# **Biology 30 Diploma REVIEW**

## **Are you ready to begin????**

## **Be sure you ask any questions you may have…that is why we are here!!!**

# **Nervous and Endocrine Systems**

# **Endocrine System**

## **Endocrine Glands**

## **Ductless**

## Maintain control for a longer duration

## Examples include adrenal glands, pituitary gland, and thyroid gland

## **Exocrine Glands**

## **Ducts**

## Examples include sweat and salivary glands

## What is an example of BOTH an exocrine and endocrine gland?

## What organ acts as both an endocrine and exocrine gland?

# **Types of Hormones**

## **Steroid Hormones**

## Made of cholesterol

## Fat soluble

## Attach to receptors in cytoplasm

## Examples include sex hormones and cortisol

## **Protein Hormones**

## F13_10Made of amino acids

## Water soluble

## Attach to receptors on cell membrane

## Examples include insulin, hGH and thyroxine

# **Homeostasis – (+) & (-) feedback**

# **Glands and Hormones**

## **Pituitary (master gland)**

### Made of 2 lobes:

#### Posterior Lobe – stores and releases hormones produced by the hypothalamus

###### Examples include ADH and oxytocin

#### Anterior Lobe – produces and releases its own hormones. Regulated by the hypothalamus

###### Examples include TSH, FSH, LH, hGH, ACTH and PRL

## NOTE - The diploma will not ask you to differentiate the hormones produced by the anterior and posterior lobe!!!

# **Human Growth Hormone (hGH)**

## Affects all cells, especially cartilage and bone cells

## At puberty:

##### A hypersecretion causes GIGANTISM

##### A hyposecretion causes DWARFISM

# Adrenal Glands

## Adrenal Medulla (inner gland)

#### Regulated by nervous system

#### Produces norepinephrine (sustain BP) and **epinephrine** during stress. Functions are:

###### Increased blood sugar

###### Increased heart rate

###### Increased breathing rate

###### Increased metabolism

###### Blood vessels dilate

###### Pupils dilate

###### Peristalsis stops

## **NOTE:** The Diploma will not ask you to differentiate between the hormones produced by the adrenal medulla and cortex

# **Adrenal Glands**

## Adrenal Cortex (outer gland)

#### Small amounts of sex hormones

###### Testosterone in females and estrogen in males

#### **Aldosterone**

###### Increase Na+ reabsorption into blood. Released when blood volume and BP are low

#### **Cortisol (LONG TERM stress)**

###### Amino acids/fats are converted into glucose

# **Antidiuretic Hormone (ADH)**

## Makes nephron permeable to water so water can be reabsorbed back into the blood

## Released when the body is dehydrated and needs to conserve body water

## Produces a concentrated urine

## **Diabetes Insipidus** – body can’t produce enough ADH

# **Negative Feedback Loop for Release of Cortisol**

## Stress signals to brain:

## hypothalamus

## ↓ releasing hormone

## pituitary gland

## ↓ **ACTH**

## adrenal gland

## ↓ **cortisol**

## target cells in liver and muscles

## change amino acids/fats to glucose

# Multiple Choice#1



# Numerical Response #1

# Numerical Response #2

# Multiple Choice #2

# Multiple Choice #3

# Multiple Choice #4

# Pancreas (Islets of Langerhans)

## **Insulin**

### Released from beta cells when blood sugar levels are high

### Makes cells permeable to glucose and converts glucose into glycogen in the liver

### Effect on blood glucose levels???

# Negative Feedback Loops

## High blood sugar Low blood sugar

## ↓ ↓

## Pancreas (beta cells) Pancreas (alpha cells)

## **↓ insulin** **↓ glucagon**

## Liver changes glucose Liver changes glycogen

## into glycogen into glucose

## AND

## Cells become permeable

## to glucose

# Diabetes Mellitus

## **Early Onset/Juvenile or Type 1 Diabetes**

#### Early degeneration of the beta cells of the islets of langerhans and thus insulin production decreases significantly

#### Treat with **insulin injections**

## **Adult Onset or Type 2 Diabetes**

#### Decreased production of insulin due to the ineffectiveness of the islets of langerhans

#### Treat with sulfa drugs and modified diet

# **Symptoms of Diabetes Mellitus**

## Glucose in urine (sweet urine)

## High urine output

## Low energy levels

# Thyroid Gland

## Located in front of trachea

## Produces 3 hormones

#### **Thyroxine**

#### Triiodothryonine

#### **Calcitonin**

## **Thyroxine** and triiodthyronine regulate metabolism

## **Thyroxine** **decreases blood sugar levels** because it **increases metabolism**

# Hypothyroidism

## Release low amounts of thyroxine

## What happens to excess glucose that can’t be broken down???

## Symptoms include:

#### Dry skin

#### Tired

#### Weight gain

#### Sensitive to cold

#### Constipation

## Treatment??

# Goiter

## An enlarged thyroid gland due to a lack of iodine in diet (component of thyroxine). As a result, the production of thyroxine is diminished

## Thyroid increases in size due to a buildup of TSH in the thyroid gland

## What is the source of our dietary iodine??

# Negative Feedback Loop for Normal Release of Thyroxine

## Hypothalamus

## ↓ releasing hormone

## Anterior pituitary

## ↓ **TSH**

## Thyroid Gland

## ↓ **thyroxine**

## Body cells (metabolism ↑)

# Hyperthyroidism

## Release high amounts of thyroxine

## Symptoms include:

#### Anxiety

#### Sweating

#### Weight loss

#### Heat intolerant

#### Racing heart

#### Bulging eyes

#### Graves Disease (in children)

## Treatment??

# **Calcitonin**

## Released when blood Ca2+ levels are:

## **high**

## 3 functions:

#### Increases Ca2+ excretion from the kidneys

#### Decreases Ca2+ release from the bones

#### Decreases Ca2+ absorption from the small intestine

## Effect on Ca2+ levels???

# **Parathyroid Gland**

## Located on top of the thyroid gland

## Releases **parathyroid hormone (PTH)** when blood Ca2+ levels are

## **LOW**

## 3 functions:

#### Decreases Ca2+ excretion from the kidneys

#### Increases Ca2+ release from the bones

#### Increases Ca2+ absorption from the small intestines

## Effect on Ca2+ levels??

# Prostaglandins

## Hormones that have an affect on a small localized area

# Multiple Choice #5

# Multiple Choice #6 and #7

# Multiple Choice #8 and #9

# Multiple Choice #10

# Multiple Choice #11, #12 and #13

# Multiple Choice #14 and #15

# **Nervous System**- works with endocrine system to maintain homeostasis

# Nerves vs. Neurons

# Three Types of Neurons

## **Sensory** – carries information from the Sensory environment to the CNS. Located in the PNS

## **Motor** – carries information from the CNS to the effectors (muscles/glands). Located in the PNS

## **Interneurons** – link the sensory and motor neurons. Located in the CNS

## \*\***Glial Cells** – nourish the neurons, remove their wastes, and defend against infection. Outnumber neurons 10 to 1

# Structure of Neuron

# Structures of Neuron

## **Dendrites**

#### Pick up impulses from the previous neuron and carry to the cell body

## **Cell Body**

#### Produces many chemicals needed by the neuron

#### Performs metabolism

## **Axon**

#### Carries the impulses from the cell body to the synapse

#### Function is to insulate the axon and thus increase the speed of impulse transmission (about 50X)

#### The larger the diameter of the axon, the faster the impulses will travel

# Axon

## In the CNS, **oligodendrocytes** form the fatty white myelin sheath around the axon

## In the PNS, **Schwann Cells** form the fatty white myelin sheath by wrapping around the axon. As each Schwann Cell wraps around the nerve fiber, its nucleus and cytoplasm are squeezed to the perimeter to form the **neurilemma**

## The function of **neurilemma** in the regeneration of neurons

# Myelin Sheath Formation

# Structures of Neuron

## **Nodes of Ranvier**

#### Gaps between the myelin sheath

#### Impulses jump from one node to the next node during **saltatory conduction**

## Synapse

#### Junction between the pre-synaptic neuron and post-synaptic neuron

#### Synaptic knobs contain

###### Vesicles that release the neurotransmitter **acetylcholine**

###### Mitochondria to produce ATP for neurotransmitter synthesis

# Synapse

# Reflex Arc

## Occurs without any brain involvement or conscious thought

## Involves the spinal cord ONLY and thus the response is quick and involuntary

## Example: touching a flame

## Reflex Arc Pathway:

## **Sensory receptor 🡪 Sensory neuron 🡪 Interneuron 🡪 Motor neuron 🡪 Effector**

# Impulse Transmission (Excitatory)

## **Resting Potential**

#### A positive outside and negative inside **MUST** be created across the axon’s membrane **BEFORE** it can transmit an impulse!

#### Created by the sodium-potassium pump that pumps 3 Na+ out for every 2 K+ in (requires ATP)

#### This difference in charge creates a voltage of -70 mV when measured with a voltmeter

#### The axon membrane is also described as **polarized**. The axon membrane is impermeable to Na+ but K+ can leak out. The negative inside is due to the presence of negatively charged proteins and fewer K+ than Na+

# Impulse Transmission (Excitatory)

## **Action Potential**

#### As the impulse starts moving down the axon, the axon’s permeability changes in that Na+ starts moving into the axon to create an axon membrane with a positive inside and a negative outside

#### Called a **wave of depolarization or depolarized membrane**. **This occurs ONLY at the nodes of Ranvier as the myelin sheath insulates the axon that it encircles**

# Impulse Transmission (Excitatory)

## **Repolarization**

#### **Na gates close, K gates open**

#### K ions diffuse out of axon making inside more negative, outside more positive

#### After the impulse passes through the axon, the Na+ and K+ are on opposite sides of the axon. Thus, the sodium-potassium pump restores the resting membrane potential by pumping 3 Na+ out for every 2 K+ in

#### **Every axon membrane must repolarize BEFORE it can transmit a second impulse**!

# **Threshold Level**

## The minimum amount of impulse needed to get an action potential (response)

## Each neuron has a different threshold level

## If the impulse exceeds the threshold, the response is the SAME…called the **ALL or NONE RESPONSE**

# **Synapse**

## Once impulse reaches the synapse, the synaptic knobs release **acetylcholine**

## Attaches to receptors on the dendrites of the post-synaptic neuron

## Causes depolarization of post-synaptic neuron so impulse continues

## Acetylcholine is then broken down by **cholinesterase** (released by dendrites of post-synaptic neuron)

## Repolarization is allowed to occur

# Random Bits of Information…

## **Stimuli Intensity** is detected 2 ways:

### The more intense the stimulus, the higher the frequency of impulses

### Each neuron has its own threshold level. The more impulses reaching the brain, the stronger the response

# Random Bits of Information…

## A **neuromuscular junction** is a synapse between a motor neuron and a muscle cell

## **Tetanization** occurs when cholinesterase is blocked/destroyed so action potentials are continuous

## The refractory period is the time it takes a neuron to repolarize

## **Summation** occurs when acetylcholine is needed from 2 or more neurons to cause depolarization of post-synaptic neurons

## **Hyperpolarization** of an axon inhibits impulses from being transmitted when the outside of an axon becomes even more positive than normal due to an accumulation of K+ leaking outside the axon. As a result, getting enough Na+ inside the axon for depolarization to occur is almost impossible

# Multiple Choice #16

# Multiple Choice #17 and Numerical Response #3

# Numerical Response #4

# Multiple Choice #18 and #19

# Multiple Choice #20 and #21

# Autonomic Nervous System (ANS) - involuntary

## **Sympathetic**

## Prepares body for stress

## Nerves originate from ribs and lower back of the spinal cord

## Effects include:

### Increased heart rate

### Increased release of epinephrine

### Increased breathing rate

### Increased metabolism

### Increased blood flow (vessels dilate)

### Pupils dilate

### Decreased peristalsis

### Increased conversion of glycogen to glucose

### Bladder sphincter relaxes

## **Parasympathetic**

## Returns body to normal

## Nerves originate from the brain, neck and tail bone of the spinal cord

## Effects include:

### Decreased heart rate

### Release of epinephrine stops

### Decreased breathing rate

### Decreased metabolism

### Decreased blood flow (vessels constrict)

### Pupils constrict

### Increased peristalsis

### Stores glucose in liver and muscles

### Bladder sphincter contracts

# Central Nervous System (CNS)

## Brain is protected by skull and 3 protective membranes called **meninges**

## Meninges prevent the direct circulation of blood through the cells of the brain and spinal cord

## This separation of blood and CNS is called the **blood-brain barrier**

## **Cerebrospinal fluid (CSF)** circulates between the meninges and the central canal of the spinal cord

## Function of the CSF is a shock absorber and transport of nutrients and wastes

## Level of brain development makes humans unique

## **Endorphins** (natural painkillers) prevent the production of pain transmitters

# Spinal Cord

## Connects the sensory and motor nerves to the brain

## Contains white matter (myelinated from oligodendrocytes) and grey matter (unmyelinated)…will these nerves regenerate?? Why or why not??

# Brain – Forebrain

## Contains the following:

#### Paired olfactory lobes

#### **Cerebrum** (2 hemispheres) – largest and most highly developed part of brain. Controls speech, reasoning, memory, personality, stores sensory information and initiates motor activities. Made of 4 lobes:

##### **Frontal** – front of head. Responsible for personality

##### **Parietal** – top of head. Responsible for touch, taste and pressure

##### **Occipital** – back of head. Responsible for vision

##### **Temporal** – near temple. Responsible for hearing and smell

# Forebrain

## Contains the following (cont’d):

#### **Cerebral Cortex** – covers the cerebrum. Made of grey matter and has fissures to increase the surface area

#### **Corpus Callosum** – allows the 2 hemispheres to communicate

#### Thalamus – below the cerebrum. Coordinates/interprets sensory information

#### **Hypothalamus** – below the thalamus

#### **Pituitary Gland** – connected to the hypothalamus

#### (links nervous and endocrine system)

# **Midbrain and Hindbrain**

## Midbrain – less developed

## Hindbrain – joins with the spinal cord. Contains the following:

#### **Cerebellum** – coordinates muscle movement. Beneath the cerebrum

#### **Medulla Oblongata** – joins the spinal cord to the cerebellum. Controls all vital functions (ANS)

#### **Pons** – relay between the medulla and cerebellum

## Right side of brain controls left side of body and vice versa

## Right side: spatial skills

## Left side: math/verbal skills

# Multiple Choice #22

# Multiple Choice #23

# Multiple Choice #24

# Multiple Choice #25 and #26

# Multiple Choice #27

# Senses

## **Sensory receptors** pick up information from our environment and send this information to our brain along the sensory nerves

## **Sensation** occurs when the neural impulses arrive at the cerebrum

## Each person’s unique **perception** results from how the cerebrum interprets the meaning of the sensory information

## **Sensory adaptation** occurs when the receptors have adjusted to changes in the environmental stimuli

# **Taste and Smell**

## Work together (eg. a cold)

## Taste sensory receptors are located on the tongue as taste buds

## 4 types: sweet, sour, salty and bitter

# **Smell and Touch**

## Smell – sensory receptors are olfactory cells in the nose. Airborne particles cause depolarization of olfactory cells. They exhibit sensory adaptation

## Touch – sensory receptors located all over the body. Many are concentrated in the genitals, fingers, tongue and lips. Sensitive to touch, pressure, pain, and high/low temperatures

# Vision

## Structure – 3 layers

## **Sclera** – outer layer that supports/protects the inner layers

#### **Cornea** – transparent and bends light towards the pupil. Receives oxygen from the gases dissolved in the tears (no blood vessels because they would distort vision).

#### **Aqueous Humor** – transparent fluid behind the cornea that supplies nutrients to the cornea

## **Choroid** – middle layer

#### **Iris** – controls the size of the pupil and thus the amount of light entering the eye

#### **Lens** – behind the iris. Focuses the image on the retina. Ciliary muscles change the shape of the lens

#### **Vitreous Humor** – jelly like fluid-filled chamber behind the lens. Maintains the shape of the eye

## **Retina** – inner layer. Contains 2 sensory photoreceptors:

#### **Rods** – used when viewing in dim light. (ie. bats…why?)

#### **Cones** – used for color vision and vision in bright light

###### **Fovea Centralis** – center of retina and most sensitive. Contains cones **ONLY** and rods surround on the periphery

###### **Blind Spot** – where the optic nerve attaches to the retina. Contains **NO** rods/cones

# Eye Structure

# Focusing An Image

## Light enters the eye through the pupil whose size is controlled by the iris

## Light is bent by the cornea towards the pupil/lens.

## Lens changes its shape as it bends the light onto the retina (inverted image)

## The lens’ ability to change its shape when viewing near/far objects is called the **accommodation reflex**

#### Close Objects – ciliary muscles contract and thus the lens thickens. The pupil constricts to focus the image on the retina

#### Far Objects – ciliary muscles relax and the lens thins. Pupil dilates to increase the amount of light entering the eye. As we age, protein builds up on the lens and thus the lens is less flexible to accommodate when viewing close objects

# Accommodation Reflex

# Chemistry of Vision

## Rods surround the cones in the fovea centralis. The rods contain a light sensitive pigment, **rhodopsin** that requires vitamin A. A lack of vitamin causes night blindness

## The cones contain pigments sensitive to three light wavelengths: blue, red and green. When one or more types of pigments are defective, it causes **colorblindness**. The most common type is **red-green colorblindness** and is most common in males as the gene is carried on the X chromosome

# Vision Defects = STS

## Glaucoma – a buildup of aqueous humor and thus the fluid pressure causes the blood vessels to collapse. Thus, oxygen and nutrients decrease. The result is neuron death and blindness

## Cataracts – the lens/cornea is cloudy and thus light can’t pass through. The lens can be replaced

## Astigmatism – abnormal curvature of the lens/cornea

## Myopia/Nearsightedness – the eyeball is too long and thus the image is focused in front of the retina. Corrected with a concave lens

## Hyperopia/Farsightedness – the eyeball is too short and thus the image is focused behind the retina. Corrected with a convex lens

# Optic Chiasma

## Where the optic nerve crosses on the underside of the brain to their respective occipital lobes

## Pathway of nerve impulses???

# Hearing

## The ear has two functions – hearing and balance

## Structure:

## Outer Ear – air filled

#### **Pinna** – funnels sound vibrations into the auditory canal

#### **Auditory Canal** – carries sound waves to the eardrum. Contains wax to trap foreign particles

## Middle Ear – Air filled

#### **Tympanic Membrane/Eardrum** – vibrates and passes sound waves to the ossicles

#### **Ossicles** – 3 tiny bones that amplify sound waves. These amplified sound waves are then passed onto the oval window membrane and then onto the round window membrane

###### Malleus/Hammer

###### Incus/Anvil

###### Stapes/Stirrup

#### **Eustachian Tube** – equalizes air pressure between the internal and external ear. Has no function in hearing!!

## Inner Ear – contains fluid filled structures

#### Vestibule – connected to the oval window at the base of the semicircular canals. Function is balance and head position (static equilibrium)

#### **Semicircular Canals** – attached to the vestibule. Function is balance and body position (dynamic equilibrium)

#### **Cochlea** – contains specialized hair cells that convert amplified sound wave vibrations into electrochemical nerve impulses

# Cochlea

## Contains the **Organ of Corti** (actual hearing apparatus) that is composed of hair cells attached to a basilar membrane. When fluid moves due to amplified sound vibrations, hair cells bend due to the movement of the basilar membrane

## Cochlea is protected by loud noises in 2 ways:

#### Muscles connected to the malleus contract and thus restricts its movement as it passes vibrations on

#### Muscles of the ossicles contract so the stapes is pulled away from the oval window

# Cochlea Cont’d

## Cochlea detects different pitches when different parts of the cochlea are stimulated

## STS - Two types of hearing loss:

#### Nerve Deafness – damage to hair cells

#### Conduction Deafness – damage to the sound conduction system of the outer/middle ear

## Cochlea 🡪 Auditory Nerve 🡪 Temporal Lobe

# Ear Structure

# Cochlear Structure

# Equilibrium

## Static/Gravitational Equilibrium (head position) – contains 2 fluid filled sacs that contain hair receptors. The sacs are the saccule and utricle. The sacs contain **otoliths** (tiny stones) so when we move our head, the stones move and bend hairs which stimulate sensory nerves to the brain

## Dynamic/Rotational Equilibrium (body position) – fluid filled **semi circular canals**. The movement of the fluid causes hair cells to move and therefore initiates nerve impulses to the brain. Motion sickness is the continuous movement of fluid.

# Equilibrium

# Multiple Choice #28

# Multiple Choice #29

# Numerical Response #5

# Multiple Choice #30

# Numerical Response #6

# Multiple Choice #31

# Multiple Choice #32

# Numerical Response #7

# Multiple Choice #33

# Numerical Response #8

# Unit A Nervous and Endocrine Systems

## Questions?

## Comments?

## Ready to continue to Unit B (Reproduction and Development?)