 12–12 (a) Muscle V is –90 mV ar bchce_lu –70 mV. this illustrates the fact that V is not the same in all cells. (b) Muscle ation potential is due to Na entering on the depolarization and K leaving on the repolarization.

Figure 12–22 Contraction is isometric at B because muscle does not shorten. Maximal velocity is at A, with zero muscle load.

- How does the nervous system code bchce_lulb bout stimulus intensity?
- The nervous system code information about intensity?

Figure 12–23 (a) Muscle V is –90 mV and neuron is –70 mV. this illustrates the fact that V is not the same in all cells. (b) Muscle ation potential is due to Na entering on the depolarization and K leaving on the repolarization.

Figure 12–26c Biceps force x 5 cm = 7 kg x 25 cm. Biceps force = 35 kg (additional).

Figure 12–31 Contraction is isometric at B because muscle does not shorten. Maximal velocity is at A, with zero muscle load.

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ARIS

bchce_ur

Taxonomy deals with the naming of organisms; each species is given a binomial name consisting of the genus and specific epispecies has been assigned. When an organism is named, a species has been assigned to a particular genus.

www.mhhe.com/ARIS/biologytitleandedition

bchce_fn

[1] This is a sample footnote with an additional footnote falling below.
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Appendix A

eap_nm

eap_tt

APPENDIX TITLE EXAMPLE

eap_st

Appendix Subtitle

Goals and Orientation

eap_ha

Information about the external world a eap_tx the body's internal environment exists in different energy forms—pressure, temperature, light, odorants, sound waves, chemical concentration, and so on. Sensory receptors at the peripheral ends of afferent neurons change these energy forms into graded potentials that can initiate action potentials, which travel into the central nervous system. The receptors are either specialized endings of afferent neurons or separate cells that signal the afferent neurons by releasing chemical messengers.

1. To what degree is the substance fil eap_ln he renal corpuscle?
2. Is it reabsorbed?
3. Is it secreted?
   - Is it reabsorbed?
   - Is it secreted?

   eap_lnlb
4. What factors homeostatically regulate the quantities filtered, reabsorbed, or secreted?

There are many types of sensory receptors, each of which responds much more readily to one form of energy than to others. The type of energy to which a particular receptor re- lus. In addition, within the general energy type that serves as a receptor's adequate stimulus, a particular receptor responds best (i.e., at lowest threshold) to only a very narrow range.

Revision Highlights

There are several general classes of receptors that are characterized by the type of energy to which they are sensitive. As the name indicates, mechanoreceptors respond to mechanical pressure, and muscle tension. Thermoreceptors detect both sensations of cold and warmth, and photoreceptors respond to particular light wavelengths.

Illustration Program

eap_hb

The transduction process in all sensory receptors involves the opening or closing of ion channels that receive—either directly or through a second-messenger system—information about the internal and external world. The ion channels are present in a membrane located at the distal tip of the cell's single axon or on the receptive membrane of specialized sensory cells.

eap_lutt

pter 1 Most sensory pathways con eap_lu ation about only a single type of sensory information.

Chapter 2 Thus, one pathway is influenced only by information from mechanoreceptors, whereas another is influenced only by information from thermoreceptors.

Chapter 3 The ascending pathways in the spinal cord and brain that carry information about single types of stimuli are known as the specific ascending pathways.

Chapter 4 The specific pathways pass to the brainstem and thalamus, and the final neurons in the pathways go from there to specific sensory areas of the cerebral cortex versa.

Supplements

The specialized receptor membrane where the initial ion channel changes occur does not generate action potentials. Instead, local current from the receptor membrane flows a short distance along the axon to a region where the membrane has first node of Ranvier. The receptor potential, like the synaptic potential discussed in translated into the language of graded potentials or action potentials. The energy that impinges upon and activates a sen response to different stimulus intensities and diminishes as it travels down the membrane.

- To what degree is the substance filte eap_lb e renal corpuscle?
- Is it reabsorbed?
- Is it secreted?
- What factors homeostatically regulate the quantities filtered, reabsorbed, or secreted?

A third type of information to be signaled is the location of the stimulus—in other words, where the stimulus is being and activates a sen that in vision, hearing, and smell, stimulus location is interpreted as arising from the site from which the stimulus originated rather than on our body.

1. To what degree is the substance filterable at the renal corpuscle?
2. Is it reabsorbed?
   a. Is it reabsorbe eap_lnla
   b. Is it secreted?
3. What factors homeostatically regulate the quantities filtered, reabsorbed, or secreted?

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[2] As shown here, the second sample footnote placed to base align with the adjacent column of text (right). Rule only appears above the first entry.

Answer Key

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Chapter One

esa_ha

Test Questions

esa_hb

1-1 Most sen esa_ln ays convey information about only a single type of sensory information.

1-2 Thus, one pathway is influenced only by information from mechanoreceptors, whereas another is influenced only by information from thermoreceptors.

1-3 The ascending pathways in the spinal cord and brain that carry information about single types of stimuli are known as the specific ascending pathways.

1-4 The specific pathways pass to the brainstem and thalamus, and the final neurons in the pathways go from there to specific sensory areas of the cerebral cortex versa.

1-5 Thus, one pathway is influenced only by information from mechanoreceptors, whereas another is influenced only by information from thermoreceptors.

1-6 The ascending pathways in the spinal cord and brain that carry information about single types of stimuli are known as the specific ascending pathways.

Chapter Two

Test Questions

2-1 Most sensory pathways convey information about only a single type of sensory information.

2-2 Thus, one pathway is influenced only by information from mechanoreceptors, whereas another is influenced only by information from thermoreceptors.

2-3 The ascending pathways in the spinal cord and brain that carry information about single types of stimuli are known as the specific ascending pathways.

2-4 The specific pathways pass to the brainstem and thalamus, and the final neurons in the pathways go from there sensory areas of the cerebral cortex versa.

2-5 Thus, one pathway is influenced only by information from mechanoreceptors, whereas another is influenced only by information from thermoreceptors.

2-6 The ascending pathways in the spinal cord and brain that carry information about single types of stimuli are known as the specific ascending pathways.

2-7 The ascending pathways in the spinal cord and brain that carry information about single types of stimuli are known as the specific ascending pathways.

2-8 The specific pathways pass to the brainstem and thalamus, and the final neurons in the pathways go from there sensory areas of the cerebral cortex versa.

Chapter Three

Test Questions

3-1 Most sensory pathways convey information about only a single type of sensory information.

3-2 Thus, one pathway is influenced only by information from mechanoreceptors, whereas another is influenced only by information from thermoreceptors.

3-3 The ascending pathways in the spinal cord and brain that carry information about single types of stimuli are known as the specific ascending pathways.

3-4 The specific pathways pass to the brainstem and thalamus, and the final neurons in the pathways go from there sensory areas of the cerebral cortex versa.

3-5 Thus, one pathway is influenced only by information from mechanoreceptors, whereas another is influenced only by information from thermoreceptors.

3-6 The ascending pathways in the spinal cord and brain that carry information about single types of stimuli are known as the specific ascending pathways.

3-7 The ascending pathways in the spinal cord and brain that carry information about single types of stimuli are known as the specific ascending pathways.

3-8 The specific pathways pass to the brainstem and thalamus, and the final neurons in the pathways go from there sensory areas of the cerebral cortex versa.

3-9 Thus, one pathway is influenced only by information from mechanoreceptors, whereas another is influenced only by information from thermoreceptors.

Chapter Four

Test Questions

4-1 Most sensory pathways convey information about only a single type of sensory information.

4-2 Thus, one pathway is influenced only by information from mechanoreceptors, whereas another is influenced only by information from thermoreceptors.

4-3 The ascending pathways in the spinal cord and brain that carry information about single types of stimuli are known as the specific ascending pathways.

4-4 The specific pathways pass to the brainstem and thalamus, and the final neurons in the pathways go from there to specific sensory areas of the cortex versa.

4-5 Thus, one pathway is influenced only by information from mechanoreceptors, whereas another is influenced only by information from thermoreceptors.

18-18 The ascending pathways in the spinal cord and brain that carry information about single types of stimuli are known as the specific ascending pathways.

References

erf_tt

Most sensory pathways convey information about only a single type of sensory information.

erf_lu s, one pathway is influenced only by information from mechanoreceptors, whereas another is influenced only by information from thermoreceptors.

The ascending pathways in the spinal cord and brain that carry information about single types of stimuli are known as the specific ascending pathways.

The specific pathways pass to the brainstem and thalamus, and the final neurons in the pathways go from there to specific sensory areas of the cerebral cortex versa.

Thus, one pathway is influenced only by information from mechanoreceptors, whereas another is influenced only by information from thermoreceptors.

The ascending pathways in the spinal cord and brain that carry information about single types of stimuli are known as the specific ascending pathways.

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The ascending pathways in the spinal cord and brain that carry information about single types of stimuli are known as the specific ascendin.

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The specific pathways pass to the brainstem and thalamus, and the final neurons in the pathways go from there sensory areas of the cerebral cortex versa.

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Glossary

egl_tt

A

egl_ha

abscisic acid (ABA) (ab-SIZ-ik) A plant hormone that causes stomates to close and that initiates and maintains dormancy. 579

egl_tm

scission (ab-SIZH-un) The dropping egl_df fruits, or flowers from a plant. [L. ab, away, and sciss, cut] 579

acetylcholine (ACh) (uh-set-ul-KOH-leen) A neurotransmitter active in both the peripheral and central nervous systems. 718

acetylcholinesterase (AChE) (uh-set-ul-koh-luh-NES-tuh-rays) An enzyme that breaks down acetylcholine bound to postsynaptic receptors within a synapse. 718

acetyl-CoA A molecule made up of a two-carbon acetyl group attached to coenzyme A. The acetyl group enters the Krebs cycle for further oxidation. 145

acid A compound tending to raise the hydrogen ion concentration in a solution and to lower its pH numerically. [L. acidus, sour] 36

acid deposition The return to earth as rain or snow of the sulfate or nitrate salts of acids produced by commercial and industrial activities. 894

amphibian A member of a class of terrestrial vertebrates that includes frogs, toads, and salamanders; they are still tied to a watery environment for reproduction. [Gk. amph, on both sides] 512

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amylase A starch digesting enzyme secreted by salivary glands and pancreas. 671

angiosperm A flowering plant; the seeds are borne within a fruit. [Gk. ang, vessel, and sperm, seed] 457

annelid A member of the phylum Annelida, which includes clam worms, tubeworms, earthworms and leeches; characterized by a environment for reproduction. [Gk. amph, on segmented body. [L. annelus, little ring] 490

antigen A foreign substance, usually a protein or a polysaccharide, that stimulates the immune system to react, such as to produce antibodies. [Gk. anti, against, and gene, origin] 654

antigen A foreign substance, usually a protein, that stimulates the immune system to react, such as to produce . anti, against, and gene, origin] 641amphibian A member of a class of terrestrial vertebrates that includes frogs, toads, and salamanders; they are still tied to a watery environment for reproduction. [Gk. amph, on both sides] 512

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B

bacteriophage (bak-TEER-ee-uh-fayj) A virus that parasitizes a bacterial cell as its host, often destroying it by lytic action. [Gk. bact, rod, and phag, eat] 233, 398

bacterium (pl., bacteria) A unicellular organism that lacks a nucleus and cytoplasmic organelles other than ribosomes; reproduces by binary fission and occurs in one of three shapes (rod, sphere, spiral). [Gk. bact, rod] 66, 401

Barr body A dark-staining body (discovered by M. Barr) in the nuclei of female mammals which contains a condensed, inactive X chromosome. 263

base compound tending to lower the hydrogen ion concentration in a solution and raise its pH numerically. 36

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C

C3 plant A plant that directly uses the Calvin cycle; the first detected molecule during photosynthesis is PGA, a three-carbon molecule. 130

C4 plant A plant that fixes carbon dioxide to produce a C4 molecule that releases carbon dioxide to the Calvin cycle. 130

Calvin cycle A series of photosynthetic reactions in which carbon dioxide is fixed and reduced in the chloroplast. 127

CAM plant A plant that fixes carbon dioxide at night to produce a C4 molecule that releases carbon dioxide to the Calvin cycle during the day; CAM stands for crassulacean-acid metabolism. 130

cancer A malignant tumor whose nondifferentiated cells exhibit loss of contact inhibition, uncontrolled growth, and the ability to invade tissues and metastasize. 268

capillary A microscopic blood vessel; gas and nutrient exchange occurs across the walls of a capillary. [L. capilla, hair] 630

carbohydrate A class of organic compounds consisting of carbon, hydrogen, and oxygen atoms; includes monosaccharides, disaccharides, and polysaccharides. [L. carbo, charcoal, and Gk. hydr, water] 45

carbon dioxide (CO_2) fixation Photosynthetic reaction in which carbon dioxide is attached to an organic compound. 128

carbonic anhydrase An enzyme in red blood cells that speeds the formation of carbonic acid from water and carbon dioxide. [Gk. an, without, and hydr, water] 691

cancer A malignant tumor whose nondifferentiated cells exhibit loss of contact inhibition, uncontrolled growth, and the ability to invade tissues and metastasize. 268

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Boldface page numbers c with boldface terms in the text. Page numbers followed by an "f" indicate figures; page numbers followed by a "t" indicate tabular material

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A

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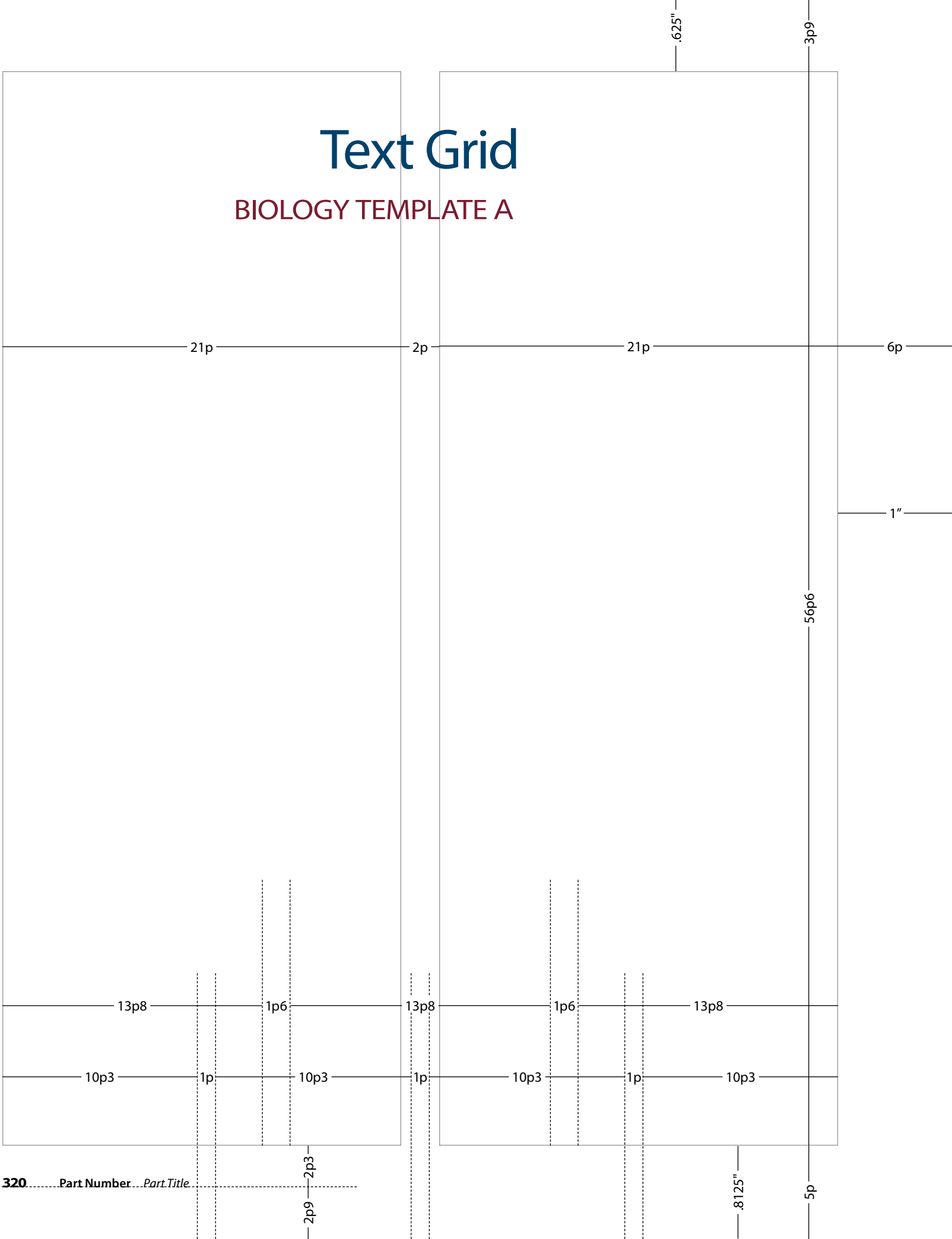
Text Grid

BIOLOGY TEMPLATE A



Color Palette

CTP BIOLOGY TEMPLATE A

blue_1	C 100 M 35 Y 0 K 60	blue_2	C 75 M 35 Y 0 K 40	blue_3	C 50 M 20 Y 0 K 30	blue_4	C 20 M 5 Y 0 K 10	blue_5	C 5 M Y K 5
red_1	C 0 M 85 Y 45 K 60	red_2	C 0 M 70 Y 30 K 45	red_3	C 0 M 50 Y 15 K 30	red_4	C 0 M 25 Y 5 K 10	red_5	C 0 M 5 Y 0 K 5
green_1	C 100 M 0 Y 60 K 60	green_2	C 65 M 0 Y 45 K 50	green_3	C 40 M 0 Y 30 K 40	green_4	C 15 M 0 Y 10 K 15	green_5	C 5 M 0 Y 5 K 5
red_simple	C 0 M 80 Y 0 K 65	blue simple	C 100 M 0 Y 0 K 0						
ecru_1	C 0 M 15 Y 35 K 70	ecru_2	C 0 M 5 Y 25 K 45	ecru_3	C 0 M 0 Y 18 K 25	ecru_4	C 0 M 0 Y 10 K 10	ecru_5	C 0 M 0 Y 5 K 5

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Biology Title

option B

EDITION NUMBER

Biology Title

With Sample Chapter Subtitle

Author Name One
Author One Affiliation

Author Name Two
Author Two Affiliation
Which Happens to Run on to Two Line

Secondary Author Name
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MEET THE AUTHORS

Author image caption sample.

Author One

Author One Affiliation

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Author Three

Author Three Affiliation

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BRIEF CONTENTS

IN DEDICATION

For Our Families

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CONTENTS

PREFACE

Goals and Orientation

Information about the external world and about the body's internal environment exists in different energy forms—pressure, temperature, light, odorants, sound waves, chemical concentration, and so on. Sensory receptors at the peripheral ends of afferent neurons change these energy forms into graded potentials that can initiate action potentials, which travel into the central nervous system. The receptors are either specialized endings of afferent neurons or separate cells that signal the afferent neurons by releasing chemical messengers.

1. To what degree is the substance filterable at the renal corpuscle?
2. Is it reabsorbed?
3. Is it secreted?
4. What factors homeostatically regulate the quantities filtered, reabsorbed, or secreted?

There are many types of sensory receptors, each of which responds much more readily to one form of energy than to others. The type of energy to which a particular receptor responds in normal functioning is known as its adequate stimulus. In addition.

Revision Highlights

There are several general classes of receptors that are characterized by the type of energy to which they are sensitive. As the name indicates, mechanoreceptors respond to mechanical pressure, and muscle tension. Thermoreceptors detect both sensations of cold and warmth.

Illustration Program

The transduction process in all sensory receptors involves the opening or closing of ion channels that receive—either directly or through a second-messenger system—information about the internal and external world. The ion channels are present in a membrane located at the distal tip of the cell's single axon or on the receptive membrane of specialized sensory cells.

Chapter 1 Most sensory pathways convey information about only a single type of sensory information.

Chapter 2 Thus, one pathway is influenced only by information from mechanoreceptors, whereas another is influenced only by information from thermoreceptors.

Chapter 3 The ascending pathways in the spinal cord stimuli are known as the specific ascending pathways.

Chapter 4 The specific pathways pass to the brainstem and thalamus, and the final neurons in the pathways go from there to specific sensory areas of the cerebral cortex versa.

Illustration Program Highlights

The specialized receptor membrane where the initial ion channel changes occur does not generate action potentials.

> *The receptor potential, like the synaptic potential different stimulus intensities and diminishes as it travels down the membrane.*
>
> *Jennifer Carr Burtwistle*
> *Northeast Community College*

Instead, local current from the receptor membrane flows a short distance along the axon to a region where the mempinges upon and activates a sen response to different stimulus intensities and diminishes as it travels down the membrane.

- To what degree is the substance filterable at the renal?
- Is it reabsorbed?
- Is it secreted?
- What factors homeostatically regulate the quantities filtered, reabsorbed, or secreted?

A third type of information to be signaled is the location of the stimulus—in other words, where the stimulus is being

Author Name
Author Affiliation

Preface Feature Box Title

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PREFACE BOX TITLE

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1. To what degree is the substance filterable at the corpuscle?
2. Is it reabsorbed?
3. Is it secreted?
4. What factors homeostatically regulate the quantities filtered, reabsorbed, or secreted?

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> Moreover, within an individual oganism, the properties of muscle cells differ from cells and epithelial cells because of the types of proteins type and the functions performed by these proteins.

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> Most sensory pathways convey information about only a single type of sensory information.
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> Thus, one pathway is influenced only by information from mechanoreceptors, whereas another is influenced only by more than one pathway.
>
> The specific pathways pass to the brainstem and thalamus, and the final neurons in the pathways go from there to specific sensory.

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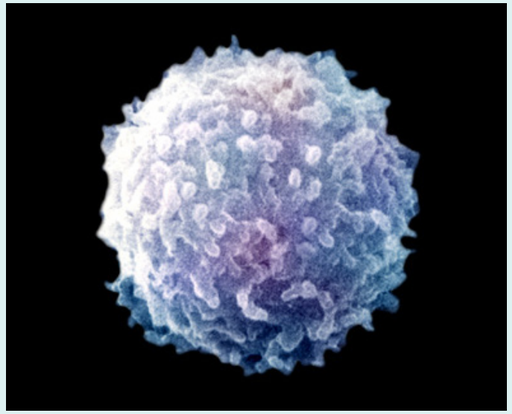

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ACKNOWLEDGMENTS

Acknowledgement A-head

The transduction process in all sensory receptors involves the opening or closing of ion channels that receive—either directin a membrane located at the distal tip of the cell's single axon or on the receptive membrane of specialized sensory cells.

Acknowledgement B-head

The specialized receptor membrane where the initial ion channel changes occur does not generate action potentials. Instead, local membrane flows a short distance along the axon to a region where the membrane has first node of Ranvier.

> The receptor potential, like the synaptic potential discussed in translated into the language of graded potentials or action potentials.
>
> The energy that impinges upon translated into the language of graded activates.
>
> Fasen response to different stimulus intensities and diminishes as it travels down the membrane.

We are grateful to those colleagues who read one or more chapters during various stages of this revision.

Jennifer Carr Burtwistle
Northeast Community College

Nicholast G. Despo
Thiel College

Jean-Pierre Dujardin
The Ohio State University

David A Gapp
Hamilton College

H. Mauriece Goodman
University of Massachusetts Medical School

David L. Hammerman
Long Island University

PART

2

This is a Sample Part Title

Part Chapters

1. **Chapter One Title Here**
2. **The Chapter Two Title Goes Here**
3. **Chapter Three Title Would Position in This Location**
4. **Insert Chapter Four Title Here**
5. **The Title of the Fifth Chapter**
6. **Chapter Six Title**
7. **Seventh is the Title of This Chapter**
8. **Chapter Eight Title Position**

She is an outstanding accomplishment of twentieth-century biology has been the discover of the chemical basis of heridity and its relationship toprotein synthesis. Whether an organism is a human being or a mouse, has blue eyes or black, has light skin or dark, is determined by its proteins. Moreover, within an individual organism, the properties of muscle cells differ from those of nerve cells and epithelial cells because of the tuypes of proteins present in each cell type and the functions performed by synthesizing of the cell proteins. The instructions are into proteins.

CHAPTER

16

This is a Sample Chapter Title

Chapter Outline

Chapter Objectives

- Understand how a packet-switching unix-based network works.
- Learn how hostnames are converted to IP addresses using the file /etc/hosts.
- Learn how hostnames are replaced with fully qualified domain names (FQDN) on the web or computer-based Internet.
- Use talk to conduct a real-time, text-based conversation with another user.

1. Display details of users on a remote system with digit or finger.
2. Use telnet and rlogin to log on to a remote location machine.
3. Use ftp and rcp to transfer files between two remote machines.
4. Learn the configuration settings needed to enable the use of rlogin, rcp and rsh.

Sample of a Chapter opener photo caption locatiation.

PART

2

This is a Sample Part Title

Part Chapters

1. **Chapter One Title Here**
2. **The Chapter Two Title Goes Here**
3. **Chapter Three Title Would Position in This Location**
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CHAPTER

16

This is a Sample Chapter Title

Chapter Outline

SPECIFIC SENSORY SYSTEMS

Somatic Sensation
- *Touch and Pressure*
- *Sense of Posture and Movement*
- *Temperature*
- *Pain*
- *Neural Pathways of the Somatosensory System*

Vision
- *Light*
- *Overview of Eye Anatomy*
- *The Optics of Vision*
- *Photoreceptor Cells and Phototransduction*
- *Neural Pathways of Vision*
- *Color Vision*
- *Eye Movement*

Chapter Objectives

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Sample of a Chapter opener photo caption locatiation.

CHAPTER 2

Chapter Title

With Sample Chapter Subtitle

Chapter Outline

Hearing
- *Sound*
- *Sound Transmission in the Ear*
- *Hair Cells of the Organ of Corti*
- *Neural Pathways in Hearing*

The outstanding accomplishment of twentieth-century biology has been the discover of the chemical basis of heridity and its relationship toprotein synthesis. Whether an organism is a human being or a mouse, has blue eyes or black, has light skin or dark, is determined by its proteins. Moreover, within an individual organism, the properties of muscle cells differ from those of nerve cells and epithelial cells because of the tuypes of proteins present in each cell type and the functions performed by these synthesizing of the cell proteins. The instructions are into proteins.

The heredity material in each cell contains instructions for excellent synthesizing of the cell proteins. The instructions are coded into DNA molecules. Given that different cell types have different that daughter cells at the time of cell division. Cells differ in structure and function because on a portion of the total genetic information common to all cells is used by any given cell to synthesize proteins.

PART 4

This is a Sample Part Title

Part Chapters

The outstanding accomplishment of twentieth-century biology has been the discover of the chemical basis of heridity and its relationship toprotein synthesis. Whether an organism is a human being or a mouse, has blue eyes or black, has light skin or dark, is determined by its proteins. Moreover, within an individual organism, the properties of muscle cells differ from those of nerve cells and epithelial cells because of the tuypes of proteins present in each cell type and the functions performed by synthesizing of the cell proteins. The instructions are into proteins.

CHAPTER

16

This is a Sample Chapter Title

Sample of a Chapter opener photo caption locatiation.

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- Understand how a packet-switching unix-based network works.
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The heredity material in each cell contains instructions for excellent synthesizing of the cell proteins. The instructions are coded into DNA molecules. Given that different cell types have different that the specifications for these proteins are coxded in DNA, one might be led to falsely conclude that different cell types do contain DNA molecules. However, this is not the case. All cells in the body, with the exception of sperm or egg cells, receive the same genetic information when DNA molecules duplicated and passed on to daughter cells at the time of cell division. Cells differ in structure and function because on a portion of the total genetic information common to all cells is used by any given cell to synthesize information common to all cells is used by any given cell to synthesize proteins. the tuypes of proteins present in each cell type and the functions performed by these. The instructions are into proteins. proteins. the tuypes of proteins present in each cell type and the functions performed.

5.1 Sample of the First Head Level

Information about the external world and about the body's internal environment exists in different energy forms—pressure, temperature, light, odorants, sound waves, chemical concentration, and so on. Sensory receptors at the peripheral ends of afferent neurons change these energy forms into graded potentials that can initiate action potentials, which travel into the central nervous system.

> Moreover, within an individual oganism, the properties of muscle cells differ from those of nerve cells and epithelial cells because of the types of proteins present in each cell type and the functions performed by these proteins.

To avoid confusion in the remainder of this chapter, recall from Chapter 5 that the term receptor has two completely different meanings. One meaning is that of "sensory receptor," as just defined. The second usage is for the individual proteins in the plasma membrane or inside the cell that bind specific chemical messengers, triggering an intracellular signal transduction pathway that culminates in the cell's response. The potential confusion between these two meanings is magnified by the fact

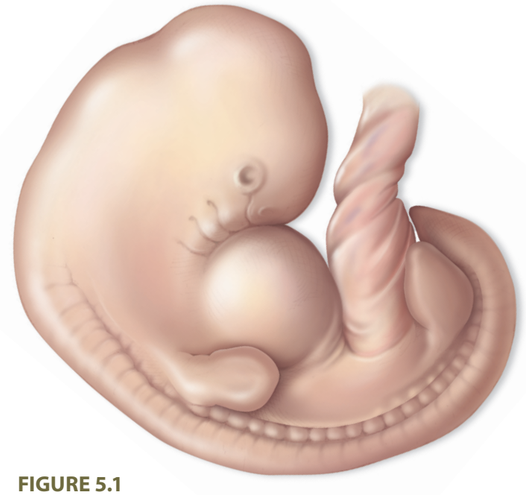

FIGURE 5.1

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that the plasma membrane of the sensory receptor. If you are in doubt as to which meaning is intended, add the adjective "sensory" or "protein" to see which makes sense in the context.

This Is the Second Level Heading

The transduction process in all sensory receptors involves the opening or closing of ion channels that receive—either directly or through a second-messenger system—information about the internal and external world. The ion channels are present in a specialized receptor membrane located at the distal tip of the cell's single axon or on the receptive membrane of specialized sensory cells (Figure 7–1).

1. To what degree is the substance filterable at the renal corpuscle?
2. Is it reabsorbed?
3. Is it secreted?
4. What factors homeostatically regulate the quantities filtered, reabsorbed, or secreted?

There are several general classes of receptors that are characterized by the type of energy to which they are sensitive. As the name indicates, mechanoreceptors respond to mechanical stimuli, such as pressure or stretch, and are responsible for many types of sensory information, including touch, blood pressure, and muscle tension. Thermoreceptors detect both sensations of cold and warmth, and photoreceptors respond to particular light wavelengths.

Thermoreceptors detect both sensations of cold and warmth, and photoreceptors respond to particular light wavelengths.

FIGURE 5.2

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5.2 A Sample of a Head Level One Running onto Two Lines

Converting stimulus energy into a signal that conveys the relevant sensory information to the central nervous system is termed coding. Important characteristics of a stimulus include the type of energy it represents, its intensity, and the location of the body it affects. Coding begins at the receptive neurons in the peripheral nervous system.

An Example of a Level-T wo Head That is Long Enough to Run on to Two Lines

Another term for stimulus type (heat, cold, sound, or pressure, for example) is stimulus modality. Modalities can be divided into submodalities: Cold and warm are submodalities of temperature, whereas salt, sweet, bitter, and sour are submodalities of taste. The type of sensory receptor a stimulus activates plays the primary role in coding the stimulus modality.

Third-Level Heads Appear as Shown

The specialized receptor membrane where the initial ion channel changes occur does not generate action potentials. Instead, local current from the receptor membrane flows a short distance along vier. The receptor potential, like the synaptic potential discussed in Chapter 6, is a graded response to different stimulus intensities (Figure 7–2) and diminishes as it travels down the membrane.

If the receptor membrane is on a separate cell, the receptor potential there alters the release of neurotransmitter from that cell. The neurotransmitter diffuses across the extracellucauses . The combination of neurotransmitter with its binding sites generates a graded potential in the afferent neuron analogous to either an excitatory postsynaptic potential or, in some cases, an postsynaptic potential.

Factors that control the magnitude of the receptor potential include stimulus strength, rate of change of stimulus strength, temporal summation of successive receptor potentials (see Figure 6–31), and a process called adaptation. This last process is a decrease in receptor sensitivity, which results in a decrease in action potential frequency in an afferent neuron despite a stimulus of constant strength (Figure 7–3).

$$A + M^* \bullet ADP \bullet P^i \longrightarrow \underset{\text{Actin binding}}{A \bullet M^* \bullet ADP \bullet P^i} \qquad (7\text{-}3)$$

A = mean number of elements

B = total number of elements

C = summary number of elements

Summary Box Title

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TABLE 25.1 A Table Title Spanning Two Lines Would Go in This Location

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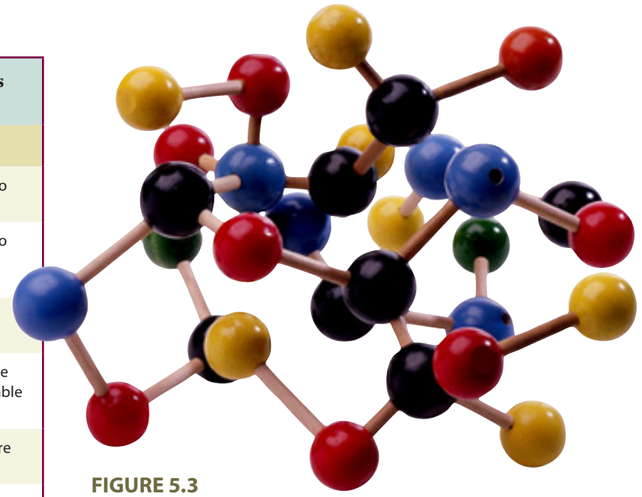

FIGURE 5.3

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All the receptors of a single afferent neuron are preferentially sensitive to the same type of stimulus; for example, they are all sensitive to cold or all to pressure. Adjacent sensory ously give rise either specialized endings of afferent neurons (Figure 7–1a) or separate cells that signal the afferent neurons by releasing specialized group chemical messengers (Figure 7–1b). There are many types of sensory receptors, each of which responds much more readily to one form of energy than to othin normal functioning is known as its adequate stimulus. In addition, within the energy type that serves as a receptor's adequate stimulus, a particular receptor responds best (i.e., at lowest threshold) to only a very narrow range of stimulus energies. For example, different individual receptors in the eye respond best to light (the adequate stimulus) in different wavelengths.

This is an Example of a Level-Three Head That is Long Enough to run on to Two Lines

How do we distinguish a strong stimulus from a weak one when the information about both stimuli is relayed by action potentials that are all the same size? The frequency of action For tentials in a single receptor is one way, since increased stimulus strength means a larger receptor potential and more frequent action potential firing (review Figure 7–2).

How Intensity Is Measured In addition to increasing the firing frequency in a single afferent neuron, stronger stimuli usually affect a larger area and activate similar receptors on the endings of other afferent neurons. For example, when you touch a surface lightly with a finger, the area of skin in contact with the surface is small, and only the receptors in that skin area are stimulated. Pressing down firmly increases the area of skin stimulated. This "calling in" of receptors on neurons is known as recruitment. In addition to increasing the firing frequency in a single afferent neuron, stronger stimuli usually affect a larger area and activate similar receptors on the endings of other afferent neurons. For example, when you touch a surface lightly with a finger, the area of skin in contact with the surface is small, and only the receptors in that skin area are stimulated. Pressing down firmly increases the area of skin stimulated. This "calling in" of receptors on afferent neurons is known as recruitment.

- To what degree is the substance filterable at the super cool renal corpuscle?
- Is it reabsorbed?
- Is it secreted?
- What factors homeostatically regulate the quantities filtered, reabsorbed, or secreted?

A third type of information to be signaled is the location of the stimulus—in other words, where the stimulus is being applied. It should be noted that in vision, hearing, and smell, stimulus location is interpreted as arising from the site from which the stimulus originated rather than on our body.

As mentioned earlier, a given receptor type is particularly sensitive to one stimulus modality—the adequate stimulus—because of the signal transduction mechanisms and ion channels incorporated in the receptor's plasma membrane.

[1] This is a sample footnote with an additional footnote falling below.

2 As shown here, the second sample footnote placed to base align with the adjacent column of text (right). Rule only appears above the first entry.

SECTION 2

Sample Section Title

This Exemplifes the Position of a Section Subtitle Across Extended Measure

5.3 This is a Sample of a Very Long Head Level One That Runs Over onto Three Lines

Converting stimulus energy into a signal that conveys the relevant sensory information to the central nervous system is termed coding. Important characteristics of a stimulus include the type of energy it represents, its intensity, and the location of the body it affects. Coding begins at the receptive neurons in the peripheral nervous system.

An Example of a Level-Two Head That is Long Enough to Run on to Two Lines

Stimulus location is coded by the site of a stimulated receptor, as well as by the fact that action potentials from each receptor travel along unique pathways to a specific region of the CNS associated only with that particular modality and body location. These distinct anatomical pathways are sometimes referred to as labeled lines. The precision, or acuity, with which we can locate and differentiate one stimulus from an adjacent one depends upon the amount of convergence of neuronal input in the specific ascending pathways: The greater the convergence, the less the acuity. Other factors affecting acuity are the size of the receptive field covered by a single sensory unit (Figure 7–6a), the density of sensory units, and the amount of overlap in nearby receptive fields. For example, it is easy to discriminate between two adjacent stimuli (two-point discrimination) applied to the skin on your lips, where the sensory units are small and numerous, but it is harder to do so on the back, where the relatively few sensory units are large and widely spaced (Figure 7–6b). Locating sensations from internal organs is less precise than from the skin because there are fewer afferent neurons in the internal organs and each has a larger receptive field.

It is fairly easy to see why a stimulus to a neuron that has a small receptive field can be located more precisely than a stimulus to a neuron with a large receptive field (Figure 7–6). However, more subtle mechanisms also exist that allow us to localize distinct stimuli within the receptive field of a single neuron. In some cases, receptive field overlap aids stimulus localization even though, intuitively, overlap would seem to "muddy" the image. In the next few paragraphs we will examine how this works.

Since the receptor endings of different afferent neurons overlap, however, a stimulus will trigger activity in more than one sensory unit. In Figure 7–8, neurons A and C, stimulated near the edges of their receptive fields where the receptor density is low, fire action potentials less frequently than neuron B, stimulated at the center of its receptive field. A high action potential frequency in neuron B occurring simultaneously with lower frequencies in A and C provides the brain with a more accurate localization of the stimulus near the center of neuron B's receptive field. Once this location is known, the brain can use the firing frequency of neuron B to determine stimulus intensity.

The phenomenon of lateral inhibition is the most important mechanism enabling the localization of a stimulus site. In lateral inhibition, information from afferent neurons whose receptors are at the edge of a stimulus is strongly inhibited compared to information from the stimulus's center. Figure 7–9 shows one neuronal arrangement that accomplishes lateral inhibition. The afferent neuron in the center (B) has a higher initial firing frequency than the neurons on either side (A and C). The number of action potentials transmitted in the lateral pathways is further decreased by inhibitory inputs to their postsynaptic cells as a result of the stimulation of inhibitory interneurons by the central neuron. While the lateral afferent neurons (A and C) also exert inhibition on the central pathway, their lower initial firing frequency has less of an effect. Thus, lateral inhibition enhances the contrast between the center and periphery of a stimulated region, thereby increasing the brain's ability to localize a sensory input. .

Lateral inhibition can be demonstrated by pressing the tip of a pencil against your finger. With your eyes closed, you can localize the pencil point precisely, even though the region around the pencil tip is also indented, activating mechanoreceptors within this region (Figure 7–10). Exact localization is possible because lateral inhibition removes the information from the peripheral regions.

Lateral inhibition is utilized to the greatest degree in the pathways providing the most accurate localization. For example, skin hair movements, which we can locate quite well, activate pathways that have significant lateral inhibition, but temperature and pain.

Receptors differ in the way they respond to a constantly maintained shows, some receptors respond very rapidly at the stimulus onset, but, after their initial burst of activity, fire only very slowly or stop firing altogether during the remainder of the stimulus. These are the rapidly adapting receptors. The rapid adaptation of these receptors codes for a restricted response in time to a stimulus, and they are important in signaling rapid change (e.g., vibrating or moving stimuli). Some receptors adapt so rapidly that they fire only a single action potential at the onset of a stimulus—a so-called "on response"—while others respond at the beginning of the stimulus and again at its removal—so-called "on-off responses." The rapid fading of the sensation of clothes pressing on one's skin is due to rapidly adapting receptors.

TABLE 25.2 **A Table Title Spanning Across a Full Text Page Width:** Including a Table Subtitle

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Table adapted from "Goodman and Gilman's The Pharmacological Basis of Theraputices," Joel G. Hardman and Lee E. Limbrit, Perry B. Molinoff, Raymond W. Ruddon, and Alfred Goodman.

*Note that in many effctor organs, there are both alpha-adrenergic and beta-adrenergic receptors. Activation of these receptors may produce either the same or opposing effects.

- Most sensory pathways convey information about only a single type of sensory information.
- Thus, one pathway is influenced only by information from mechanoreceptors, whereas another is influenced only by information from thermoreceptors.
- The ascending pathways in the spinal cord and brain that carry information about single types of stimuli are known as the specific ascending pathways.
- The specific pathways pass to the brainstem and thalamus, and the final neurons in the pathways go from there to specific sensory areas of the cerebral cortex versa.

To avoid confusion in the remainder of this chapter, recall from Chapter 5 that the term receptor has two completely different meanings. One meaning is that of "sensory receptor," as just defined. The second usage is for the individual proteins in the plasma membrane or inside the cell that bind specific chemical messengers, triggering an intracellular signal transduction pathsion between these two meanings it.

This Is the Second Level Heading

Slowly adapting receptors maintain their response at or near the initial level of firing regardless of the stimulus duration (Figure 7–11). These receptors signal slow changes or prolonged events, such as those that occur in the joint and muscle receptors that participate in the maintenance of upright posture when standing or sitting for long periods of time.

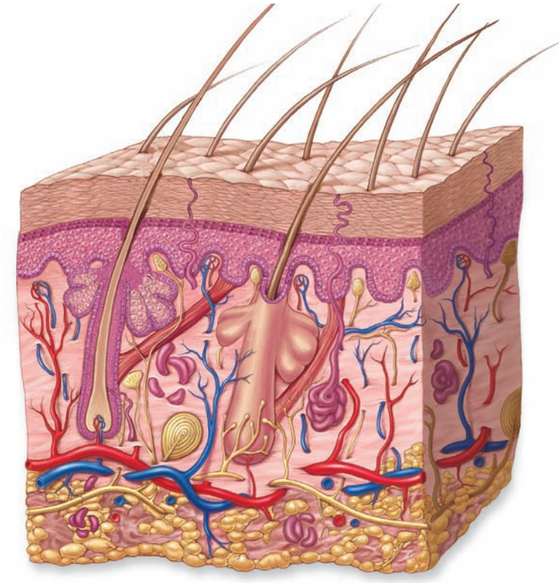

FIGURE 5.4

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BOX 25-1

Sample Box Title Set Across Measure

This is a Sample of a Box Head Level One That Runs Over onto Two Lines

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This is an Example of a Level-T wo Box Head That is Long Enough to Run on to Two Lines

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1. To what degree is the substance filterable at the corpuscle?
2. Is it reabsorbed?
3. Is it secreted?
4. What factors homeostatically regulate the quantities filtered, reabsorbed, or secreted?

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> Moreover, within an individual oganism, the properties of muscle cells differ from cells and epithelial cells because of the types of proteins type and the functions performed by these proteins.

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> Most sensory pathways convey information about only a single type of sensory information.
>
> Thus, one pathway is influenced only by information from mechanoreceptors, whereas another is influenced only.
>
> The specific pathways pass to the brainstem and thalamus, and the final neurons in the pathways go from there to specific sensory.

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- To what degree is the substance filterable at the corpuscle?
- Is it reabsorbed?
- What factors homeostatically regulate the quantities filtered, reabsorbed, or secreted?

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FIGURE 5–2
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Summary

The transduction process in all sensory receptors involves—either directly or indirectly—the opening or closing of ion channels in the receptor. Ions then flow across the, a receptor potential.

This is an Example of Unnumber List Title

1. **Sensory Processing** begins with the transformation of stimulus energy into graded potentials and then into action potentials in nerve fibers.
   - To what degree is the substance filterable at the corpuscle?
   - Is it reabsorbed?
   - What factors homeostatically regulate the quantities filtered, reabsorbed, or secreted?
2. **Information Carried** in a sensory system may or may not lead to a conscious awareness of the stimulus.

Sensory Receptors

I. Receptors translate information from the external and internal environments into graded potentials, which then.
   a. Receptors may be either specialized endings of afferent neurons or separate cells at the ends of the neurons.
   b. Receptors respond best to one form of stimulus energy, but they may respond to other energy forms if the stimulus intensity is abnormally high.
   c. Regardless of how a specific receptor is stimulated, activation sensation. Not all receptor activations.

II. The transduction process in all sensory receptors involves—either directly or indirectly—the opening or closing of ion channels in the receptor. Ions then flow across the membrane, causing a receptor potential.
   a. Receptor potential magnitude and action potential frequency increase as stimulus strength increases.
   b. Receptor potential magnitude varies with stimulus strength, rate of change of stimulus application, temporal summation of successive receptor potentials, and adaptation.

The transduction process in all sensory receptors involves—either directly or indirectly—the opening or closing of ion channels in the receptor. Ions then flow across the, a receptor potential. The transduction process in all sensory receptors involves—either directly or indirectly—the opening or closing of ion channels in the receptor. Ions then flow across the, a receptor potential.

This is an Example of Unnumber List Title

> Most sensory pathways convey information about only a single type of sensory information.
>
> Thus, one pathway is influenced only by information from mechanoreceptors, whereas another is influenced only by information from thermoreceptors.
>
> The ascending pathways in the spinal cord and brain that carry information about single types of stimuli are known as the specific ascending pathways.
>
> The specific pathways pass to the brainstem and thalamus, and the final neurons in the pathways go from there to specific sensory areas of the cerebral cortex versa.

The transduction process in all sensory receptors involves—either directly or indirectly—the opening or closing of ion channels in the receptor. Ions then flow across the, a receptor potential.

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Key Terms

acuity *216*
adaptation *214*
adequate stimulus *212*
ascending pathway *220*
auditory cortex *221*
central sulcus *221*
chemoreceptor *213*
coding *214*
cortical association area *221*
labeled lines *216*
lateral inhibition *218*
mechanoreceptor *212*
modality *215*
nociceptor *213*
nonspecific ascending pathway *221*
perception *212*
photoreceptor *212*
polymodal neuron *221*

1 This is a sample footnote with an additional footnote falling below.
2 As shown here, the second sample footnote placed to base align with the adjacent column of text (right). Rule only appears above the first entry.

Questions

(Answers appear in Appendix A.)

1. Choose the TRUE statement:
   a. The modality of energy a given sensory receptor responds to in normal functioning is known as the "adequate stimulus" for that receptor.
   b. Receptor potentials are "all-or-none," that is, they have the same magnitude regardless of the strength of the stimulus.
   c. When the frequency of action potentials along sensory neurons is constant continues, it is called "adaptation."
2. Using a single intracellular recording electrode, in what part of a sensory neuron could you simultaneously record both receptor potentials and action potentials?

Sensory Receptors

Receptors and Their Meaning

I. Receptors translate information from the external and internal environments into graded potentials, which then.
   a. Receptors may be either specialized endings.
   b. Receptors respond best to one form of stimulus energy.

II. The Transduction Process in all sensory receptors involves the opening or closing of ion channels in the receptor.

Critical Thinking Questions

(Answers appear in Appendix A.)

1. Describe several mechanisms by which pain could theoretically be controlled medically or surgically.
2. At what two sites would central nervous system injuries interfere with the perception thae perception that heat is being applied to either side of the body?
3. What would vision be like after a drug has destroyed all the cones in the retina?
4. Damage t(a) A person walks into a chair placed applied to the end of the chain or segment of code displayed. (b) The person does not walk into the chair, but she does not know what the chair can be used for.

Answers to Chapter Questions

Figure 12–12 (a) Muscle V is –90 mV and neuron is –70 mV. this illustrates the fact that V is not the same in all cells. (b) Muscle ation potential is due to

Figure 12–22 Contraction is isometric at B because muscle does not shorten. Maximal velocity is at A, zero muscle load.
- How does the nervous system code information about stimulus intensity?
- The nervous system code information about intensity?

Figure 12–23 (a) Muscle V is –90 mV and neuron is –70 mV. this illustrates the fact that V is not the same in all cells. (b) Muscle ation potential is due to Na entering on the depolarization and K leaving on the repolarization.

Figure 12–26c Biceps force x 5 cm = 7 kg x 25 cm. Biceps force = 35 kg (additional).

Figure 12–31 Contraction is isometric at B because muscle does not shorten. Maximal velocity is at A, with zero muscle

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ARIS

Taxonomy deals with the naming of organisms; each species is given a binomial name consisting of the genus and specific epispecies has been assigned. Consisting of the genus and specific epispecies has been assigned. When an organism is named, a species has been assigned to a particular genus consisting of the genus and specific epispecies has been assigned.

www.mhhe.com/ARIS/biologytitleandedition

Appendix Title Example

Appendix Subtitle

Goals and Orientation

Information about the external world and about the body's internal environment exists in different energy forms—pressure, temperature, light, odorants, sound waves, chemical concentration, and so on. Sensory receptors at the peripheral ends of afferent neurons change these energy forms into graded potentials that can initiate action potentials, which travel into the central nervous system. The receptors are either specialized endings of afferent neurons or separate cells that signal the afferent neurons by releasing chemical messengers.

1. To what degree is the substance filterable at the renal corpuscle?
2. Is it reabsorbed?
3. Is it secreted?
   - Is it reabsorbed?
   - Is it secreted?
4. What factors homeostatically regulate the quantities filtered, reabsorbed, or secreted?

There are many types of sensory receptors, each of which responds much more readily to one form of energy than to others. The type of energy to which a particular receptor relus. In addition, within the general energy type that serves as a receptor's adequate stimulus, a particular receptor responds best (i.e., at lowest threshold) to only a very narrow range.

Revision Highlights

There are several general classes of receptors that are characterized by the type of energy to which they are sensitive. As the name indicates, mechanoreceptors respond to mechanical pressure, and muscle tension.

Illustration Program

The transduction process in all sensory receptors involves the opening or closing of ion channels that receive—either directly or through a second-messenger system—information about the internal and external world. The ion channels are present in a membrane located at the distal tip of the cell's single axon or on the receptive membrane of specialized sensory cells.

This is an Example of Unnumber List Title

Chapter 1 Most sensory pathways convey information about only a single type of sensory information.

Chapter 2 Thus, one pathway is influenced only by information from mechanoreceptors, whereas another is influenced only by information from thermoreceptors.

Chapter 3 The ascending pathways in the spinal cord and brain that carry information about single types of stimuli are known as the specific ascending pathways.

Supplements

The specialized receptor membrane where the initial ion channel changes occur does not generate action potentials. Instead, local current from the receptor membrane flows a short distance along the axon to a region where the membrane has first node of Ranvier. The receptor potential, like the synaptic potential discussed in translated into the language of graded potentials or action potentials. The energy that impinges upon and activates a sen response to different stimulus intensities and diminishes as it travels down the membrane.

- To what degree is the substance filterable at the renal corpuscle?
- Is it reabsorbed?
- Is it secreted?
- What factors homeostatically regulate the quantities filtered, reabsorbed, or secreted?

A third type of information to be signaled is the location of the stimulus—in other words, where the stimulus is being and activates a sen that in vision, hearing, and smell, stimulus location is interpreted as arising from the site from which the stimulus originated rather than on our body.

1. To what degree is the substance filterable at the renal corpuscle?
2. Is it reabsorbed?
   a. Is it reabsorbed?
   b. Is it secreted?
3. What factors homeostatically regulate the quantities filtered, reabsorbed, or secreted?

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Chapter One

Test Questions

1-1 Most sensory pathways convey information about only a single type of sensory information.

1-2 Thus, one pathway is influenced only by information from mechanoreceptors, whereas another is influenced only by information from thermoreceptors.

1-3 The ascending pathways in the spinal cord and brain that carry information about single types of stimuli are known as the specific ascending pathways.

1-4 The specific pathways pass to the brainstem and thalamus, and the final neurons in the pathways go from there to specific sensory areas of the cerebral cortex versa.

1-5 Thus, one pathway is influenced only by information from mechanoreceptors, whereas another is influenced only by information from thermoreceptors.

1-6 The ascending pathways in the spinal cord and brain that carry information about single types of stimuli are known as the specific ascending pathways.

Chapter Two

Test Questions

2-1 Most sensory pathways convey information about only a single type of sensory information.

2-2 Thus, one pathway is influenced only by information from mechanoreceptors, whereas another is influenced only by information from thermoreceptors.

2-3 The ascending pathways in the spinal cord and brain that carry information about single types of stimuli are known as the specific ascending pathways.

2-4 The specific pathways pass to the brainstem and thalamus, and the final neurons in the pathways go from there sensory areas of the cerebral cortex versa.

2-5 Thus, one pathway is influenced only by information from mechanoreceptors, whereas another is influenced only by information from thermoreceptors.

2-6 The ascending pathways in the spinal cord and brain that carry information about single types of stimuli are known as the specific ascending pathways.

2-7 The ascending pathways in the spinal cord and brain that carry information about single types of stimuli are known as the specific ascending pathways.

2-8 The specific pathways pass to the brainstem and thalamus, and the final neurons in the pathways go from there sensory areas of the cerebral cortex versa.

2-9 The specific pathways pass to the brainstem and thalamus, and the final neurons in the pathways go from there sensory areas of the cerebral cortex versa.

Chapter Three

Test Questions

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3-2 Thus, one pathway is influenced only by information from mechanoreceptors, whereas another is influenced only by information from thermoreceptors.

3-3 The ascending pathways in the spinal cord and brain that carry information about single types of stimuli are known as the specific ascending pathways.

3-4 The specific pathways pass to the brainstem and thalamus, and the final neurons in the pathways go from there sensory areas of the cerebral cortex versa.

3-5 Thus, one pathway is influenced only by information from mechanoreceptors, whereas another is influenced only by information from thermoreceptors.

3-6 The ascending pathways in the spinal cord and brain that carry information about single types of stimuli are known as the specific ascending pathways.

3-7 The ascending pathways in the spinal cord and brain that carry information about single types of stimuli are known as the specific ascending pathways.

3-8 The specific pathways pass to the brainstem and thalamus, and the final neurons in the pathways go from there sensory areas of the cerebral cortex versa.

3-9 Thus, one pathway is influenced only by information from mechanoreceptors, whereas another is influenced only by information from thermoreceptors.

Chapter Four

Test Questions

4-1 Most sensory pathways convey information about only a single type of sensory information.

4-2 Thus, one pathway is influenced only by information from mechanoreceptors, whereas another is influenced only by information from thermoreceptors.

4-3 The ascending pathways in the spinal cord and brain that carry information about single types of stimuli are known as the specific ascending pathways.

4-4 The specific pathways pass to the brainstem and thalamus, and the final neurons in the pathways go from there to specific sensory areas of the cortex versa.

4-5 Thus, one pathway is influenced only by information from mechanoreceptors, whereas another is influenced only by information from thermoreceptors.

18-18 The ascending pathways in the spinal cord and brain that carry information about single types of stimuli are known as the specific ascending pathways.

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A

abscisic acid (ABA) (ab-SIZ-ik) A plant hormone that causes stomates to close and that initiates and maintains dormancy. 579

abscission (ab-SIZH-un) The dropping of leaves, fruits, or flowers from a plant. [L. ab, away, and sciss, cut] 579

acetylcholine (ACh) (uh-set-ul-KOH-leen) A neurotransmitter active in both the peripheral and central nervous systems. 718

acetylcholinesterase (AChE) (uh-set-ul-koh-luh-NES-tuh-rays) An enzyme that breaks down acetylcholine bound to postsynaptic receptors within a synapse. 718

acetyl-CoA A molecule made up of a two-carbon acetyl group attached to coenzyme A. The acetyl group enters the Krebs cycle for further oxidation. 145

acid A compound tending to raise the hydrogen ion concentration in a solution and to lower its pH numerically. [L. acidus, sour] 36

acid deposition The return to earth as rain or snow of the sulfate or nitrate salts of acids produced by commercial and industrial activities. 894

amphibian A member of a class of terrestrial vertebrates that includes frogs, toads, and salamanders; they are still tied to a watery environment for reproduction. [Gk. amph, on both sides] 512

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amylase A starch digesting enzyme secreted by salivary glands and pancreas. 671

angiosperm A flowering plant; the seeds are borne within a fruit. [Gk. ang, vessel, and sperm, seed] 457

annelid A member of the phylum Annelida, which includes clam worms, tubeworms, earthworms and leeches; characterized by a environment for reproduction. [Gk. amph, on segmented body. [L. annelus, little ring] 490

antigen A foreign substance, usually a protein or a polysaccharide, that stimulates the immune system to react, such as to produce antibodies. [Gk. anti, against, and gene, origin] 654

antigen A foreign substance, usually a protein, that stimulates the immune system to react, such as to produce . anti, against, and gene, origin] 641amphibian A member of a class of terrestrial vertebrates that includes frogs, toads, and salamanders; they are still tied to a watery environment for reproduction. [Gk. amph, on both sides] 512

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B

bacteriophage (bak-TEER-ee-uh-fayj) A virus that parasitizes a bacterial cell as its host, often destroying it by lytic action. [Gk. bact, rod, and phag, eat] 233, 398

bacterium (pl., bacteria) A unicellular organism that lacks a nucleus and cytoplasmic organelles other than ribosomes; reproduces by binary fission and occurs in one of three shapes (rod, sphere, spiral). [Gk. bact, rod] 66, 401

Barr body A dark-staining body (discovered by M. Barr) in the nuclei of female mammals which contains a condensed, inactive X chromosome. 263

base compound tending to lower the hydrogen ion concentration in a solution and raise its pH numerically. 36

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base A compound tending to lower the and raise its pH numerically. 36

base compound tending to lower the hydrogen ion concentration in a solution and raise its pH numerically. 36

C

C3 plant A plant that directly uses the Calvin cycle; the first detected molecule during photosynthesis is PGA, a three-carbon molecule. 130

C4 plant A plant that fixes carbon dioxide to produce a C4 molecule that releases carbon dioxide to the Calvin cycle. 130

Calvin cycle A series of photosynthetic reactions in which carbon dioxide is fixed and reduced in the chloroplast. 127

CAM plant A plant that fixes carbon dioxide at night to produce a C4 molecule that releases carbon dioxide to the Calvin cycle during the day; CAM stands for crassulacean-acid metabolism. 130

cancer A malignant tumor whose nondifferentiated cells exhibit loss of contact inhibition, uncontrolled growth, and the ability to invade tissues and metastasize. 268

capillary A microscopic blood vessel; gas and nutrient exchange occurs across the walls of a capillary. [L. capilla, hair] 630

carbohydrate A class of organic compounds consisting of carbon, hydrogen, and oxygen atoms; includes monosaccharides, disaccharides, and

I N D E X

Boldface page numbers corespond with boldface terms in the text. Page numbers followed by an "f" indicate figures; page numbers followed by a "t" indicate tabular material

A

B

C

Text Grid

BIOLOGY TEMPLATE B

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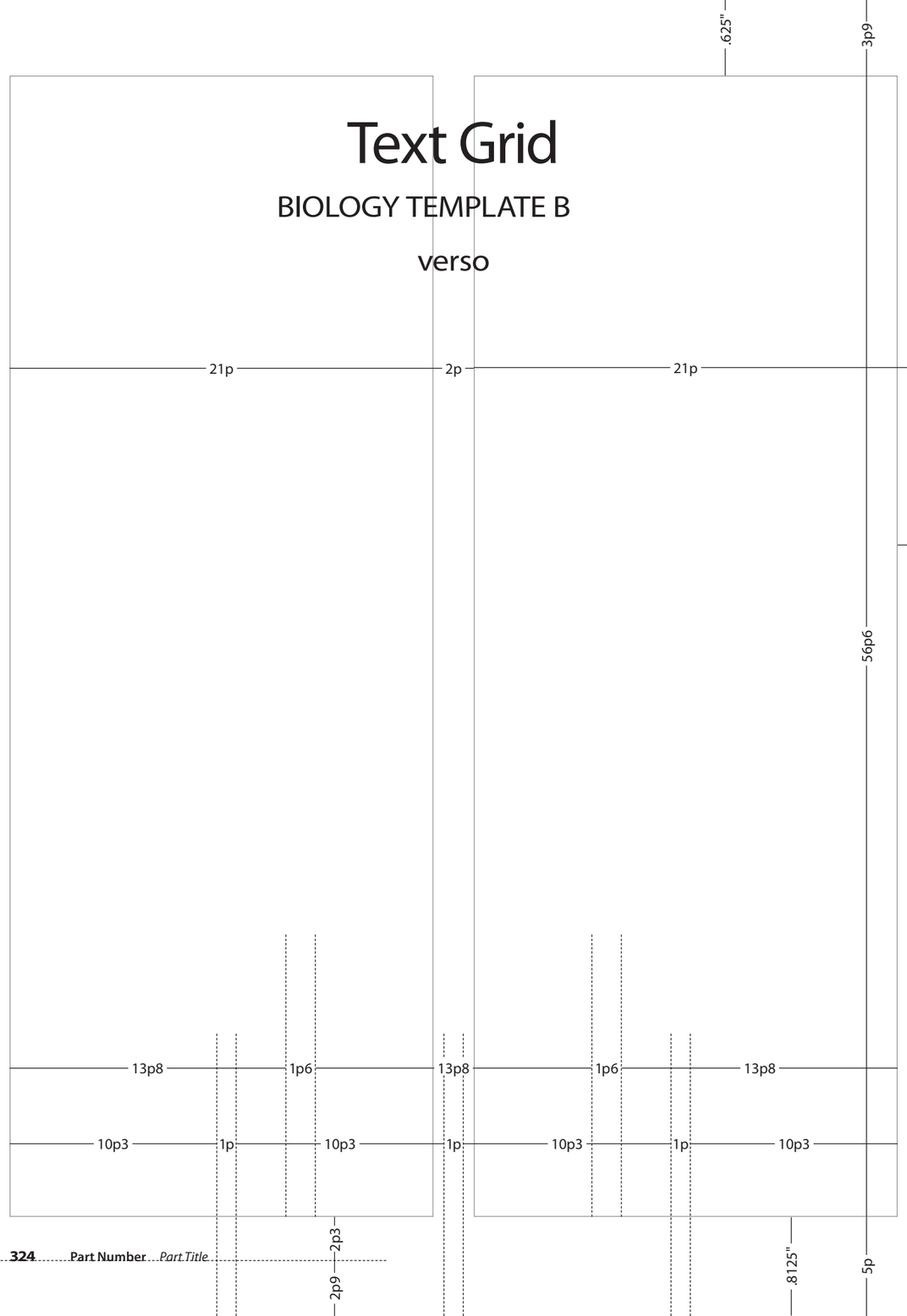

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BIOLOGY TEMPLATE B

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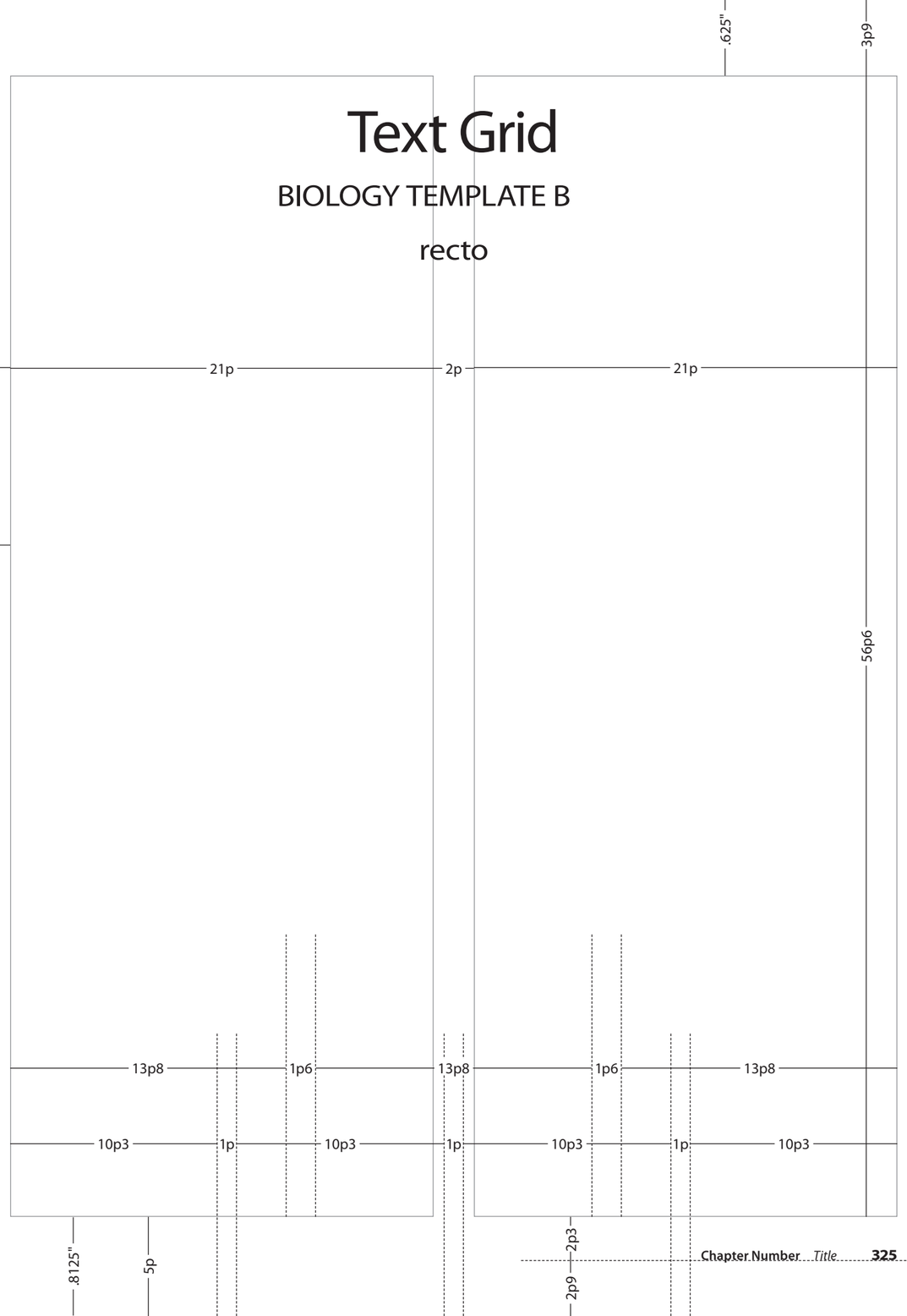

Color Palette

BIOLOGY TEMPLATE B

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F	C 17 M 0 Y 39 K 8	G	C 22 M 0 Y 47 K 12	H	C 20 M 0 Y 35 K 15	I	C 35 M 0 Y 55 K 30	J	C 75 M 0 Y 90 K 60		
K	C 12 M 0 Y 5 K 0	L	C 15 M 0 Y 13 K 0	M	C 22 M 0 Y 15 K 9	N	C 36 M 0 Y 18 K 25	O	C 70 M 0 Y 20 K 75		
P	C 0 M 0 Y 10 K 4	Q	C 0 M 0 Y 30 K 12	R	C 0 M 23 Y 39 K 26	S	C 0 M 45 Y 60 K 50	T	C 0 M 60 Y 73 K 73		
U	C 0 M 45 Y 0 K 64	V	C 0 M 75 Y 60 K 12	W	C 0 M 100 Y 65 K 25	X	C 0 M 100 Y 65 K 35	Y	C 0 M 100 Y 40 K 60		
Z	C 0 M 0 Y 8 K 25	AA	C 0 M 0 Y 0 K 25	BB	C 85 M 0 Y 0 K 65	CC	C 0 M 0 Y 50 K 70	DD	C 0 M 100 Y 0 K 60		

COLOR PALETTE, BIOLOGY C

BIOLOGY TEMPLATE

1 C-20 M-0 Y-5 K-2	5 C-20 M-5 Y-0 K-10	10 C-0 M-10 Y-30 K-10	15 C-0 M-7 Y-25 K-0
2 C-100 M-0 Y-40 K-30	6 C-75 M-35 Y-0 K-40	11 C-0 M-60 Y-75 K-30	16 C-0 M-100 Y-0 K-60
3 C-23 M-0 Y-40 K-5	7 C-0 M-8 Y-0 K-20	12 C-0 M-0 Y-10 K-10	
4 C-60 M-28 Y-71 K-0	8 C-28 M-44 Y-0 K-40	13 C-0 M-0 Y-18 K-25	
	9 C-28 M-55 Y-0 K-55	14 C-0 M-10 Y-30 K-60	

ftp_nm edition number

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Biology Title

Example of Biology Subtitle ftp_st

option C

ftp_au

Author Name One

ftp_af

Author One Affiliation

Author Name Two

Author Two Affiliation
Which Happens to Run on to Two Lines

Secondary Author Name

ftp_ha

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Secondary Author Name

Secondary Author Affiliation

Meet the Authors

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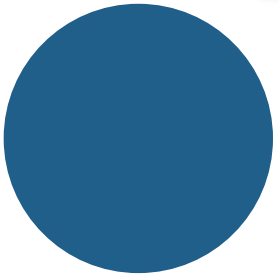

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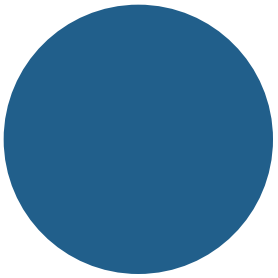
Author Two

Author Two Affiliation



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Author Three

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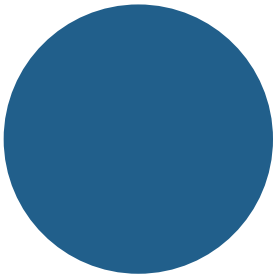

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Brief Contents

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In Dedication

For Our Familifdd_st

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Table of Contents

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Chapter 24

Sample Chapter Title 00

Chapter 25

A Chapter Title Sample That also Shows a Runover Line 00

Preface

fpr_tt

Goals and Orientation

fpr_ha

Information about the external world and about the body's internal environment exists in different energy forms—pressure, temperature, light, odorants, sound waves, chemical concentration, and so on. Sensory receptors at the peripheral ends of afferent neurons change these energy forms into graded potentials that can initiate action potentials, which travel into the central nervous system. The receptors are either specialized endings of afferent neurons or separate cells that signal the afferent neurons by releasing chemical messengers.

fpr_tx

1. To what degree is the substance filterable at the renal corpuscle?
2. Is it reabsorbed?
3. Is it secreted?
4. What factors homeostatically regulate the quantities filtered, reabsorbed, or secreted?

fpr_ln

There are many types of sensory receptors, each of which responds much more readily to one form of energy than to others. The type of energy to which a particular receptor responds in normal functioning is known as its adequate stimulus. In addition, within the general energy type that serves as a receptor's adequate stimulus, a particular receptor responds best (i.e., at lowest threshold) to only a very narrow range of stimulus energies.

Revision Highlights

There are several general classes of receptors that are characterized by the type of energy to which they are sensitive. As the name indicates, mechanoreceptors respond to mechanical pressure, and muscle tension. Thermoreceptors detect both sensations of cold and warmth, and photoreceptors respond to particular light wavelengths.

Illustration Program

fpr_hb

The transduction process in all sensory receptors involves the opening or closing of ion channels that receive—either directly or through a second-messenger system—information about the internal and external world. The ion channels are present in a membrane located at the distal tip of the cell's single axon or on the receptive membrane of specialized sensory cells.

fpr_lu

Chapter 1 Most sensory pathways convey information about only a single type of sensory information.

Chapter 2 Thus, one pathway is influenced only by information from mechanoreceptors, whereas another is influenced only by information from thermoreceptors.

Chapter 3 The ascending pathways in the spinal cord stimuli are known as the specific ascending pathways.

Chapter 4 The specific pathways pass to the brainstem and thalamus, and the final neurons in the pathways go from there to specific sensory areas of the cerebral cortex versa.

Illustration Program Highli

fpr_hc

The specialized receptor membrane where the initial ion channel changes occur does not generate action potentials.

The receptor potential, like the synaptic p fpr_qd
different stimulus intensities and diminishes as it travels down the membrane.

Jennifer Carr Burtwistle
Northeast Community C fpr_qdau

Instead, local current from the receptor membrane flows a short distance along the axon to a region where the

- To what degree is the substance filterable at the renal?
- Is it reabsorbed?
- Is it secreted?
- What factors homeostatically regulate the quantities filtered, reabsorbed, or secreted?

fpr_lb

A third type of information to be signaled is the location of the stimulus—in other words, where the stimulus is being location is than on our body.

Author Name fpr_au
Author Affiliation fpr_af

Preface Feature Box Title

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A-head design for Preface Feature

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1. To what degree is the substance filterable at the co fprba_ln
2. Is it reabsorbed?
3. Is it secreted?
4. What factors homeostatically regulate the quantities filtered, reabsorbed, or secreted?

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Most sensory pathways convey information about only a sing fprba_lu type of sensory information.
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- To what degree is the substance filterable at the corpuscle? fprba_lb
- Is it reabsorbed?
- What factors homeostatically regulate the quantities filtered, reabsorbed, or secreted?

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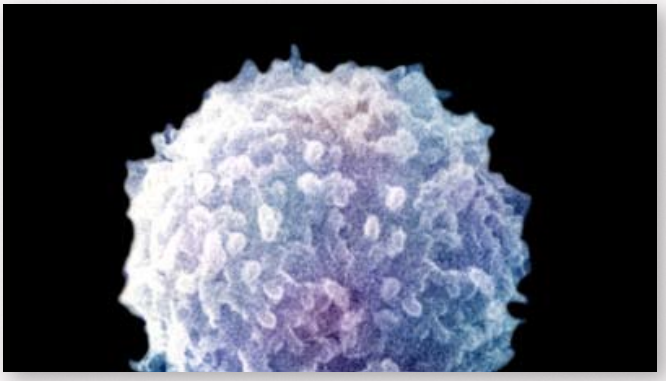

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Author Name
Author Affiliation

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ACKNOWLEDGMENTS

Acknowledgement A-he

fak_ha

The transduction process in all s eptors involves the opening or closing of ion channels that receive—either directin a membrane located at the distal tip of the cell's single axon or on the receptive membrane of specialized sensory cells.

fak_tx

Acknowledgement B-hea

fak_hb

The specialized receptor membrane where the initial ion channel changes occur does not generate action potentials. Instead, local membrane flows a short distance along the axon to a region where the membrane has first node of Ranvier.

The receptor potential, like the s tential discussed in translated into the language of graded potentials or action potentials.

fak_lu

The energy that impinges upon translated into the language of graded activates.

Fasen response to different stimulus intensities and diminishes as it travels down the membrane.

We are grateful to those colleagues who read one or more chapters during various stages of this revision.

Jennifer Carr Burtw

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Northeast Community Coll

fak_af

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Thiel College

bpt_nm

PART IV

bpt_tt

This is a Sample Part Title

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Part Chapters

bptop_ln

bpt_tx

She outstanding accomplishment of twentieth-century She outstanding accomplishment of twentieth-century biology has been the discover of the chemical basis of heridity and its relationship toprotein synthesis. Whether an organism is a human being or a mouse, has blue eyes or black, has light skin or dark, is determined by its proteins. Moreover, within an individual organism, the properties of muscle cells differ from those of nerve cells and epithelial cells because of the tuypes of proteins present in each cell type and the functions performed by synthesizing of the cell proteins. The instructions are into proteins.

bch_nm

Chapter 23

Sample Two-Line Chapter Opener bch_tt

bchop_tt

Chapter Outline

bchop_lu

Specific Sensory Systems

Somatic Sensation

Touch and Pressure
Sense of Posture and Movement
Temperature
Pain
Neural Pathways of the Somatosensory System

Vision

Light
Overview of Eye Anatomy
The Optics of Vision
Photoreceptor Cells and Phototransduction
Neural Pathways of Vision
Color Vision
Eye Movement

bchob_tt

Chapter Objectives

bchob_lb

- Understand how a packet-switching unix-based network works.
- Learn how hostnames are converted to IP addresses using the file /etc/hosts.
- Learn how hostnames are replaced with fully qualified domain names (FQDN) on the web or computer-based Internet.
- Use talk to conduct a real-time, text-based conversation with another user.

bchob_ln

1. Display details of users on a remote system with digit or finger.
2. Use telnet and rlogin to log on to a remote location machine.
3. Use ftp and rcp to transfer files between two remote machines.
4. Learn the configuration settings needed to enable the use of rlogin, rcp and rsh.

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PART IV Sample Part Title Goes in This

Chapter 11 Chapter Title

bch_st

With Sample Chapter Subtitle

Chapter Outline

Specific Sensory Systems

Somatic Sensation

- *Touch and Pressure*
- *Sense of Posture and Movement*
- *Temperature*
- *Pain*
- *Neural Pathways of the Somatosensory System*

Vision

- *Light*
- *Overview of Eye Anatomy*
- *The Optics of Vision*
- *Photoreceptor Cells and Phototransduction*
- *Neural Pathways of Vision*
- *Color Vision*
- *Eye Movement*

Hearing

- *Sound*
- *Sound Transmission in the Ear*
- *Hair Cells of the Organ of Corti*
- *Neural Pathways in Hearing*

Vestibular System

- *The Semicircular Canals*
- *The Utricle and Saccule*
- *Vestibular Information and Pathways*

Chemical Senses

- *Taste*
- *Smell*

Additional Clinical Examples

- *Hearing and Balance: Losing Both at Once*
- *Color Blindness*

Hearing

- *Sound*
- *Sound Transmission in the Ear*
- *Hair Cells of the Organ of Corti*
- *Neural Pathways in Hearing*

bchop_tx

The outstanding accomplishment of twentieth-century biology has been the discover of the chemical basis of heridity and its relationship toprotein synthesis. Whether an organism is a human being or a mouse, has blue eyes or black, has light skin or dark, is determined by its proteins. Moreover, within an individual organism, the properties of muscle cells differ from those of nerve cells and epithelial cells because of the tuypes of proteins present in each cell type and the functions performed by these synthesizing of the cell proteins. The instructions are into proteins.

The heredity material in each cell contains instructions for excellent synthesizing of the cell proteins. The instructions are coded into DNA molecules. Given that different cell types have different that daughter cells at the time of cell division. Cells differ in structure and function because on a portion of the total genetic information common to all cells is used by any given cell to synthesize proteins.

Chapter 5 This is a Sample of a Chapter Title in Three Lines

Chapter Outline

When the outstanding accomplishment of twentieth-century biology has been the discover of the chemical basis of heridity and its relationship toprotein synthesis. Whether an organism is a human being or a mouse, has blue eyes or black, has light skin or dark, is determined by its proteins. Moreover, within an individual organism, the properties of muscle cells differ from those of nerve cells and epithelial cells because of the types of proteins present in each cell type and the functions performed by proteins. The instructions are into proteins.

The heredity material in each cell contains bchop_tx no drop excellent synthesizing of the cell proteins. The instructions are coded into DNA molecules. Given that different cell types have different that the specifications for these proteins are coxded in DNA, one might be led to falsely conclude that different cell types do contain DNA molecules. However, this is not the case. All cells in the body, with the exception of sperm or egg cells, receive the same genetic information when DNA molecules duplicated and passed on to daughter cells at the time of cell division. Cells differ in structure and function because on a portion of the total genetic information common to all cells is used by any given cell to synthesize proteins. the tuypes of proteins present in each cell type and the functions performed by these synthesizing of the cell proteins. The instructions are into proteins.

5.1 Sample of the Level One H bch_ha

Information about the external world and about the body's internal environment exists in different energy forms—pressure, temperature, light, odorants, sound waves, chemical concentration, and so on. Sensory receptors at the peripheral e[illegible] bch_tx ent neurons change these energy forms into grade[illegible]ls that can initiate action potentials, which travel into the central nervous system.

> Moreover, within an individual oganism, the pro[illegible] bch_et muscle cells differ from those of nerve cells and e[illegible] cells because of the types of proteins present in each cell type and the functions performed by these proteins.

To avoid confusion in the remainder of this chapter, recall from Chapter 5 that the term receptor has two completely different meanings. One meaning is that of "sensory receptor," as just defined. The second usage is for the individual proteins in the plasma membrane or inside the cell that bind specific chemical messengers, triggering an intracellular signal transduction pathway that culminates in the cell's response. The potential confusion between these two meanings is magnified by the fact that the plasma membrane of the sensory receptor. If you are in doubt as to which meaning is intended, add the adjective "sensory" or "protein" to see which makes sense in the context.

bch_fgnm

Figure 5.1

This is a sample of a figure legend title bch_fgtt

bch_fgct [illegible]im etuercin ero odolore modolesto con eum velesse [illegible] sustrud tis nulla feugue vullutat, vel eum ad magnibh endre ero dolore essectet, quate mincilis nibh eugue tat aliquatu.

This Is the Second Level H bch_hb

The transduction process in all sensory receptors involves the opening or closing of ion channels that receive—either directly or through a second-messenger system—information about the internal and external world. The ion channels are present in a specialized receptor membrane located at the distal tip of the cell's single axon or on the receptive membrane of specialized sensory cells (Figure 7–1).

1. To what degree is the substar bch_ln le at the renal corpuscle?
2. Is it reabsorbed?
3. Is it secreted?
4. What factors homeostatically regulate the quantities filtered, reabsorbed, or secreted?

There are several general classes of receptors that are characterized by the type of energy to which they are sensitive. As the name indicates, mechanoreceptors respond to mechanical stimuli, such as pressure or stretch, and are responsible for many types of sensory information, including touch, blood pressure, and muscle tension. Thermoreceptors detect both sensations of cold and warmth, and photoreceptors respond to particular light wavelengths.

Figure 5.2

Essit lut wisi ex eu faccum duis ad ming euisl dolupta tueros accumsa ndiamcor si. Agnit ute del enibh exerostion ulla facilit, velesse quatem euguer summodit, quatissim quis augiamc onseniat utat. Duismod olorer si.

5.2 This is a Sample of a Head Level One Running onto Two Lines

Converting stimulus energy into a signal that conveys the relevant sensory information to the central nervous system is termed coding. Important characteristics of a stimulus include the type of energy it represents, its intensity, and the location of the body it affects. Coding begins at the receptive neurons in the peripheral nervous system.

This is an Example of a Level-Two Head That Runs onto Two Lines

Another term for stimulus type (heat, cold, sound, or pressure, for example) is stimulus modality. Modalities can be divided into submodalities: Cold and warm are submodalities of temperature, whereas salt, sweet, bitter, and sour are submodalities of taste. The type of sensory receptor a stimulus activates plays the primary role in coding the stimulus modality.

Third-Level Heads Appear as Sl

bch_hc

The specialized receptor membrane where the initial ion channel changes occur does not generate action potentials. Instead, local current from the receptor membrane flows a short distance along vier. The receptor potential, like the synaptic potential discussed in Chapter 6, is a graded response to different stimulus intensities (Figure 7–2) and diminishes as it travels down the membrane.

bchfe_tx

bchfe_lb

If the receptor membrane is on a separate cell, the receptor potential there alters the release of neurotransmitter from that cell. The neurotransmitter diffuses across the extracellucauses . The combination of neurotransmitter with its binding sites generates a graded potential in the afferent neuron analogous to either an excitatory postsynaptic potential or, in some cases, an postsynaptic potential.

Factors that control the magnitude of the receptor potential include stimulus strength, rate of change of stimulus strength, temporal summation of successive receptor potentials (see Figure 6–31), and a process called adaptation. This last process is a decrease in receptor sensitivity, which results in a decrease in action potential frequency in an afferent neuron despite a stimulus of constant strength (Figure 7–3).

bch_eq

bch_eqnm

$$A + M^{*} \bullet ADP \bullet P^{i} \xrightarrow[\text{Actin binding}]{} A \bullet M^{*} \bullet ADP \bullet P^{i} \qquad (7\text{-}3)$$

A = mean number of elements
B = total number of elements
C = summary number of elements

bch_eqlu

All the receptors of a single afferent neuron are preferentially sensitive to the same type of stimulus; for example, they are all

Summary Box Title bchfe_tt

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bch_tbnm

Table 25.1 **A Table Title Spanning Two Would Go in This Location** bch_tbtt

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bch_tbha This is a table A-Head
bch_tbln 1. A table numbered list would appear in this general way. And so this is how a table numbered list would look.
2. A table numbered list would appear in this general way. And so this is how this is how a table numbered list would look, if one were looking table numbered list.
3. A table numbered list would appear in this general way. And so to see what a table numbered list would appear to be.
4. List would appear in this general way. And so this is how a table numbered list would look, if one were looking to see what a table list would appear to be.
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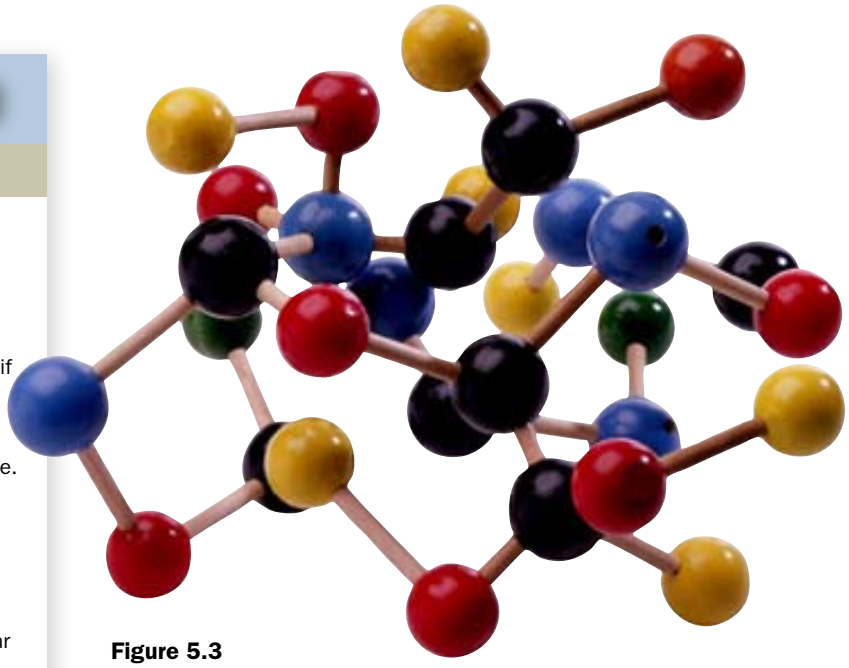

Figure 5.3

Essit lut wisi ex eu faccum duis ad ming euisl dolupta tueros accumsa ndiamcor si. Agnit ute del enibh exerostion ulla facilit, velesse quatem euguer summodit, quatissim quis augiamc onseniat utat. Duismod olorer si.

sensitive to cold or all to pressure. Adjacent sensory ously give rise either specialized endings of afferent neurons (Figure 7–1a) or separate cells that signal the afferent neurons by releasing specialized group chemical messengers (Figure 7–1b). There are many types of sensory receptors, each of which responds much more readily to one form of energy than to othin normal functioning is known as its adequate stimulus. In addition, within the energy type that serves as a receptor's adequate stimulus, a particular receptor responds best (i.e., at lowest threshold) to only a very narrow range of stimulus energies. For example, different individual receptors in the eye respond best to light (the adequate stimulus) in different wavelengths.

This is an Example of a Level-Three Head That is Long Enough to run on to Two Lines

How do we distinguish a strong stimulus from a weak one when the information about both stimuli is relayed by action potentials that are all the same size? The frequency of action For tentials in a single receptor is one way, since increased stimulus strength means a larger receptor potential and more frequent action potential firing (review Figure 7–2).

bch_hd

ow Intensity Is Measured In addition to increasing the firing frequency in a single afferent neuron, stronger stimuli usually affect a larger area and activate similar receptors on the endings of other afferent neurons. For example, when you touch a surface lightly with a finger, the area of skin in contact with the surface is small, and only the receptors in that skin area are stimulated. Pressing down firmly increases the area of skin stimulated. This "calling in" of receptors on neurons is known as recruitment. In addition to increasing the firing frequency in a single afferent neuron, stronger stimuli usually affect a larger area and activate similar receptors on the endings of other afferent neurons. For example, when you touch a surface lightly with a finger, the area of skin in contact with the surface is small, and only the receptors in that skin area are stimulated. Pressing down firmly increases the area of skin stimulated. This "calling in" of receptors on afferent neurons is known as recruitment.

- To what degree is the substance filterable at the super cool renal corpuscle? bch_lb
- Is it reabsorbed?
- Is it secreted?
- What factors homeostatically regulate the quantities filtered, reabsorbed, or secreted?

A third type of information to be signaled is the location of the stimulus—in other words, where the stimulus is being applied. It should be noted that in vision, hearing, and smell, stimulus location is interpreted as arising from the site from which the stimulus originated rather than on our body.

As mentioned earlier, a given receptor type is particularly sensitive to one stimulus modality—the adequate stimulus—because of the signal transduction mechanisms and ion channels incorporated in the receptor's plasma membrane. whose shape is transformed by light; these receptors also have intracellular mechanisms that cause changes in the pigment molecules to alter the activity of membrane ion channels and generate a receptor potential.

bch_fn

1 This is a sample footnote with an additional footnote falling below.
2 As shown here, the second sample footnote placed to base align with the adjacent column of text (right). Rule only appears above the first entry.

5.3 This is a Sample of a Very Long Head Level One That Runs Over onto Three Lines

Converting stimulus energy into a signal that conveys the relevant sensory information to the central nervous system is termed coding. Important characteristics of a stimulus include the type of energy it represents, its intensity, and the location of the body it affects. Coding begins at the receptive neurons in the peripheral nervous system.

This is an Example of a Level-Two Head That is Long Enough to Run on to Two Lines

Stimulus location is coded by the site of a stimulated receptor, as well as by the fact that action potentials from each receptor travel along unique pathways to a specific region of the CNS associated only with that particular modality and body location. These distinct anatomical pathways are sometimes referred to as labeled lines. The precision, or acuity, with which we can locate and differentiate one stimulus from an adjacent one depends upon the amount of convergence of neuronal input in the specific ascending pathways: The greater the convergence, the less the acuity. Other factors affecting acuity are the size of the receptive field covered by a single sensory unit (Figure 7–6a), the density of sensory units, and the amount of overlap in nearby receptive fields. For example, it is easy to discriminate between two adjacent stimuli (two-point discrimination) applied to the skin on your lips, where the sensory units are small and numerous, but it is harder to do so on the back, where the relatively few sensory units are large and widely spaced (Figure 7–6b). Locating sensations from internal organs is less precise than from the skin because there are fewer afferent neurons in the internal organs and each has a larger receptive field.

It is fairly easy to see why a stimulus to a neuron that has a small receptive field can be located more precisely than a stimulus to a neuron with a large receptive field (Figure 7–6). However, more subtle mechanisms also exist that allow us to localize distinct stimuli within the receptive field of a single neuron. In some cases, receptive field overlap aids stimulus localization even though, intuitively, overlap would seem to "muddy" the image. In the next few paragraphs we will examine how this works.

Since the receptor endings of different afferent neurons overlap, however, a stimulus will trigger activity in more than one sensory unit. In Figure 7–8, neurons A and C, stimulated near the edges of their receptive fields where the receptor density is low, fire action potentials less frequently than neuron B, stimulated at the center of its receptive field. A high action potential frequency in neuron B occurring simultaneously with lower frequencies in A and C provides the brain with a more accurate localization of the stimulus near the center of neuron B's receptive field. Once this location is known, the brain can use the firing frequency of neuron B to determine stimulus intensity.

The phenomenon of lateral inhibition is the most important mechanism enabling the localization of a stimulus site. In lateral inhibition, information from afferent neurons whose receptors are at the edge of a stimulus is strongly inhibited compared to information from the stimulus's center. Figure 7–9 shows one neuronal arrangement that accomplishes lateral inhibition. The afferent neuron in the center (B) has a higher initial firing frequency than the neurons on either side (A and C). The number of action potentials transmitted in the lateral pathways is further decreased by inhibitory inputs to their postsynaptic cells as a result of the stimulation of inhibitory interneurons by the central neuron. While the lateral afferent neurons (A and C) also exert inhibition on the central pathway, their lower initial firing frequency has less of an effect. Thus, lateral inhibition enhances the contrast between the center and periphery of a stimulated region, thereby increasing the brain's ability to localize a sensory input. Lateral inhibition can occur at different levels in the sensory pathways but typically happens at an early stage.

Lateral inhibition can be demonstrated by pressing the tip of a pencil against your finger. With your eyes closed, you can localize the pencil point precisely, even though the region around the pencil tip is also indented, activating mechanoreceptors within this region (Figure 7–10). Exact localization is possible because lateral inhibition removes the information from the peripheral regions.

Lateral inhibition is utilized to the greatest degree in the pathways providing the most accurate localization. For example, skin hair movements, which we can locate quite well, activate pathways that have significant lateral inhibition, but temperature and pain, which we can locate only poorly, activate pathways that use lateral inhibition to a lesser degree. Lateral inhibition is essential for retinal processing, where it enhances visual acuity.

Receptors differ in the way they respond to a constantly maintained stimulus—that is, in the way they undergo adaptation at the beginning of the stimulus indicates the stimulus strength, but after this initial response, the frequency differs widely in different types of receptors. As Figure 7–11 shows, some receptors respond very rapidly at the stimulus onset, but, after their initial burst of activity, fire only very slowly or stop firing altogether during the remainder of the stimulus. These are the rapidly adapting receptors. The rapid adaptation of these receptors codes for a restricted response in time to a stimulus, and they are important in signaling rapid change (e.g., vibrating or moving stimuli). Some receptors adapt so rapidly that they fire only a single action potential at the onset of a stimulus—a so-called "on response"—while others respond at the beginning

bch_tbnm bch_tbtt bch_tbst

Table 25.2 **A Table Title Spanning Across a Full Text Page Width:** Including a Table Subtitle

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bch_tbso

Table adapted from "Goodman and Gilman's The Pharmacological Basis of Th G. Hardman and Lee E. Limbrit, Perry B. Molinoff, Raymond W. Ruddon, and Alfred Goodman.

bch_tbfn

*Note that in many effctor organs, there are both alpha-adrenergic and beta-a rs. Activation of these receptors may produce either the same or opposing effects.

of the stimulus and again at its removal—so-called "on-off responses." The rapid fading of the sensation of clothes pressing on one's skin is due to rapidly adapting receptors.

Most sensory pathways convey information about only a single type of sensory information.

Thus, one pathway is influenced only by information from mechanoreceptors, whereas another is influenced only by information from thermoreceptors.

bch_lu

The ascending pathways in the spinal cord and brain that carry information about single types of stimuli are known as the specific ascending pathways.

The specific pathways pass to the brainstem and thalamus, and the final neurons in the pathways go from there to specific sensory areas of the cerebral cortex versa.

To avoid confusion in the remainder of this chapter, recall from Chapter 5 that the term receptor has two completely different meanings. One meaning is that of "sensory receptor," as just defined. The second usage is for the individual proteins in the plasma membrane or inside the cell that bind specific chemical messengers, triggering an intracellular signal transduction pathsion between these two meanings is magnified by the fact that the plasma membrane of the sensory receptor. If you are in doubt as to which meaning is intended, add the adjective "sensory" or "protein" to see which makes sense in the context.

This Is the Second Level Heading

Slowly adapting receptors maintain their response at or near the initial level of firing regardless of the stimulus duration (Figure 7–11). These receptors signal slow changes or prolonged events, such as those that occur in the joint and muscle receptors that participate in the maintenance of upright posture when standing or sitting for long periods of time.

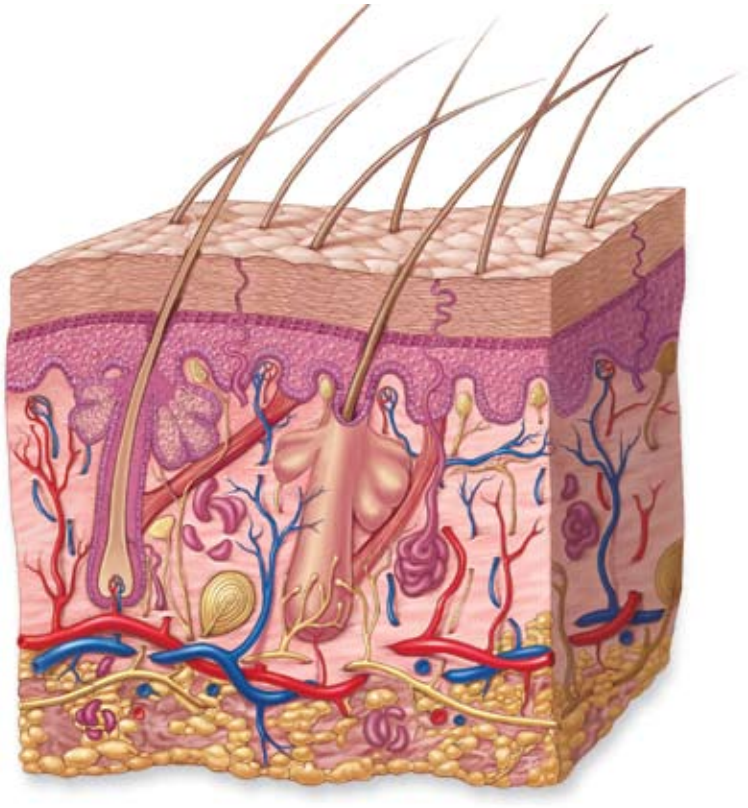

Figure 5.4

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bch_fgqi

bchba_nm

Box 25–1

bchba_tt

This Is a Sample Box Title

bchba_ha

s is a Sample of a Box Head Level One That Runs Over onto Two Lines

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s is an Example of a Level-T wo Box Head That is Long Enough to Run on to Two Lines

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bchba_ln

1. To what degree is the substance filterable at the corpuscle?
2. Is it reabsorbed?
3. Is it secreted?
4. What factors homeostatically regulate the quantities filtered, reabsorbed, or secreted?

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Box Table 25–1 **itle Spanning Two Lines Would Go in This Location**

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ble numbered list would appear in this general way. And so this is how a table numbered list would look.
2. A table numbered list would appear in this general way. And so this is how this is how a table numbered list would look, if one were looking table numbered list.
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> Moreover, within an individual oganism, the propertie cells differ from cells and epithelial cells because of the types of proteins type and the functions performed by these proteins.

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Most sensory pathways convey information about only a single type of sensory information.

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Thus, one pathway is influenced only by information f mechanoreceptors, whereas another is influenced only by.

The specific pathways pass to the brainstem and thalamus, and the final neurons in the pathways go from there to specific sensory.

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bchba_lb

- To what degree is the substance filterable at t
- Is it reabsorbed?
- What factors homeostatically regulate the quantities filtered, reabsorbed, or secreted?

bchba_fn

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Figure 5–

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bchba_fgct

Summary

bsu_tt

The transduction process in all sensory re bsu_tx volves—either directly or indirectly—the opening or closing of ion channels in the receptor. Ions then flow across the, a receptor potential.

bsu_lntt

1. **Sensory Processing** begins with the t bsu_ln tion of stimulus energy into graded potentials and then into action potentials in nerve fibers.
   - To what degree is the substance filter bsu_lnlb corpuscle?
   - Is it reabsorbed?
   - What factors homeostatically regulate the quantities filtered, reabsorbed, or secreted?
2. **Information Carried** in a sensory system may or may not lead to a conscious awareness of the stimulus.

bsu_tbln

bsu_ha

Sensory Receptors

I. Receptors translate information from bsu_la l and internal environments into graded potentials, which then.
   a. Receptors may be either specialized endings of afferent neurons or separate cells at the ends of the bsu_lb urons.
   b. Receptors respond best to one form of stimulus energy, but they may respond to other energy forms if the stimulus intensity is abnormally high.
   c. Regardless of how a specific receptor is stimulated, activation sensation. Not all receptor activations lead, however, to conscious sensations.

II. The transduction process in all sensory receptors involves—either directly or indirectly—the opening or

bsu_tbcn

Unnumbered Summary Table Column Hea

1. A table numbered list would appear in this general way. And so this is how a table numbered list would look.
2. A table numbered list would appear in this general way. And so this is how this is how a table numbered list would look, if ne were looking table numbered list.
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Key Terms

bchce_tt

bchce_lu

acuity 216
adaptation 214
adequate stimulus 212
ascending pathway 220
auditory cortex 221
central sulcus 221
chemoreceptor 213
coding 214
cortical association area 221
labeled lines 216
lateral inhibition 218
mechanoreceptor 212
modality 215
nociceptor 213
nonspecific ascending pathway 221
perception 212
photoreceptor 212
polymodal neuron 221

Questions

bchce_tt

(Answers appea bchce_tx *ix A.)*

1. Choose the TRUE statement:
   a. The modality of energy a given sensory receptor responds to in normal functioning is known as the "adequate stimulus" for that receptor.
   b. Receptor potentials are "all-or-none," that is, they have the same magnitude regardless of the strength of the stimulus.
   c. When the frequency of action potentials along sensory neurons is constant continues, it is called "adaptation."
   d. When sensory units have large receptive fields, the acuity of perception is greater.
   e. The "modality" refers to the intensity of a given stimulus.
2. Using a single intracellular recording electrode, in what bchce_ln part of a sensory neuron could you simultaneously record both receptor potentials and action potentials?
   a. in the cell body
   b. at the node of Ranvier nearest the periphera bchce_lnla
   c. at the receptor membrane where the stimulus occurs
   d. at the central axon terminals within the CNS

Sensory Receptors bchce_ha

I. Receptors translate information from the external and internal environments into graded potentials, wh bchce_la
   a. Receptors may be either specialized endings of afferent neurons or separate cells at the ends of the neurons.
   b. Receptors respond best to one form of stimulus energy, but they may respond to other energy forms if the stimulus intensity is abnormally high.
   c. Regardless of how a specific receptor is stimulated, activation sensation. Not all receptor activations lead, however, to conscious sensations.

II. The Transduction Process in all sensory rece bchce_latt involves—either directly or indirectly—the opening or closing of ion

_____ bchce_lafi

_____

Critical Thinking Qu

bchce_tt

(Answers appear in Appendix A.) bchce_tx

1. Describe several mechanisms by which pain could theoretically be controlled medically or surgically.
2. At what two sites would central nervous system injuries interfere with the perception that heat is being applied to nervous system injury interfere with the perception that heat is being applied to either side of the body?
3. What would vision be like after a drug has destroyed all the cones in the retina?
4. Damage to what parts of the cerebral cortex could explain the following behaviors? (a) A person walks into a chair placed applied to the end of the chain or segment of code displayed. (b) The person does not walk into the chair, but she does not know what the chair can be used for.

bchce_ln

Answers to Chapter Q ons

bchce_tt

Figure 12–12 (a) Muscle V is –90 m bchce_lu is –70 mV. this illustrates the fact that V is not the same in all cells. (b) Muscle ation potential is due to Na entering on the depolarization and K leaving on the repolarization.

Figure 12–22 Contraction is isometric at B because muscle does not shorten. Maximal velocity is at A, with zero muscle load.

- How does the nervous system co about bchce_lulb stimulus intensity?
- The nervous system code information about intensity?

Figure 12–23 (a) Muscle V is –90 mV and neuron is –70 mV. this illustrates the fact that V is not the same in all cells. (b) Muscle ation potential is due to Na entering on the depolarization and K leaving on the repolarization.

Figure 12–26c Biceps force x 5 cm = 7 kg x 25 cm. Biceps force = 35 kg (additional).

Figure 12–31 Contraction is isometric at B because muscle does not shorten. Maximal velocity is at A, with zero muscle load.

Unnumbered Summary Table Column He bchce_tbcn

1. A table numbered list would appear in this general way. And bchce_tbln this is how a table numbered list would look.
2. A table numbered list would appear in this general way. And so this is how this is how a table numbered list would look, if one were looking table numbered list.
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ARIS

bchce_ur

Taxonomy deals with the naming of organisms; each species is given a binomial name consisting of the genus and specific epispecies has been assigned. When an organism is named, a species has been assigned to a particular genus.

www.mhhe.com/ARIS/biologytitleandedition

bchce_fn

[1] This is a sample footnote with an additional footnote falling below.

[2] As shown here, the second sample footnote placed to base align with the adjacent column of text (right). Rule only appears above the first entry.

Appendix A

eap_nm

eap_tt

Appendix title example

eap_st

Appendix Subtitle

Goals and Orientation

eap_ha

Information about the external world and about the body's internal environment exists in different eap_tx rms—pressure, temperature, light, odorants, sound waves, chemical concentration, and so on. Sensory receptors at the peripheral ends of afferent neurons change these energy forms into graded potentials that can initiate action potentials, which travel into the central nervous system. The receptors are either specialized endings of afferent neurons or separate cells that signal the afferent neurons by releasing chemical messengers.

1. To what degree is the substance filt eap_ln he renal corpuscle?
2. Is it reabsorbed?
3. Is it secreted?
   - Is it reabsorbed?
   - Is it secreted?

   eap_lnlb
4. What factors homeostatically regulate the quantities filtered, reabsorbed, or secreted?

There are many types of sensory receptors, each of which responds much more readily to one form of energy than to others. The type of energy to which a particular receptor relus. In addition, within the general energy type that serves as a receptor's adequate stimulus, a particular receptor responds best (i.e., at lowest threshold) to only a very narrow range.

Revision Highlights

There are several general classes of receptors that are characterized by the type of energy to which they are sensitive. As the name indicates, mechanoreceptors respond to mechanical pressure, and muscle tension. Thermoreceptors detect both sensations of cold and warmth, and photoreceptors respond to particular light wavelengths.

Illustration Program

eap_hb

The transduction process in all sensory receptors involves the opening or closing of ion channels that receive—either directly or through a second-messenger system—information about the internal and external world. The ion channels are present in a membrane located at the distal tip of the cell's single axon or on the receptive membrane of specialized sensory cells.

eap_lutt **hapter 1** Most sensory pathways con eap_lu ation about only a single type of sensory information.

Chapter 2 Thus, one pathway is influenced only by information from mechanoreceptors, whereas another is influenced only by information from thermoreceptors.

Chapter 3 The ascending pathways in the spinal cord and brain that carry information about single types of stimuli are known as the specific ascending pathways.

Chapter 4 The specific pathways pass to the brainstem and thalamus, and the final neurons in the pathways go from there to specific sensory areas of the cerebral cortex versa.

Supplements

The specialized receptor membrane where the initial ion channel changes occur does not generate action potentials. Instead, local current from the receptor membrane flows a short distance along the axon to a region where the membrane has first node of Ranvier. The receptor potential, like the synaptic potential discussed in translated into the language of graded potentials or action potentials. The energy that impinges upon and activates a sen response to different stimulus intensities and diminishes as it travels down the membrane.

- To what degree is the substance f the renal corpuscle?

  eap_lb
- Is it reabsorbed?
- Is it secreted?
- What factors homeostatically regulate the quantities filtered, reabsorbed, or secreted?

A third type of information to be signaled is the location of the stimulus—in other words, where the stimulus is being and activates a sen that in vision, hearing, and smell, stimulus location is interpreted as arising from the site from which the stimulus originated rather than on our body.

1. To what degr eap_lnla ubstance filterable at the renal corpuscle?
2. Is it reabsorbed?
   a. Is it reabsorbed?
   b. Is it secreted?
3. What factors homeostatically regulate the quantities filtered, reabsorbed, or secreted?

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[1] This is a sample footnote with an additional footno eap_fn ow.

[2] As shown here, the second sample footnote placed to base align with the adjacent column of text (right). Rule only appears above the first entry.

Answer Key

esa_tt

Chapter One

esa_ha

esa_hb

esa_ln

Test Questions

1-1 Most sensory pathways convey information about only a single type of sensory information.

1-2 Thus, one pathway is influenced only by information from mechanoreceptors, whereas another is influenced only by information from thermoreceptors.

1-3 The ascending pathways in the spinal cord and brain that carry information about single types of stimuli are known as the specific ascending pathways.

1-4 The specific pathways pass to the brainstem and thalamus, and the final neurons in the pathways go from there to specific sensory areas of the cerebral cortex versa.

1-5 Thus, one pathway is influenced only by information from mechanoreceptors, whereas another is influenced only by information from thermoreceptors.

1-6 The ascending pathways in the spinal cord and brain that carry information about single types of stimuli are known as the specific ascending pathways.

Chapter Two

Test Questions

2-1 Most sensory pathways convey information about only a single type of sensory information.

2-2 Thus, one pathway is influenced only by information from mechanoreceptors, whereas another is influenced only by information from thermoreceptors.

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2-4 The specific pathways pass to the brainstem and thalamus, and the final neurons in the pathways go from there sensory areas of the cerebral cortex versa.

2-5 Thus, one pathway is influenced only by information from mechanoreceptors, whereas another is influenced only by information from thermoreceptors.

2-6 The ascending pathways in the spinal cord and brain that carry information about single types of stimuli are known as the specific ascending pathways.

2-7 The ascending pathways in the spinal cord and brain that carry information about single types of stimuli are known as the specific ascending pathways.

2-8 The specific pathways pass to the brainstem and thalamus, and the final neurons in the pathways go from there sensory areas of the cerebral cortex versa.

Chapter Three

Test Questions

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3-2 Thus, one pathway is influenced only by information from mechanoreceptors, whereas another is influenced only by information from thermoreceptors.

3-3 The ascending pathways in the spinal cord and brain that carry information about single types of stimuli are known as the specific ascending pathways.

3-4 The specific pathways pass to the brainstem and thalamus, and the final neurons in the pathways go from there sensory areas of the cerebral cortex versa.

3-5 Thus, one pathway is influenced only by information from mechanoreceptors, whereas another is influenced only by information from thermoreceptors.

3-6 The ascending pathways in the spinal cord and brain that carry information about single types of stimuli are known as the specific ascending pathways.

3-7 The ascending pathways in the spinal cord and brain that carry information about single types of stimuli are known as the specific ascending pathways.

3-8 The specific pathways pass to the brainstem and thalamus, and the final neurons in the pathways go from there sensory areas of the cerebral cortex versa.

3-9 Thus, one pathway is influenced only by information from mechanoreceptors, whereas another is influenced only by information from thermoreceptors.

Chapter Four

Test Questions

4-1 Most sensory pathways convey information about only a single type of sensory information.

4-2 Thus, one pathway is influenced only by information from mechanoreceptors, whereas another is influenced only by information from thermoreceptors.

4-3 The ascending pathways in the spinal cord and brain that carry information about single types of stimuli are known as the specific ascending pathways.

4-4 The specific pathways pass to the brainstem and thalamus, and the final neurons in the pathways go from there to specific sensory areas of the cortex versa.

4-5 Thus, one pathway is influenced only by information from mechanoreceptors, whereas another is influenced only by information from thermoreceptors.

18-18 The ascending pathways in the spinal cord and brain that carry information about single types of stimuli are known as the specific ascending pathways.

References

erf_tt

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Glossary

egl_tt

A

egl_ha

abscisic acid (ABA) (ab-SIZ-ik) A plant hormone that causes stomates to close and that initiates and maintains dormancy. 579

egl_tm

scission (ab-SIZH-un) The dropping egl_df fruits, or flowers from a plant. [L. ab, away, and sciss, cut] 579

acetylcholine (ACh) (uh-set-ul-KOH-leen) A neurotransmitter active in both the peripheral and central nervous systems. 718

acetylcholinesterase (AChE) (uh-set-ul-koh-luh-NES-tuh-rays) An enzyme that breaks down acetylcholine bound to postsynaptic receptors within a synapse. 718

acetyl-CoA A molecule made up of a two-carbon acetyl group attached to coenzyme A. The acetyl group enters the Krebs cycle for further oxidation. 145

acid A compound tending to raise the hydrogen ion concentration in a solution and to lower its pH numerically. [L. acidus, sour] 36

acid deposition The return to earth as rain or snow of the sulfate or nitrate salts of acids produced by commercial and industrial activities. 894

amphibian A member of a class of terrestrial vertebrates that includes frogs, toads, and salamanders; they are still tied to a watery environment for reproduction. [Gk. amph, on both sides] 512

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amylase A starch digesting enzyme secreted by salivary glands and pancreas. 671

angiosperm A flowering plant; the seeds are borne within a fruit. [Gk. ang, vessel, and sperm, seed] 457

annelid A member of the phylum Annelida, which includes clam worms, tubeworms, earthworms and leeches; characterized by a environment for reproduction. [Gk. amph, on segmented body. [L. annelus, little ring] 490

antigen A foreign substance, usually a protein or a polysaccharide, that stimulates the immune system to react, such as to produce antibodies. [Gk. anti, against, and gene, origin] 654

antigen A foreign substance, usually a protein, that stimulates the immune system to react, such as to produce . anti, against, and gene, origin] 641amphibian A member of a class of terrestrial vertebrates that includes frogs, toads, and salamanders; they are still tied to a watery environment for reproduction. [Gk. amph, on both sides] 512

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acid deposition The return to earth as rain or snow of the sulfate or salts of acids produced by commercial and industrial activities. 894

B

bacteriophage (bak-TEER-ee-uh-fayj) A virus that parasitizes a bacterial cell as its host, often destroying it by lytic action. [Gk. bact, rod, and phag, eat] 233, 398

bacterium (pl., bacteria) A unicellular organism that lacks a nucleus and cytoplasmic organelles other than ribosomes; reproduces by binary fission and occurs in one of three shapes (rod, sphere, spiral). [Gk. bact, rod] 66, 401

Barr body A dark-staining body (discovered by M. Barr) in the nuclei of female mammals which contains a condensed, inactive X chromosome. 263

base compound tending to lower the hydrogen ion concentration in a solution and raise its pH numerically. 36

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C

C3 plant A plant that directly uses the Calvin cycle; the first detected molecule during photosynthesis is PGA, a three-carbon molecule. 130

C4 plant A plant that fixes carbon dioxide to produce a C4 molecule that releases carbon dioxide to the Calvin cycle. 130

Calvin cycle A series of photosynthetic reactions in which carbon dioxide is fixed and reduced in the chloroplast. 127

CAM plant A plant that fixes carbon dioxide at night to produce a C4 molecule that releases carbon dioxide to the Calvin cycle during the day; CAM stands for crassulacean-acid metabolism. 130

cancer A malignant tumor whose nondifferentiated cells exhibit loss of contact inhibition, uncontrolled growth, and the ability to invade tissues and metastasize. 268

capillary A microscopic blood vessel; gas and nutrient exchange occurs across the walls of a capillary. [L. capilla, hair] 630

carbohydrate A class of organic compounds consisting of carbon, hydrogen, and oxygen atoms; includes monosaccharides, disaccharides, and polysaccharides. [L. carbo, charcoal, and Gk. hydr, water] 45

carbon dioxide (CO_2) fixation Photosynthetic reaction in which carbon dioxide is attached to an organic compound. 128

carbonic anhydrase An enzyme in red blood cells that speeds the formation of carbonic acid from water and carbon dioxide. [Gk. an, without, and hydr, water] 691

cancer A malignant tumor whose nondifferentiated cells exhibit loss of contact inhibition, uncontrolled growth, and the ability to invade tissues and metastasize. 268

CAM plant A plant that fixes carbon dioxide at night to produce a C4 molecule that releases carbon dioxide to the Calvin cycle crassulacean-acid metabolism. 130

capillary A microscopic blood vessel; gas and nutrient exchange occurs across the walls of a capillary. [L. capilla, hair] 630

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carbohydrate A class of organic compounds consisting of carbon, hydrogen, and disaccharides, and polysaccharides. [L. carbo, charcoal, and Gk. hydr, water] 45

Index

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Boldface page numbers c
with boldface terms in the text. Page numbers followed by an "f" indicate figures; page numbers followed by a "t" indicate tabular material

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A

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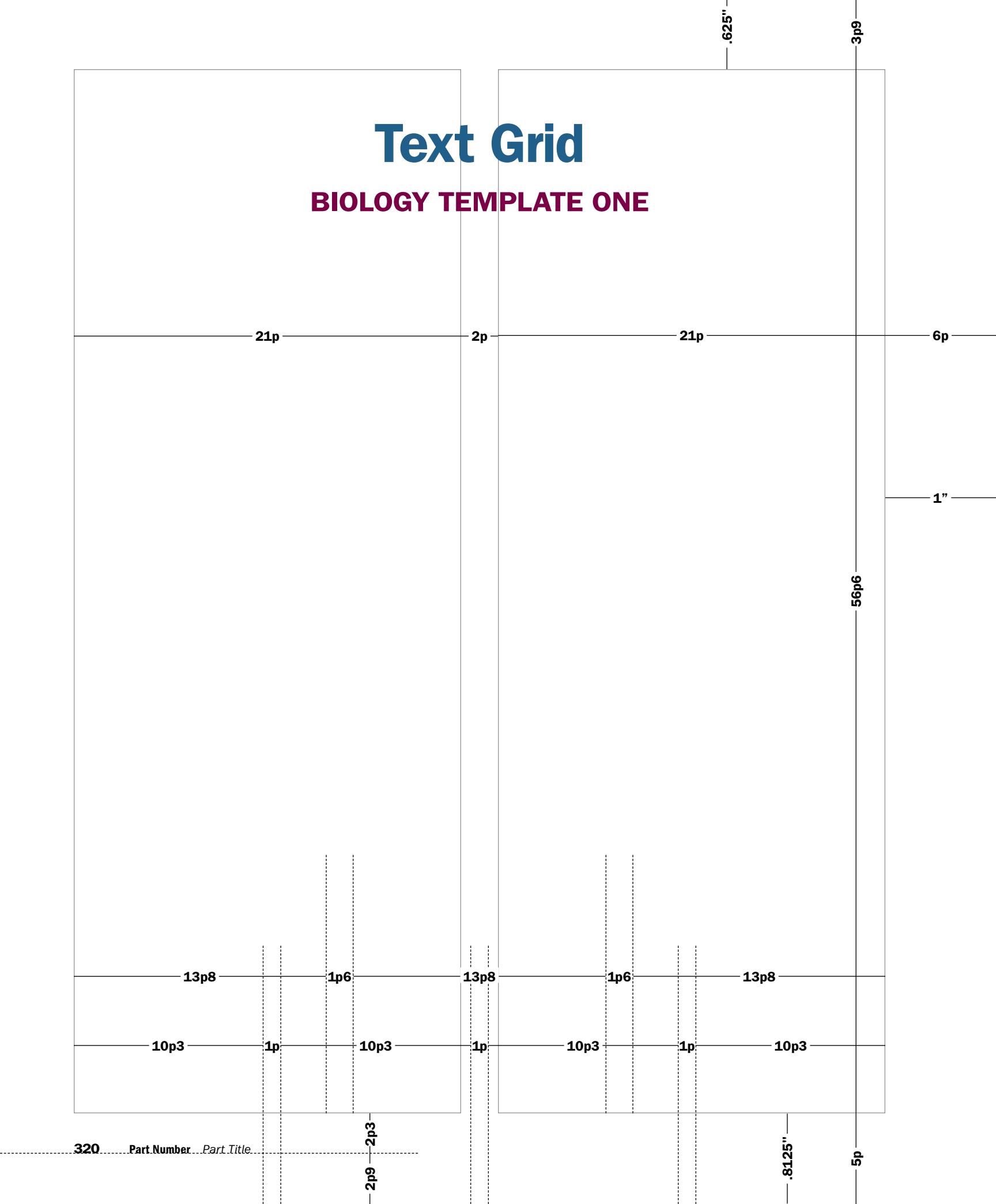
B

C

Text Grid

BIOLOGY TEMPLATE ONE



The phenomenon of lateral inhibition is the most important mechanism enabling the localization of a stimulus site. In lateral inhibition, information from afferent neurons whose receptors are at the edge of a stimulus is strongly inhibited compared to information from the stimulus's center. Figure 7–9 shows one neuronal arrangement that accomplishes lateral inhibition. The afferent neuron in the center (B) has a higher initial firing frequency than the neurons on either side (A and C). The number of action potentials transmitted in the lateral pathways is further decreased by inhibitory inputs to their postsynaptic cells as a result of the stimulation of inhibitory interneurons by the central neuron. While the lateral afferent neurons (A and C) also exert inhibition on the central pathway, their lower initial firing frequency has less of an effect. Thus, lateral inhibition enhances the contrast between the center and periphery of a stimulated region, thereby increasing the brain's ability to localize a sensory input. Lateral inhibition can occur at different levels in the sensory pathways but typically happens at an early stage.

Lateral inhibition can be demonstrated by pressing the tip of a pencil against your finger. With your eyes closed, you can localize the pencil point precisely, even though the region around the pencil tip is also indented, activating mechanoreceptors within this region (Figure 7–10). Exact localization is possible because lateral inhibition removes the information from the peripheral regions.

Lateral inhibition is utilized to the greatest degree in the pathways providing the most accurate localization. For example, skin hair movements, which we can locate quite well, activate pathways that have significant lateral inhibition, but temperature and pain, which we can locate only poorly, activate pathways that use lateral inhibition to a lesser degree.

Receptors differ in the way they respond to a constantly maintained stimulus—that is, in the way they undergo adaptation at the beginning of the stimulus indicates the stimulus strength, but after this initial response, the frequency differs widely in different types of receptors. The rapid adaptation of these receptors codes for a restricted response in time to a stimulus, and they are important in signaling rapid change (e.g., vibrating or moving stimuli).

Summary

The transduction process in all sensory receptors involves—either directly or indirectly—the opening or closing of ion channels in the receptor. Ions then flow across the, a receptor potential.

bsu_lutt

Sensory Processing begins with the transforr bsu_lu stimulus energy into graded potentials and then into action potentials in nerve fibers.

- To what degree is the substance filterable at the corpuscle?
- Is it reabsorbed?
- What factors homeostatically regulate the quantities filtered, reabsorbed, or secreted?

Information Carried in a sensory system may or may not lead to a conscious awareness of the stimulus.

Sensory Receptors

I. Receptors translate information from the external and internal environments into graded potentials, which then.
   a. Receptors may be either specialized endings of afferent neurons or separate cells at the ends of the neurons.
   b. Receptors respond best to one form of stimulus energy, but they may respond to other energy forms if the stimulus intensity is abnormally high.
   c. Regardless of how a specific receptor is stimulated, activation sensation. Not all receptor activations lead, however, to conscious sensations.

II. The transduction process in all sensory receptors involves—either directly or indirectly—the opening or

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1. A table numbered list would appear in this general way. And so this is how a table numbered list would look.
2. A table numbered list would appear in this general way. And so this is how this is how a table numbered list would look, if one were looking table numbered list.
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Key Terms

acuity 216
adaptation 214
adequate stimulus 212
ascending pathway 220
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chemoreceptor 213
coding 214
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