

Adult Basic Education  
Science

---

# Biology 3101A

## Maintaining Dynamic Equilibrium II

# Study Guide

**Prerequisite:**      Biology 2101A  
                            Biology 2101C

**Credit Value:**      1

**Text:** *Biology*.      Bullard, Chetty, et al; McGraw-Hill Ryerson, 2003.

**Biology Concentration**

Biology1106A  
Biology 2101A  
Biology 2101B  
Biology 2101C  
**Biology 3101A**  
Biology 3101B  
Biology 3101C



## Table of Contents

To the Student .....	v
Introduction to Biology 3101A .....	v
Use of Science Study Guides .....	vi
Recommended Evaluation .....	vii
Unit 1 - Nervous System: Structures .....	Page 1
Unit 2 - Nervous System: Neurons .....	Page 3
Unit 3 - Nervous System: Disrupting Homeostasis .....	Page 5
Unit 4 - Nervous System: Sense Organs .....	Page 6
Unit 5 - Endocrine System: Maintaining Homeostasis .....	Page 7
Unit 6 - Endocrine System: Feedback Mechanisms .....	Page 11
Appendix A .....	Page 13
Appendix B .....	Page 21



## To the Student

### I. Introduction to Biology 3101A

Biology 3101A is the first of three courses (the others are Biology 3101B and Biology 3101C) that are equivalent to Biology 3201 in the current high school system.

**Biology 2101A, *The Cell*, and Biology 2101C, *Maintaining Dynamic Equilibrium I*, are pre-requisites for this course.** However, before deciding to leave out any courses in the Biology concentration, you should ensure that you are aware of the courses you need to complete in order to meet the entrance requirements for the receiving post-secondary institution that you plan to attend.

Biology 3101A will identify and introduce the role of the nervous (electrochemical) and endocrine (chemical) systems in the body. Cells, tissues, organ systems and ultimately organisms must maintain a biological balance despite changing external conditions. Homeostasis is the state of internal balance so critical to existence. It represents a dynamic equilibrium, displaying constant interactions and checks and balances both within organisms and between organisms and their environment. There are a variety of systems within living things responsible for the maintenance of this delicate balance.

## To the Student

### II. Use of Science Study Guides

Before beginning this course, ensure you have the text and any other resources needed (*see the information in the Introduction to this course for specifics*).

As you work through the Study Guide, you will see that it is divided according to the Units listed in the Table of Contents. When you open a unit it will have the following components:

#### **Reading for this Unit:**

Here you will find the chapters, sections and pages of the text you will use to cover the material for this unit. Skim the sections of the textbook, look at the titles of the sections, scan the figures and read any material in the margins. Once you have this overview of the unit, you are ready to begin. Do not be intimidated by the content. You will work through the text, section by section, gaining knowledge and understanding of the material as you go.

References and Notes	Work to Submit
This left hand column guides you through the material to read from the text. Read any highlighted notes that follow the reading instructions. The symbols   direct you to the questions that you should complete when finished a reading assignment..	<p>You come across three (3) headings in this right hand column.</p> <p><b>Writing:</b> This section comprises your notes for the unit. Here you will find either written questions or references to specific questions or problems from your text. You may want to write out each question followed by the answer. This material should be checked by your instructor before moving on to the next unit. Mathematical problems should have their solutions checked <u>as you go</u>.</p> <p><b>Laboratory:</b> This section indicates if there is a Core Lab that should be completed for the unit. Let the instructor know in advance that you will be ready for the lab. A lab report should be submitted for each Core Lab. Your instructor will provide guidelines as to how s/he wants the report written.</p> <p><b>Assignment:</b> This section indicates if there is an assignment that should be completed for the Unit. The information in the “References and Notes” column will indicate how you obtain the assignment. These assignments frequently relate the science content to technology, society and the environment.</p>

## To the Student

### **III. Recommended Evaluation**

Written Notes	10%
Labs/Assignments	20%
Test(s)	20%
Final Exam ( <i>entire course</i> )	<u>50%</u>
	100%

**The overall pass mark for the course is 50%.**



## Unit 1 - Nervous System: Structures

To fulfill the objectives of this unit, students should complete the following:

### Reading for this unit: *Biology*

Chapter 12: Section 12.1: pages 392 - 401

“Organization of the Nervous System”: Figure 1: Appendix A

References and Notes	Work to Submit
<p><i>Referring to pages 392-394 and 399-401, write answers for questions 1.1 - 1.5</i>  </p>	<p><b>Writing:</b></p> <p>1.1 Name the 2 parts that make up the human nervous system.</p> <p>1.2 What are the 2 parts of the central nervous system (CNS)?</p> <p>1.3 What is the function of the CNS?</p> <p>1.4 What is the function of the spinal cord?</p> <p>1.5 Explain how the parts of the brain and spinal cord are protected.</p>

## Unit 1 - Nervous System: Structures

References and Notes	Work to Submit
<p><i>Referring to pages 392-394 and 399-401, write answers for questions 1.6 - 1.7 □ □</i></p> <p><b>Note:</b> <i>You should practice labelling the diagrams until you are able to do it without looking in the text.</i></p> <p><i>See your instructor to discuss which questions you should do from the “Section Review” and/or “Chapter Review” and any additional work that may be required for this unit.</i></p>	<p><b>Writing:</b></p> <p>1.6 (a) Explain the function of the parts of the following parts of the brain:</p> <ul style="list-style-type: none"><li>(i) cerebrum</li><li>(ii) cerebellum</li><li>(iii) medulla oblongata</li><li>(iv) thalamus</li><li>(v) hypothalamus</li><li>(vi) midbrain</li><li>(vii) pons</li><li>(viii) corpus callosum</li></ul> <p>(b) Label the diagram of the brain (found in Appendix A).</p> <p>1.7 (a) What are the 2 divisions of the peripheral nervous system? In terms of control, how are these 2 different?</p> <p>(b) What are the 2 divisions of the autonomic nervous system (ANS)?</p> <p>(c) Explain the functions of each of these 2 divisions of the ANS.</p>

## Unit 2 - Nervous System: Neurons

To fulfill the objectives of this unit, students should complete the following:

**Reading for this unit:** *Biology*

Chapter 12: Section 12.1: pages 392 and 395

Chapter 9: Section 9.1: pages 300 - 302

### Review:

You should review the concepts of **dynamic equilibrium, negative feedback loop, sensory receptors, integrator** and **effectors** before moving on in this section. You will find these concepts discussed on pages 300-302.

A negative feedback loop is a process that detects and reverses deviations from normal body constants.

In order for a nervous response to occur, there are four requirements:

1. **Sensory receptors** - these are found throughout the body and include the skin, eye, ear, tongue and nose.
2. **Impulse transmission** - transmission from the sensory receptors and back to the effectors is done by neurons ( you will learn more about neurons in this unit).
3. **Interpretation and analysis of the impulses** - the brain and spinal cord are the parts of the nervous system that serve to accomplish this.
4. **Effectors** - these receive information from the integrator (brain or spinal cord) and make changes to the body (e.g. a gland, an organ, a muscle).

## Unit 2 - Nervous System: Neurons

References and Notes	Work to Submit
<p><i>Referring to the above review, write an answer for question 2.1</i></p> <p>►►</p> <p><i>Referring to section 12.1, pages 395-396, write answers for questions 2.2 - 2.5</i> ►►</p>	<p><b>Writing:</b></p> <p>2.1 What are the four requirements necessary for a nervous response to occur?</p> <p>2.2 Define the terms neuron and nerve.</p> <p>2.3 What is a reflex arc?</p> <p>2.4 (a) Label the diagram of a neuron (found in Appendix A) . (b) Explain the function of the axon, dendrite and cell body.</p> <p>2.5 Describe what happens during a simple reflex such as touching something hot.</p>
<p><i>In addition to the terms for which you are writing definitions, you should know how to use the following terms correctly as you complete the writing for this section:</i></p> <ul style="list-style-type: none"><li>■ <i>reflex</i></li><li>■ <i>sensory neuron</i></li><li>■ <i>motor neuron</i></li><li>■ <i>interneuron</i></li></ul> <p><i>Referring to Investigation 12.A; “The Nervous System and Reflex Responses”, pages 396-397, do the following</i> ►►</p> <p><b>Note:</b> “Exploring Further” section of Lab is not required.</p> <p><i>See your instructor to discuss which questions you should do from the “Section Review” and/or “Chapter Review” and any additional work that may be required for this unit.</i></p>	<p><b>Laboratory:</b></p> <p>2.6 Complete the investigation and record your observations.</p> <p>2.7 Complete <i>Post Lab Questions and Conclude and Apply</i> section.</p>

## Unit 3 - Nervous System: Disrupting Homeostasis

To fulfill the objectives of this unit, students should complete the following:

<b>Reading for this unit:</b>	<i>Biology</i>
Chapter 12:	Section 12.1: pages 398-399 Section 12.2: pages 404-408
Assignment 1:	“Nervous System Disorders”: Appendix B
Assignment 2:	“Drugs and Homeostasis”: Appendix B

References and Notes	Work to Submit
<p><i>Assignment 1 is found in Appendix B of this Study Guide. Refer to pages 406-408 and 398-399 to do the assignment.</i>  </p> <p><i>Assignment 2 is found in Appendix B of this Study Guide. Read the material carefully and complete the assigned questions</i>  </p> <p><b>Note:</b> <i>The material covered in the assignments will not be tested. You should submit the completed assignments to your instructor for marking.</i></p> <p><i>See your instructor to discuss which questions you should do from the “Section Review” and/or “Chapter Review” and any additional work that may be required for this unit.</i></p>	<p><b>Assignment :</b></p> <p>3.1 Complete Assignment 1, “<i>Nervous System Disorders</i>”.</p> <p><b>Assignment :</b></p> <p>3.2 Complete Questions 1- 4 in the <i>Understanding Concepts</i> section of Assignment 2, “<i>Drugs and Homeostasis</i>”.</p> <p><b>Optional :</b></p> <p>3.3 Complete 1 or more of the questions in the <i>Extensions</i> section. (Discuss this option with your instructor.)</p>

## Unit 4 - Nervous System: Sense Organs

To fulfill the objectives of this unit, students should complete the following:

**Reading for this unit:** *Biology*

Chapter 12: Section 12.3: pages 409 - 416

### References and Notes

*Referring to pages 409-413,  
write answers for questions  
4.1 - 4.4*  

#### Note:

*You should practice labelling the  
diagram until you are able to do  
it without looking in the text.*

### Work to Submit

#### Writing:

4.1. Label the diagram of the eye found in Appendix A.  
4.2 Describe and give the function of each of the following parts of the eye

- (i) lens
- (ii) iris
- (iii) retina
- (iv) cornea
- (v) choroid layer
- (vi) fovea centralis
- (vii) rods
- (viii) cones
- (ix) pupil
- (x) blind spot
- (xi) optic nerve
- (xii) aqueous humour
- (xiii) vitreous humour

4.3 Describe the path of light through each part of the eye, from the outermost structure to the retina.

4.4 Explain how the amount of light entering the eye is regulated.

## Unit 4 - Nervous System: Sense Organs

### References and Notes

*Referring to pages 414-416, write answers for questions 4.5 - 4.8*



#### Note:

*You should practice labelling the diagrams until you are able to do it without looking in the text.*

### Work to Submit

#### Writing:

4.5 Label the diagram of the ear found in Appendix A.

4.6 Into what 3 sections is the human ear divided?

4.7 Describe and give the function of each of the following parts of the ear and indicate the section of the ear in which each is located.

- (i) pinna
- (ii) tympanic membrane
- (iii) ossicles (i.e., malleus, incus, stapes)
- (iv) eustachian tube
- (v) semi-circular canals
- (vi) cochlea
- (vii) auditory nerve

4.8 Describe the path of a sound wave through the ear.  
( Start with the pinna and end with the auditory nerve.)

*See your instructor to discuss which questions you should do from the “Section Review” and/or “Chapter Review” and any additional work that may be required for this unit.*

## Unit 5 - Endocrine System: Maintaining Homeostasis

To fulfill the objectives of this unit, students should complete the following:

### Reading for this unit: *Biology*

Chapter 13: Introduction: page 420  
Section 13.1: pages 422 - 426  
Section 13.2: pages 427-440  
Section 13.2: pages 441- 446  
Chapter 15: Section 15.1: pages 486 - 487  
pages 490-491

### References and Notes

Referring to pages 422 - 426, write answers for questions 5.1 - 5.3 □ □

In addition to the terms for which you are writing definitions, you should know how to use the following terms correctly as you complete the writing for this section:

- *endocrine system*
- *endocrine gland*
- *steroid hormone*
- *non-steroid hormone*

### Work to Submit

#### Writing:

5.1 (a) Define hormone.  
(b) What is meant by target organ?

5.2 (a) Label the diagram (found in Appendix A) showing the location of the principal endocrine glands in the human body.  
(b) Describe the general function of each of the glands you labelled.

## Unit 5 - Endocrine System: Maintaining Homeostasis

References and Notes	Work to Submit	
	5.3 Copy and complete the following table comparing steroid and non-steroid hormones:	
	Fat soluble?	Steroid
	Location of receptors	Non-steroid
	Action	

## Unit 5 - Endocrine System: Maintaining Homeostasis

References and Notes	Work to Submit
<p><i>Referring to, pages 428, 430, 442,435-436,444 , write answers for question 5.4</i> □ □</p>	<p><b>Writing:</b></p> <p>5.4 For each of the hormones listed below, give the following information:</p> <ul style="list-style-type: none"><li>(i) whether it is a steroid or non steroid hormone,</li><li>(ii) where it is produced,</li><li>(iii) its general effects.</li></ul> <ul style="list-style-type: none"><li>(a) HGH - human growth hormone</li><li>(b) ADH - Anti-diuretic hormone</li><li>(c) thyroxine</li><li>(d) insulin</li><li>(e) glucagon</li><li>(f) adrenaline</li></ul>

## Unit 6 - Endocrine System: Feedback Mechanisms

To fulfill the objectives of this unit, students should complete the following:

**Reading for this unit:** *Biology*

Chapter 13: Section 13.2: pages 431- 439

### References and Notes

*Referring to pages 431, 432, 435,436, write answers for questions 6.1 - 6.3* □ □

*In addition to the terms for which you are writing definitions, you should know how to use the following terms correctly as you complete the writing for this section:*

- oxytocin
- pancreas
- TSH - thyroid stimulating hormone

*Assignment 3 is found in Appendix B of this Study Guide. Refer to pages 429, 432 - 433, 437,439 to do the assignment.* □□

**Note:**

***The material covered in the assignments will not be tested. You should submit the completed assignments to your instructor for marking.***

### Work to Submit

**Writing:**

- 6.1 Draw a diagram (flow chart) to show how negative feedback by hormones keeps the amount of thyroxine at a level suitable to the body's needs.
- 6.2 Explain how the hormone oxytocin illustrates a positive feedback loop.
- 6.3 Explain how the level of blood sugar is regulated by controlled release of insulin and glucagon

**Assignment:**

- 6.4 Complete Assignment 3, “Endocrine System Disorders”.

**Laboratory:**

- 6.5 See your instructor to find out if there is a lab that you should complete in this unit.

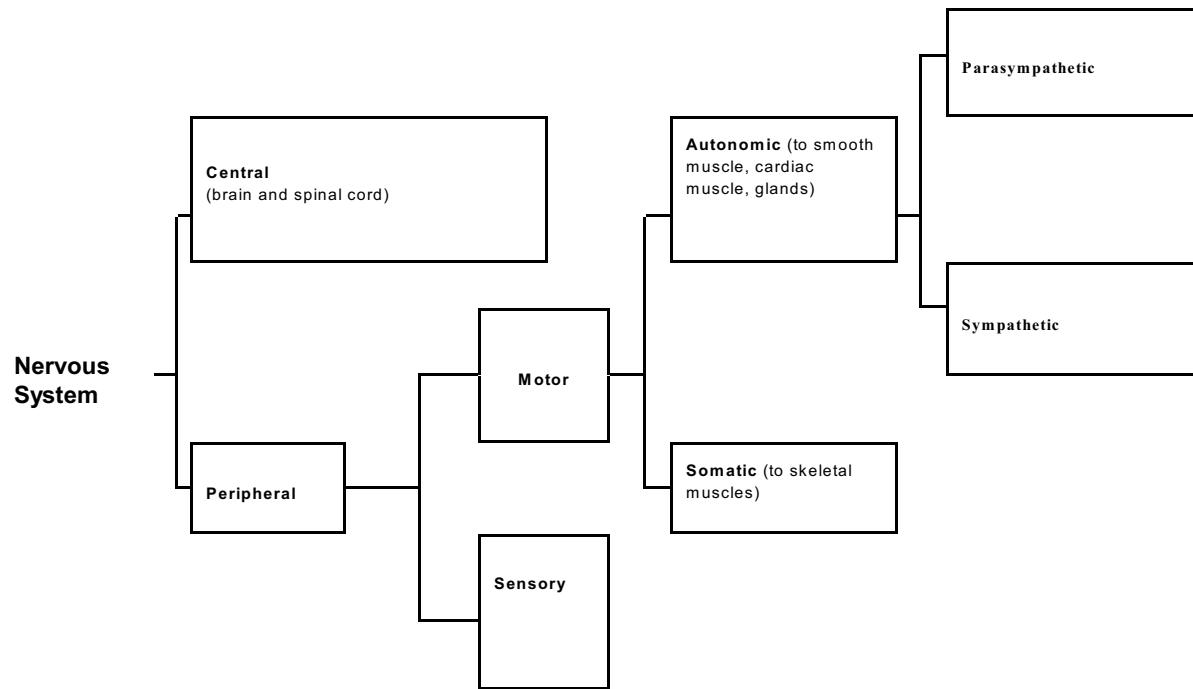


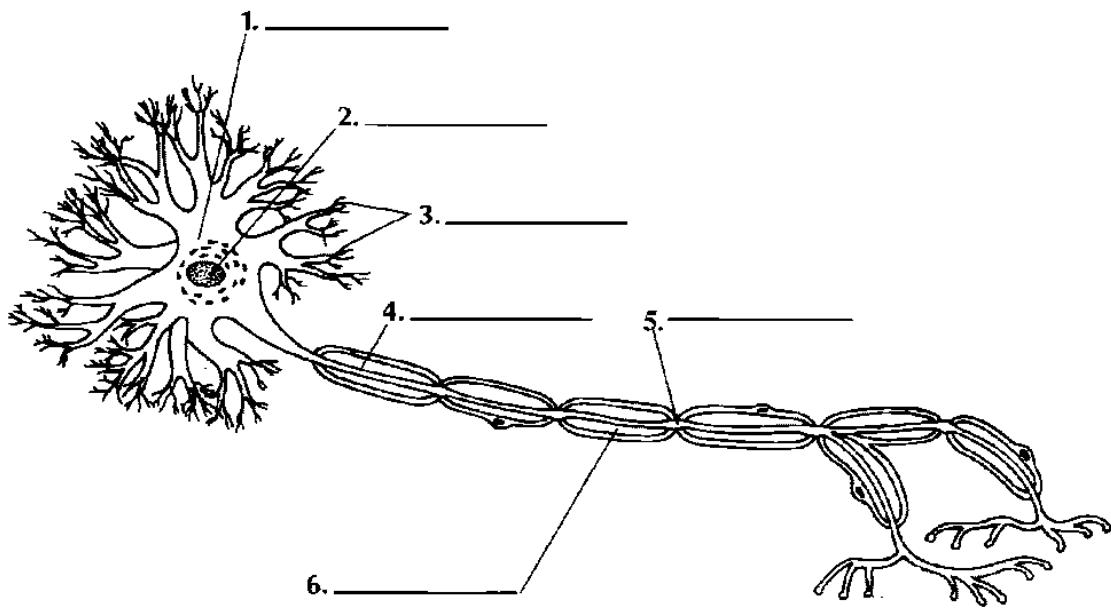
# **Appendix A**

# **Diagrams**

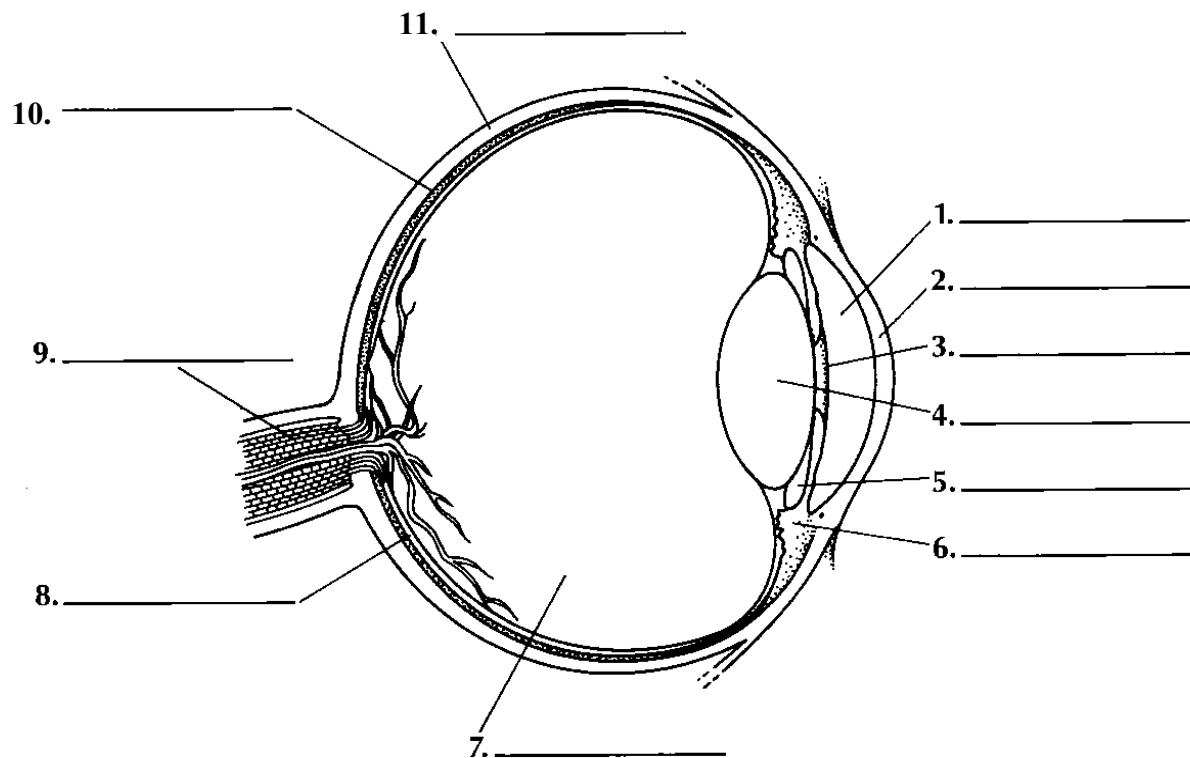


**Figure 1 - Chart of the Nervous System**

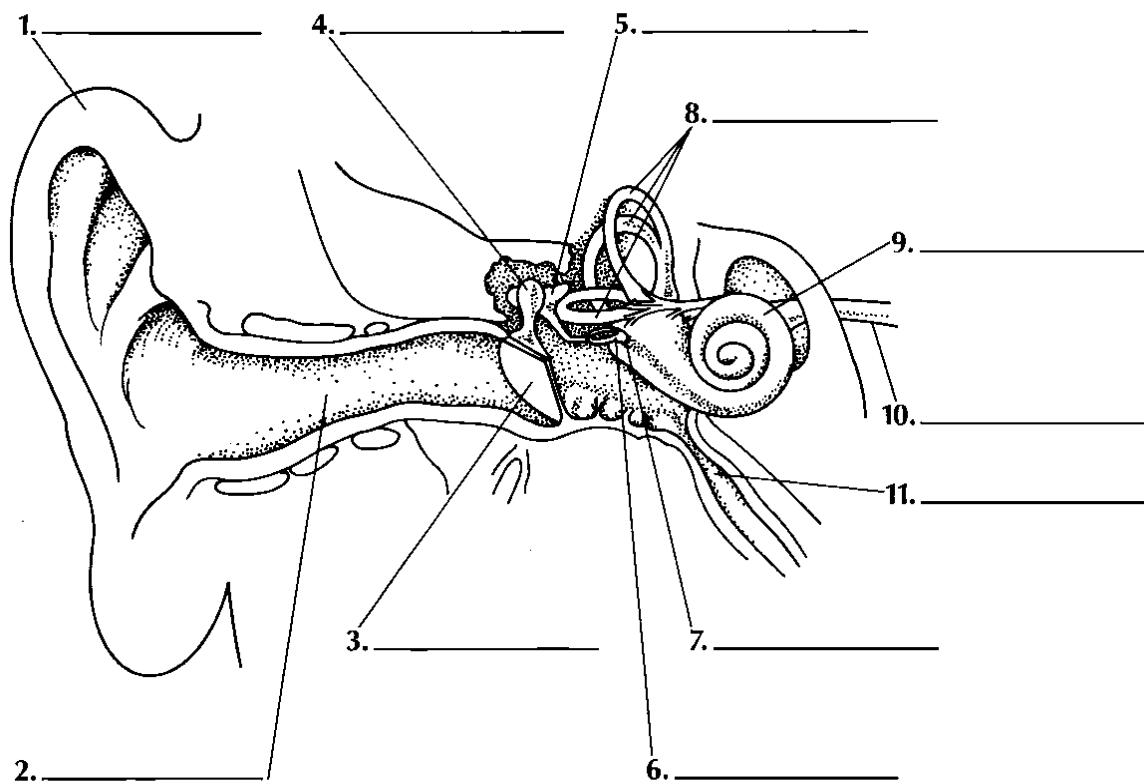




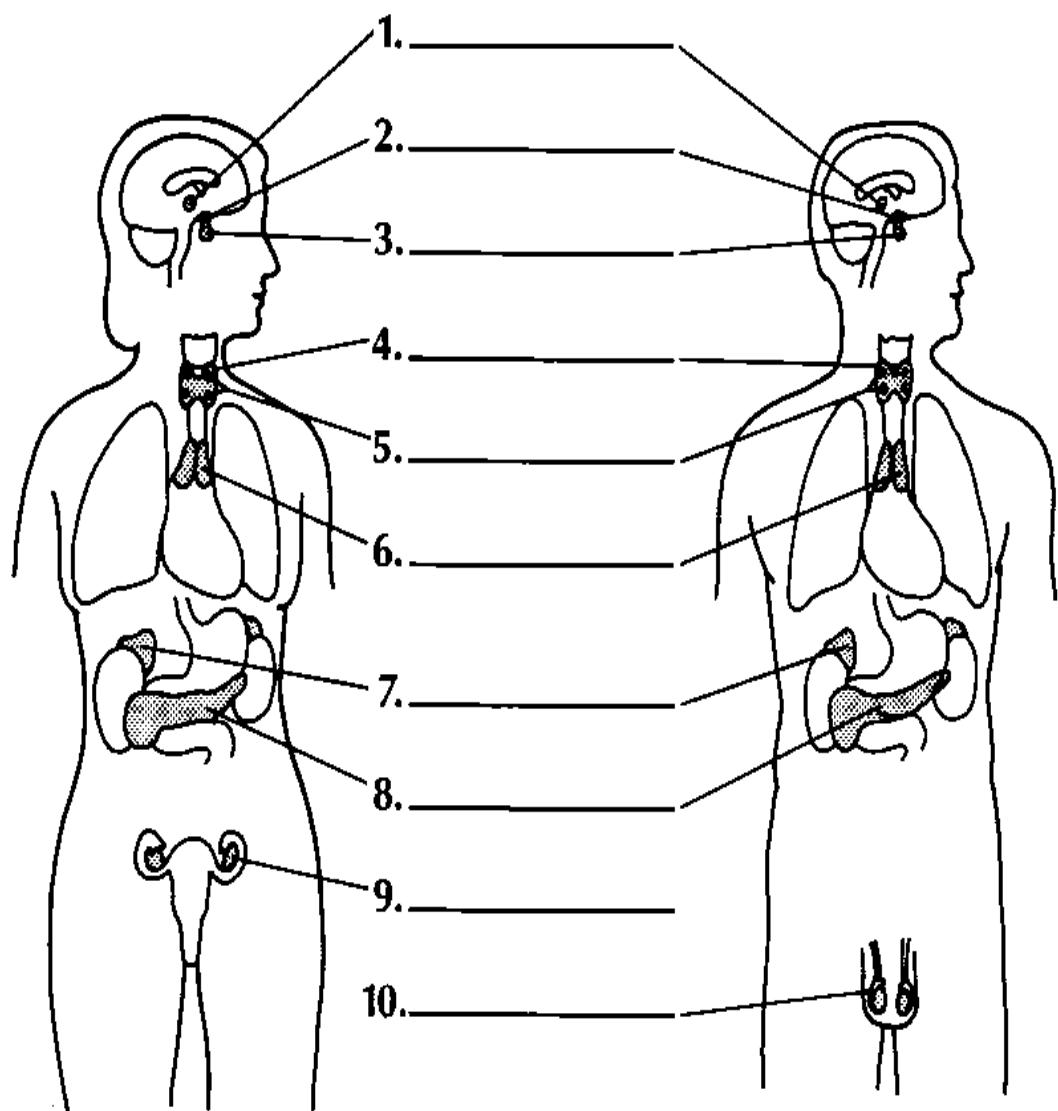
**Structure of a Neuron**



### Structure of the Eye



## Structure of the Ear



### Glands of the Human Endocrine System



# **Appendix B**



## **Assignment 1**

### **Nervous System Disorders**

1. For each of the following disorders;

Multiple Sclerosis, Alzheimer's Disease, Parkinson's Disease, Meningitis:

(a) Explain how it affects the nervous system

(b) Give the cause (if known)

(c) Describe the symptoms

(d) Describe treatment(s)

2. Explain how EEG, MRI and CAT scan are used to help understand brain function.

## Assignment 2

### Drugs and Homeostasis

#### Outcomes:

1. Analyze the effects of drugs on homeostasis.
2. Describe disorders linked to the nervous system and their effect on the homeostasis of the system and the organism as a whole. (317-4)
3. Describe how the use of prescription and nonprescription drugs can have a role in maintaining or disrupting homeostasis. (317-7)

#### Introduction

Drugs have been considered invaluable to society as an instrument in the treatment of disease. Insulin is a hormone used to control diabetes. Chemotherapy uses drugs to destroy cancer cells. The use of painkillers such as Tylenol and antibiotics are prevalent in society. Prozac is a well-known drug used in the treatment of depression. Drugs have also been considered a danger to society because of their inappropriate use and addictive nature. Many high profile actors have admitted to drug and alcohol abuse such as Ben Affleck, Winona Rider and Robert Downey Jr. and have sought rehabilitation for their addictions. This module will examine the medical use of drugs in the treatment of disease, as well as their abuse in society. It will also examine the long-term affects of drugs on the health of the human body.

#### Neurotransmitters and the Nervous Response

Many drugs affect neurotransmitters. Neurotransmitters are chemicals secreted by neurons which stimulate motor neurons or

#### *Clinical Depression*

Clinical depression is the most frequently encountered mental illness. Clinical depression is now considered a physical condition in which there is a fault in the brain chemistry. It may afflict up to 5% of the population. Symptoms of depression include a distinct change in mood accompanied by an extreme feeling of hopelessness. Other symptoms include: loss of appetite, weight loss, headaches, sleeplessness, loss of energy, tiredness, and anxiety. Suicide is common in about 15% of depressed patients.

Serotonin, dopamine, and noradrenaline are neurotransmitters linked to clinical depression. Those suffering from depression either secrete too little of a particular neurotransmitter or too much of the neurotransmitter which is broken down by enzymes (monoamine oxidases) when it is reabsorbed into nerve endings.

Three major classes of drugs are used in the treatment of depression. They are monoamine oxidase inhibitors (MAOI's), selective serotonin re-uptake inhibitors

neurons of the central nervous system.

Some neurotransmitters are excitatory and include acetylcholine, norepinephrine (noradrenaline), serotonin and dopamine. Other neurotransmitters are associated with relaxation such as dopamine and serotonin. Many neurotransmitters can have multiple functions.

The drugs abused in society are typically stimulants or depressants thought to block or enhance certain neurotransmitters. Diseases of the nervous system are often associated with the improper functioning of a neurotransmitter or improper functioning of the enzyme used to break them down once they have been released and attached to the receptor site of the postsynaptic neuron. Drugs can be developed to mimic the effects of the affected neurotransmitter or enzyme to treat these diseases.

### **Drugs in the Treatment of Disease**

As just outlined, imbalances in neurotransmitters can contribute to certain diseases. Several well known examples are Parkinson's disease and Huntington's disease. Parkinson's disease is believed to be caused by a dopamine deficiency due to the gradual death of the neurons that produce dopamine. A dopamine deficiency can result in tremors and rigidity in the limbs since messages can not be sent between areas of the brain controlling body movement.

Huntington's disease is believed to be caused by a malfunctioning of an inhibitory neurotransmitter. Huntington's is a genetic disorder characterized by jerky movements and loss of mental and emotional abilities

(SSRI's), and tricyclic compounds.

Drug treatment is difficult because some drugs may have no effect and the patient may spend a period of time searching for the proper drug and dosage that may help to alleviate the depression. It also takes several weeks for the drugs to take effect, if they are to work. In this time period, the patient could go into remission or the condition may worsen. The result can be unrelated to the drug. These factors may make the treatment with drugs difficult and the process of finding a successful drug very lengthy. It is unknown why the effect of drugs taken such a length of time or why some drug treatments are successful and others are not. More research into the causes of depression is needed in order to obtain more successful treatment.

Tricyclic inhibitors appear to slow the re-uptake of serotonin and noradrenaline.

MAOI's are believed to inhibit monoamine oxidase (MAO). MAO is an enzyme that is believed to break down serotonin and noradrenaline. It has been shown that enhancement of these neurotransmitter systems leads to the elevation of mood. A danger of MAOI's and tricyclic compounds is the increased risk of heart failure.

MAO inhibitors can not be taken with certain foods such as cheese, avocado, and wine because this interaction will raise blood pressure that can cause heart failure and death. Usually, doctors will avoid prescribing MAOI's for these reasons. These drugs can also be lethal at relatively low dosages, which is a concern for suicidal patients.

**Serotonin** re-uptake inhibitors are the most widely prescribed antidepressant. It appears

due to the destruction of neurons in certain areas of the brain.

Potential treatment is aimed at replacing the damaged neurons in both of these cases through the experimental use of stem cell transplants. At present, other treatments involve targeting the defective neurotransmitters such as increasing dopamine levels in Parkinson's patients.

More and more research has shown that mental illness is also a result of imbalances of neurotransmitters. Mental illnesses were once considered to have no biological basis but rather be due to factors in an individual's environment such as experiencing stress or forms of mental and physical abuse. At one time, sufferers of mental illness were deemed as "weak-minded" and lacking the skills to cope with life.

As science has progressed, genetic connections were made with individuals in the same family suffering from mental illness. This led to the exploration of a biological basis for mental disorders and resulted in a greater understanding by society regarding the causes of mental illness. Mental illness is now discussed more openly in society and is appreciated as a medical condition.

Debate still continues regarding the issue of nature versus nurture in the onset of mental illness but all must agree that the biological basis of mental disorders exists. The effective treatment of mental disorders with drugs also adds support to the biological basis of these disorders. This next section will explore the biological basis of certain mental illnesses and the use of drugs in their treatment.

to have fewer dangerous side-effects. A well known example is Prozac. It functions by blocking serotonin uptake and therefore increase the levels of serotonin at the synapse. Side-effects include nausea, headache, insomnia and anxiety.

### *Bipolar Disorder*

Bipolar disorder is also known as manic depression. It affects about 5 in 1000 people. It is characterized by severe mood swings ranging from mania to depression, with normal periods in between. During a manic phase, individuals may think that they are invincible, behave recklessly or believe in delusions such as ones of fame. During the depressive phase, the individual loses interest in his/her usual activities, may sleep excessively or suffer from insomnia. They may also be at risk of suicide during the depressive stage.

At one time, sufferers from manic depression were unable to function in life normally. Fortunately, manic depression can now be treated with both medication and psychotherapy. The most common medication is lithium carbonate. It functions by maintaining the chemical balances in the brain to prevent mood swings. Lithium appears to work in the treatment of both mania and depression. This is because it is believed that the depressive phase is a result of the preceding manic phase. If the manic phase can be controlled, then the depressive phase can be controlled indirectly. Other drugs may be used to treat the symptoms of depression.

Unfortunately, the long term use of lithium can affect the kidney and thyroid gland since lithium interferes with water and salt

balance. There must be regular check ups to ensure that the lithium levels do not rise to a toxic level. Other side-effects of lithium treatment include: diarrhea, nausea, hand tremor, blurred vision, confusion, and swelling in the legs and feet. The side effects of this medication are why some manic depressives are reluctant to continue use of lithium. Researchers and drug companies are working to find better medications with less side-effects. In the meantime, patients are left with the dilemma of taking a medication that provides the benefit of treating their mental disorder but can also create grave concerns over some of its very serious side-effects.

The causes of manic depression are still uncertain. There appears to be a genetic link and episodes can also be triggered by stress. Chemical changes are also being studied. Manic behaviour is believed to be due to a high level of noradrenergic activity. This activity continues until the neurotransmitter systems are depleted. It is believed that lithium may prevent mania by preventing noradrenaline depletion.

### *Schizophrenia*

A greater understanding in society of schizophrenia as a mental illness was created by the award winning movie, *A Beautiful Mind*. The movie focusses on the life of John Forbes Nash Jr. and his struggle to cope with his mental illness. Nash was a mathematical genius who later received a Nobel Prize in Economics. Actor, Russell Crowe, plays Nash and portrays the symptoms of the disorder, as well as Nash's struggle. The primary symptoms of schizophrenia include disturbance of thought patterns, disturbance of affective reactions

and autism or withdrawal. Secondary symptoms include hallucinations, delusions and paranoia. These symptoms all represent a loss of contact with reality. This disorder appears at a rate of 1 to 2 percent in the population.

There is a biological basis that predisposes individuals to the development of schizophrenia. A form of dopamine dysfunction, such as excessive dopamine activity, is believed to cause schizophrenia. Schizophrenic patients seem to have an excess number of dopamine receptors.

Chlorpromazine and related drugs have been used in the treatment of schizophrenia and function in blocking the dopamine receptors. Unfortunately, the side effects are similar to Parkinson's disease. Other side-effects include abnormal body and facial movements and extreme pacing. If this occurs, either the dosage is adjusted or a new medication is prescribed. Other side-effects include dry mouth, constipation, blurred vision and low blood pressure.

Unfortunately, patients with schizophrenia are faced with a similar dilemma as those with bipolar disorder. They must rely on a drug to treat their disorder and enable normal functioning in life, but it has difficult side-effects.

### **Commonly Abused Drugs**

#### *Alcohol*

Alcohol is probably the most commonly abused drug in society. Of all abused drugs, it is presently the only one considered legal upon reaching of age. It has been a large part of our culture for many years and is often

associated with social functions and celebrations. However, alcohol use definitely has its dark side. It is known to alter personalities and cause people to behave in a manner outside their normal personalities. A night of abusing alcohol can lead to embarrassment and regret once the effects have worn off. Poor judgment while drinking alcohol can lead to making deadly decisions such as drunk driving. Also, people have abused alcohol to the extent they vomit in their sleep and choke to death. Groups such as MADD (Mothers Against Drunk Driving) are advocating for the responsible use of alcohol.

Alcohol is usually considered to be a depressant but can act as a stimulant in small doses. Alcohol affects the nervous system by increasing the inhibitory neurotransmitter GABA (Gamma Amici Biotypic Acid). It also modifies the effects of another excitatory neurotransmitter called glutamate. A blood alcohol content of 0.10 can induce blurred vision, slurred speech, poor muscle coordination, and lack of rational judgment. A blood alcohol content of 0.40 to 0.50 g/100 ml will induce coma and a level of 0.60 will result in death. If a Newfoundland and Labrador driver is found to have a Blood Alcohol Concentrate (BAC) of 0.05 g/100 ml, he/she receives a fine and a 24 hours suspension of the licence. If the driver is found to have a BAC of 0.08 g/100 ml or greater criminal charges will be laid. Alcohol abuse can lead to short-term memory loss and blackouts. It can irritate the gastrointestinal tract and increase hydrochloric acid production. Its long-term use can also cause disorders such as cirrhosis of the liver and heart disease.

Alcoholism is considered to be a genetic and environmental disease that can lead to death. Alcoholism is associated with addictive personalities and may be a secondary result of depression. Severe alcoholics often appear jaundiced due to cirrhosis of the liver. Their immune systems are impaired and they are more prone to disease. There are organizations such as Alcoholics Anonymous that enable sufferers of alcoholism and their families to cope with this disease.

### *Marijuana*

A Canadian Senate committee has proposal the legalization of marijuana for non-medical use, citing that it is less harmful than alcohol. They believe that marijuana should be governed by the same laws as alcohol. They believe legalization would allow for better regulation and taxation of the drug. Many argue that prohibition of drugs such as marijuana supports organized crime. It would also save money in law enforcement. This means that it could potentially be sold in corner stores. Others raise concerns about addiction and health concerns. There is also concern that it may be the “gateway” to abuse of more dangerous drugs. It is believed that if marijuana is legalized, more teens will abuse the drugs because access would be easier. As a result of this, the Supreme Court of Canada has drafted legislation that would decriminalize marijuana usage. Individuals possessing a small amount of the drug would be fined much like a speeding ticket. It is quite possible that within the lifetime of this module marijuana will be decriminalized.

Marijuana is derived from the Indian hemp plant *Cannabis sativa*. The active compound in marijuana, tetrahydrocannabinol (THC), works by binding to CB1 receptors found on presynaptic membranes in the brain. These receptors function in blunting pain. THC also causes the release of the neurotransmitter dopamine which elevates mood and controls muscle movements. These biochemical pathways can explain how the drug affects its users and how it may also be used for medicinal purposes.

In low concentrations, THC causes euphoria. It has the ability of enabling the user to block out pain, frustration or confusion. There are also some serious health concerns regarding the use of marijuana. In high concentrations it can cause hallucinations, anxiety, depression, and psychotic symptoms. Smoking marijuana can cause lung cancer, sinusitis, and bronchitis. It increases the level of carbon monoxide in the blood which, in turn, reduces the amount of oxygen reaching the heart. Repeated use tends to lead to the inability to deal with everyday challenges. Long term use can result in: impaired speech, memory loss, difficulty in understanding complex ideas, insomnia, impaired visual perception, and infertility. Marijuana use has also been linked to reducing immunity towards disease.

Marijuana has been demonstrated to have some positive effects in the treatment of disease. It has been used to treat medical conditions such as nausea in chemotherapy patients and to stimulate appetite in AIDS patients. It may also offer relief from pain and reduce spasticity due to multiple sclerosis. It has been shown to help sufferers of severe arthritis. It can be used as an

anti-epileptic and anti-depressant. It is believed to be far less addictive than many prescribed painkillers. Furthermore, it is believed that marijuana could be manufactured in other forms so that it does not have to be smoked and harm the lungs.

Regulations are now in place that permit sufferers from terminal illnesses and chronic conditions to grow and smoke their own marijuana. They may also designate someone to grow it for them. At present, the Canadian Medical Society opposes marijuana use for medicinal purposes because of the lack of clinical research. Debate continues among the medical community about prescribing the use of marijuana. The legal system, however, supports the use of marijuana for medicinal purposes since denying an individual treatment that they believe helps their medical problem would be infringing on their human rights.

### *Cocaine*

Cocaine is derived from the plant *Erythroxylon coca* and can be inhaled, smoked or injected. It results in a feeling of euphoria followed by depression. Cocaine acts by first stimulating the release of norepinephrine and dopamine and, in higher doses, the release of serotonin. Cocaine then interferes with the re-uptake of these neurotransmitters and these neurotransmitters build up in the synapse. Prolonged use will cause the body to produce less dopamine and the user will need more cocaine. Side effects include mental impairment, convulsions, hallucinations, stroke, heart attack and death.

### *Heroin*

Heroin is a highly addictive derivative of morphine and comes from the opium poppy, *Papaver somniferum*. Heroin is normally injected but can also be snorted or smoked. It operates by binding to opioid receptors in the brain in which natural chemical endorphins are involved in the relief of pain. Heroin mimics the action of endorphins. After initial exposure users experience a surge of euphoria “rush” followed by a drowsy trance-like state. Prolonged use can cause less endorphin production. Side-effects include: depressed respiration, impaired coordination, and decreased tolerance to pain, long term effects can include: collapsed veins, infections of heart valves and liver disease. Death can result from overdose.

### *Rohypnol*

Rohypnol is a drug associated with rave parties and comes from the benzodiazepine family. It is considered to be the “date rape” drug and has become infamous for its use in committing sexual assault. It is often given to unsuspecting victims by dissolving it in a beverage while they are unaware. It is similar to Valium™ but has ten times its strength. In combination with alcohol, it can be deadly. Rohypnol is highly addictive and induces severe withdrawal symptoms. Its use can cause deep sedation, respiratory distress, blackouts for up 24 hours, and amnesia.

### *Ecstasy*

Ecstasy is known as Methylene Dioxy Meth Amphetamine (MDMA) and has street names such as X, Rolls, E, Adam, Beans and Buddies. It is one of the designer drugs

associated with rave parties. When Ecstasy first became popular, it was believed to be a “safe” drug with no side-effects. It was soon discovered, like many drugs, to have deadly consequences with its abuse.

The initial use of ecstasy results in: increased heart rate, increased blood pressure, dilation of pupils and bronchi, brain stimulation, increased motor activity, tightening of jaw muscles, grinding of jaws, overheating, sweating, heat stroke, and dehydration. Complications can result in renal failure, depression, liver failure, cardiovascular collapse and respiratory failure to name a few. The long-term use of ecstasy can result in irreparable brain damage. Its use is known to damage the brain cells that produce serotonin. In fact, long after ecstasy use, the nerve fibres in the brain that were destroyed have grown back abnormally or not at all.

### *OxyContin*

OxyContin is a trade name for the drug oxycodone hydrochloride. It was developed in 1996 as a slow release pain reliever for people who suffer from severe or chronic pain. Because of its chemical similarity to codeine, methadone and morphine, this semisynthetic opiate works by acting as a central nervous system depressant causing a range of effects from analgesia to respiratory depression.

At the street level, OxyContin is often referred to as Oxy’s, OC’s or Hillbilly Heroin. Most abusers of this drug avoid the slow release properties by chewing, snorting or injecting the medication to get an instant and intense “high”. Since its introduction, OxyContin abuse has caused a dramatic rise

in the incidence of overdose, emergency room treatment and death.

The short term effects of this drug are constipation, nausea, vomiting, lack of interest, dizziness, sweating and weakness. However, the long term effects are primarily addiction. OxyContin abuse is no different from heroin, cocaine or alcohol abuse. The addict's change their lifestyle to allow more and more drug use.

### **Designer Drugs**

Designer drugs are associated with underground high school and college parties called raves. They are called designer drugs because they are created by altering the molecular structure of existing drugs to enhance their effects. They are prepared by underground chemists known as "cookers". "Cookers" are untrained and unlicensed chemists that work in poorly constructed laboratories. Of course, these conditions offer little quality control and makes abuse of these drugs even more dangerous.

Designer drugs are derived from three different types of drugs. These drugs are known as PCP, fentanyl, and amphetamine/methamphetamine. The street drugs created from these drugs are known as XTC, Ecstasy, Adam, Eve, Lover's Speed, GHB, Special K, Fantasy and Nature's Quaalude. Fentanyl derivatives are known to be up to 1000 times more potent than heroin. In general, designer drugs can create a wide range of physical problems such as: hypertension, uncontrolled tremors, total paralysis, seizures, permanent brain damage, and death.

### **Prescription Drugs**

In recent years, concern has arisen over the abuse of prescription drugs. Some prescription drugs are easily addictive and patients can experience difficulty with withdrawal along with dangerous side effects. Some adolescents are becoming frequent abusers of prescription drugs due to the effects of euphoria that can be produced by these drugs. Crimes of breaking and entering pharmacies for the purpose of stealing prescription drugs are on the rise. There are three main prescription drugs that are most commonly abused: Opioids, CNS depressants and stimulants.

#### *Opioids*

Opioids are typically used to treat pain. These medications fall into a class of narcotics and include oxycontin, morphine, codeine and DemerolTM. Opioids function by attaching to specific proteins called opioid receptors. These receptors are found in the brain, spinal cord and gastrointestinal tract. When opioids attach to the opioid receptors they are able to block the transmission of pain messages to the brain. Opioids can produce a feeling of euphoria by affecting regions of the brain that enable us to perceive pleasure. However, they can result in physical dependence and addiction.

Tolerance of opioids can result in the need to take higher doses to achieve the same effect. Withdrawal will cause: restlessness, muscle and bone pain, insomnia, diarrhea, vomiting, cold flashes, goose bumps, and involuntary leg movements. A large dose can lead to respiratory depression resulting in death.

### *CNS Depressants*

CNS depressants are often used to treat anxiety and sleep disorders by slowing normal brain function. Common CNS depressants include barbiturates and Valium™. Most CNS depressants act on the brain by affecting the neurotransmitter gammaaminobutyric acid (GABA). The function of GABA in the human body is to decrease brain activity. Therefore, increased doses will create the drowsy effect required to treat anxiety and sleep disorders. Individuals can build a tolerance to CNS depressants over time and require larger doses. Withdrawals can cause the opposite effects of the drug. The mind can race out of control, possibly resulting in seizures and other problems.

### *Stimulants*

Stimulants are used to treat narcolepsy, obesity, depression, and attention-deficit hyperactivity disorder (ADHD). These drugs enhance brain activity and result in increased alertness, energy, elevated blood pressure, increased heart rate and respiration. Examples of stimulants include Ritalin™ and Dexandrine™. The chemical structure of stimulants is similar to the chemical structure of the neurotransmitters norepinephrine and dopamine. Stimulants work by increasing the amount of these neurotransmitters to the brain. An increase in dopamine results in an increase in blood pressure, increase in heart rate, constriction of blood vessels, increase in blood glucose and it opens the pathways of the respiratory system. Stimulants do not result in physical dependence or withdrawal. However, they can be used compulsively and high doses repeatedly can lead to feelings of hostility

and paranoia. High doses can cause body temperatures to rise to a dangerously high level. They can also create an irregular heartbeat leading to the risk of cardiovascular failure. There is also the potential of lethal seizures.

## **Conclusion**

Drugs can play a role in both maintaining and disrupting homeostasis. When problems in the neurotransmitter balance occur, such as in the case of mental illness, drugs can play a role in restoring the balance. However, further study into the effects of different neurotransmitters is essential to achieve a better understanding of diseases caused by neurotransmitter imbalance. This can lead to better drug treatments that have less serious side-effects. Drug abuse can also disrupt homeostasis. Understanding the effects of drug abuse on neural pathways and the overall health of an individual can aid in the education of individuals considering drug abuse. It can also aid in the treatment of those suffering from addiction. Understanding the seriousness of drug abuse on long-term health may make one think twice about engaging in the legal and illegal use of drugs.

## **Questions**

### *Understanding Concepts*

1. For each mental illness, (clinical depression, bipolar disorder and schizophrenia) list the neurotransmitters involved, the nature of the imbalance of the neurotransmitter, the drugs used in their treatment, and side-effects of each of these drugs. This may be

done in the form of a chart.

2. For each street drug, (alcohol, marijuana, cocaine, heroin, Rohypnol™, ecstasy and OxyContin®) list the effects on neural pathways, the short-term effects of the drug and the long-term effects of the drug.
3. What are the dangers of using designer drugs?
4. For each of the prescription drugs, (opioids, CNS depressants and stimulants) list the effects on neural pathways, the short-term effects of the drug and the long-term effects of the drug.
5. Choose a drug of interest to research. Report your findings in the form of a magazine article.
6. Write a letter to an imaginary friend whom you know is abusing drugs. In this letter, use what you know about the dangers of drug use to persuade them quit and seek help.

*Extensions*

1. Debate the pros and cons of the use of marijuana in the treatment of chronic pain.
2. Debate the merits of whether or not to use drugs for treatments of nervous diseases such as mental illness disorders despite the side effects of these drugs.
3. Debate the merits of legalizing marijuana. Research the present legislation regarding the legalization of marijuana.
4. Using the knowledge that you have gained about the causes of mental illness, respond to the following statement: "Mental illness is a figment of one's imagination and one can choose whether or not to control his/her thoughts."

## References

Bullard, Chetty et al. (2003). Biology. McGraw-Hill Ryerson. Toronto

Brown, DeNeen L. (2002). Canadian Panel Back Legalizing Marijuana. WP Foreign Press. Available at:  
<http://www.cannabisnews.com/news/thread14010.shtml>

Common Drugs and Their Symptoms. Available at:  
[www.cornerdrugstore.org/CommonDrugsPage.htm](http://www.cornerdrugstore.org/CommonDrugsPage.htm)

Drug Abuse: Chemical Changes in the Brain. Available at:  
[www.epub.org.br/cm/n08/doencas/drugs/abuse06\\_i.htm](http://www.epub.org.br/cm/n08/doencas/drugs/abuse06_i.htm)

Drugs and the Nervous System. Available at:  
<http://learn.dccc.edu/~saquilan/ppt/nervous/sld056.html>

Drugs and the Nervous System. Available at:  
<http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/D/Drugs.html>

Facts about Manic Depression. Missouri Council for Comprehensive Psychiatric Services. Available at: [www.parquad.org/mdfacts.htm](http://www.parquad.org/mdfacts.htm)

NIDA- Research Report Series – Marijuana Abuse. Available at:  
[wysiwyg://86http://www.nida.nih.gov/ResearchReports/Marijuana/Marijuana3.html](http://www.nida.nih.gov/ResearchReports/Marijuana/Marijuana3.html)

OxyContin Diversion and Abuse. National Drug Intelligence Center. January 2002.

OxyContin: Pharmaceutical Diversion. DEA Drug Intelligence Brief. March 2002.

Research Report Series – Prescription Drugs: Abuse and Addiction. Available at:  
[wysiwyg://143/http://www.nida.nih.gov/Reports/Prescription/prescription2.html](http://wysiwyg://143/http://www.nida.nih.gov/Reports/Prescription/prescription2.html)

Substance Abuse and Mental Health Services Administration's (SAMHSA), Drug Abuse Warning Network (DAWN).

SANE. Available at:  
[www.sane.org.uk/About Mental Illness/](http://www.sane.org.uk/About_Mental_Illness/)

The Nervous System. Available at:  
[www.emc.maricopa.edu/faculty/farabee/BIOBK/BioBookNERV.html](http://www.emc.maricopa.edu/faculty/farabee/BIOBK/BioBookNERV.html)

Timmons and Hamilton. Drugs, Brain and Behavior – Ch. 6. Available at:  
[www.rci.rutgers.edu/~lwh/drugs/chap06.htm](http://www.rci.rutgers.edu/~lwh/drugs/chap06.htm)

Timmons and Hamilton. Drugs, Brain and Behavior – Ch. 7. Available at:  
[www.rci.rutgers.edu/~lwh/drugs/chap07.htm](http://www.rci.rutgers.edu/~lwh/drugs/chap07.htm)

Wadler, Gary. Designer drugs. Available at:  
<http://espn.go.com/special/s/drugsandsports/>

## **Assignment 3**

### **Endocrine System Disorders**

1. For each of the disorders listed below, give its cause and a brief description of its effects on the person who has it:

(i) pituitary dwarfism

(ii) gigantism

(iii) hyperthyroidism

(iv) hypothyroidism

(v) diabetes mellitus

2. (a) Name the 2 Canadian scientists who are recognized for the discovery of insulin.

(b) What disease is insulin used to treat?