

### Lecture 21:

# Human Growth Hormone (HGH) and Its Abuse in Sports

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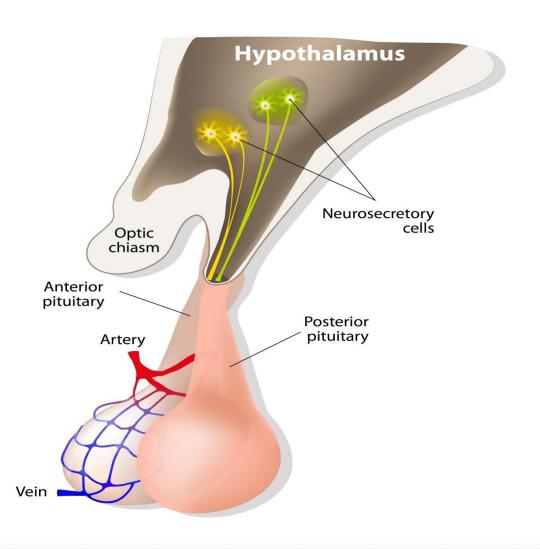
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### **Human Growth Hormone:**

 Human growth hormone is a single chain polypeptide or complex protein containing 191 amino acids with a molecular weight of 22000 Daltons.

 Human growth hormone (GH) is secreted by the pituitary gland, "the master gland" of the body. It is located at the base of skull and is composed of two parts.

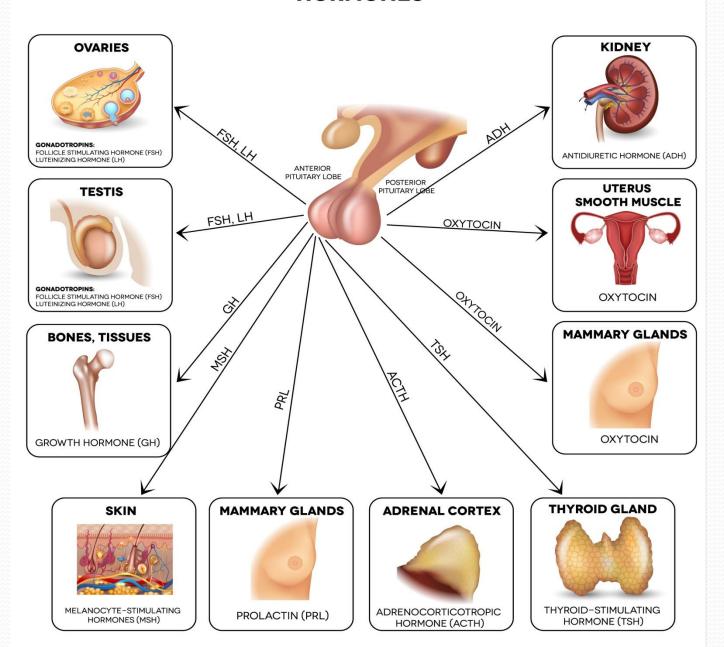
### HYPOTHALAMUS AND PITUITARY GLAND



• The anterior part of the pituitary gland secrets different hormones, such as adrenocorticotropin (ACTH), growth hormone (GH), prolactin (PRL), thyroid-stimulating hormone (TSH), luteinizing hormone (LH), and follicle-stimulating hormone (FSH).

 The posterior part of the pituitary gland secrets antiduretic hormone (ADH, Vasopressin) and Oxytocin.

### THE PITUITARY GLAND HORMONES



### **Secretion of Growth Hormone:**

 The most plentiful hormone released by the pituitary gland of the body is GH, a super hormone that acts as a water-soluble neurotransmitter.

Normal daily secretion of GH is about 0.5 to 2 mg.
The secretion of GH is not continuous and
uniform, but is pulsatile and occurs in brief
bursts called pulses or "GH Surges".

 GH secretion follows a diurnal pattern meaning that the peak of secretion occurs shortly after the deepest sleep. In fact, your growth takes place while you are in sleep.

### **GH Surges:**

- 1) Shortly after falling asleep, and during dreaming.
- 2) Within 30 60 minutes after exercise.
- 3) 3 to 5 hours after eating

### **Stimulating Factors:**

- Exercise.
- Stress (Eustress).
- Emotional excitement (positive).
- High protein diet.
- Hypoglycemia.

**Counter regulatory hormones** are the hormones released in response to low blood sugar:

- Growth hormone
- Epinephrine
- Glucagon
- Cortisol

### **Effects of Growth Hormone:**

- Growth hormone, after being released in bursts, enters the bloodstream and circulates around the body.
- To exert its effects, GH needs to bind to specific receptors on the surface of different tissues and must do so quickly because it only circulates in the bloodstream for a few minutes.
- GH binds to receptors in the liver, where it is converted to growth factors. The most important of these factors is Insulin-like Growth Factor I (IGF), which is also known as somatomedin-C.

- Even though many other cells can produce IGF-I, the liver produces most of it.
- Due to rapid destruction of GH by the liver, kidneys, and peripheral tissues, only a trace amount of it is excreted in urine, which means urine has no diagnostic value in cases of abuse.
- The major actions of GH are stimulation of growth and regulation of metabolism. Growth is largely mediated by IGF-I and it is IGF-I, rather than GH itself, which affects the body tissues, and varies throughout the day.

### **Effect on Growth:**

- Growth hormone causes different body tissues to grow via IGF-I.
- An important target for IGF-I is cartilage cells.
   Direct action of IGF-I on cells located at the epiphyseal plates which are at the ends of long bones results in elongation of the bones.
- Growth results because GH increases the number of cells. However, it enlarges the size of skin and its appendages and skeletal muscles.

### **Effect on Protein Metabolism:**

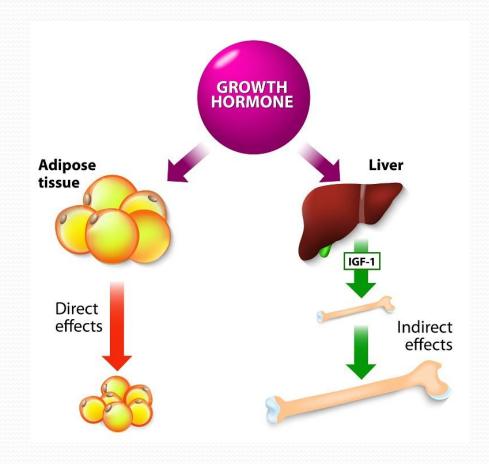
- Has anabolic effect causing retention of nitrogen.
- Increases the synthesis of protein by transporting amino acids into the cells.

# Effect on Metabolism of Carbohydrate and Fat:

The metabolic effects of GH are biphasic:

Insulin – like effects

• Anti – insulin effects:



### **Insulin – Like Effects:**

- Increasing glucose uptake in muscles and fat.
- Stimulating amino acids uptake and protein synthesis in the liver and muscles.
- Inhibiting lipolysis in adipose tissues.

- Anti Insulin Effects (occur several hours later):
- Glucose uptake and utilization are inhibited, causing blood glucose to rise.
- Lipolysis increases, causing blood free fatty acids to rise.

### **Growth Hormone and Life Span:**

- From the beginning of time until our own era, human beings have tried to combat aging and death and to gain eternal life.
- In their research to increase life span, many researchers have focused their attention on growth hormone and its effect on longevity.
- Most research indicate that GH and IGF-I levels decline with aging and that replacing them can reverse most of the effects of aging.

### **Anti – Aging Activity of GH:**

- Improving and revitalizing the immune system.
- Acting as a tonic agent for heart, lungs, liver, and kidneys.
- Increasing the growth of hair and reducing wrinkles.



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- Building muscles and strengthening the bones.
- Fighting osteoporosis.
- Maintaining flexibility and mobility of the musculoskeletal system.
- Preventing a decrease in hearing, taste, and smell.
- Improving memory.

 Breaking down of fats and acting as an antiobesity agent.

 Increasing elasticity of vessels and lowering the bad cholesterol profile, consequently, reducing the risk of arteriosclerosis and heart attacks.

Increasing maximal breathing capacity.

Increasing sexual drives.

# Abuse of Growth Hormone in Sports

 "Citius, Altius, Fortius", a latin phrase meaning "swifter, higher, stronger" is the Olympic motto.

 It calls for people to strive for excellence, while respecting the physical and psychological integrity of athletes.

 It forbids partial manipulation of any of his or her capabilities.  One of the most important problems in the world of sports is substance abuse for enhancing performance.

- We believe that we cannot prevent drug abuse in sports only by drug testing.
- Drug testing is neither an effective way nor the only answer.

 Not only is testing costly, but loopholes also help many drug users cheat and not be caught.
 On the other hand, drug testing, only increases pharmaceutical wars. • The best way to reduce drug abuse in sports is to provide alternatives to the most commonly abused drugs—growth hormone and testosterone.

 Because only champions are loved and respected, many athletes resort to the motto of "winning at all costs".

 Growth hormone and testosterone are the most commonly abused drugs by athletes.  Prior to the Sydney 2000 Olympic games, abuse of GH by athletes was so common that the Atlanta 1996 Olympic Games were called the "Growth Hormone Games".

 For this reason, by spending an enormous expense, the International Olympic Committee (IOC) tried to take drastic measures to develop a test for GH by the start of the Sydney 2000 Olympic games. They succeeded.

### **GH** Abuse by Athletes:

 Even though growth hormone is not a steroid hormone, its effects are similar to those of anabolic steroids.



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- Bodybuilders were the first to use GH as a substitute for anabolic steroids; then its use spread to all sports.
- Because of the ability of synthetic growth hormone to build muscle and burn fat, its use boomed in the mid 1980s among athletes and continues to do so.

- Among athletes, GH is called the "hormone of championship".
- The main reason for using it is to take advantage of its ability to build muscle and to repair muscle tissues damaged under workout stress.
   Consequently, it helps enhance physical performance.
- Growth hormone reshapes the body by accelerating the burn of fat as well as by bulking muscles.

### Why Athletes Abuse GH:

Gain anabolic effect and build up muscles.



 Provide a source of energy that allows them to increase the duration of workouts.

Enhance physical performance and endurance.

• Strengthen the immune system.

Increase bone density.

 Prevent from muscle tissue break down during workout stress.

Shed fat.

 Increase protein synthesis by promoting the uptake of amino acids.

Improve concentration and athletic drive.

Improve lung capacity.

- The abuse of growth hormone by athletes has been reduced because of the following reasons, although its abuse continues:
- 1) Natural alternatives to synthetic GH.
- 2) High expense of preparing synthetic GH.
- 3) Occurrence of potential side effects.
- 4) Discovery of a laboratory technique for GH detection.

## Side Effects of Excess Growth Hormone

### Side Effects of Excess Growth Hormone:

The unwanted effects of excess GH can result from:

- Excessive secretion of GH.
- Extensive use of synthetic GH.

### Some common concerns regarding the impact of excessive growth hormone are:

- 1) Gigantism and Acromegaly.
- 2) Carpal Tunnel Syndrome.
- 3) Growth Hormone and Cancer.
- 4) Hypothyroidism.
- 5) Slipped Capital Femoral Epiphysis (SCFE).
- 6) Acromegaly-Like Changes.

# 1) Gigantism and Acromegaly:

• Gigantism and acromegaly are not side effects of the use of external GH.

 They are conditions caused by excessive secretion of GH from the pituitary gland nearly always due to a pituitary tumor, also called adenoma. • Gigantism is a rare condition caused by excessive secretion of GH during childhood, prior to closure of the epiphyses (growth plates).

- It leads to the exaggerated skeletal growth and allows the bones to continue to lengthen.
- Growth velocity is accelerated in children, but there is a little bony deformity.

### Other signs of gigantism are as follows:

- Swelling of soft tissues
- Enlarged peripheral nerves
- Delayed puberty
- Low function of sexual glands, also called hypogonadism.

- Acromegaly occurs as a result of excessive production of GH in adults, after closure of growth plates.
- The earliest sign is coarsening of the facial features and swelling of the soft tissue in the hands and feet.
- The faces of acromegalics are seen in paintings and sculptures throughout history.

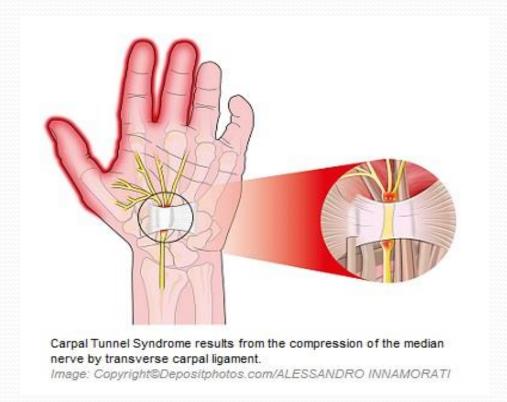
#### Other Signs of Acromegaly are:

- Change in appearance
- Increase in coarse body hair.
- Thickening and darkening of the skin
- Increased sweating and production of an offensive body odor
- Pain in joint
- Protrusion of the jaws
- Improper occlusion of the teeth
- Deep husky voice as a result of changes in the larynx

- Enlargement of the tongue, thyroid, liver, kidneys, spleen, heart, and pancreas
- Cancerous changes in the large intestine
- Increased blood pressure
- Disorder and irregularity in menstrual period
- Impairment in carbohydrate and fat metabolism
- Spontaneous and involuntary secretion of milk from the breasts (also called galactorrhea) in some women with acromegaly

# 2) Carpal Tunnel Syndrome:

 Carpal tunnel syndrome is a condition caused by compression of the median nerve along its course, mostly at the level of wrist.



 Women are affected more than men, and people with it complain of tingling and numbness in their hands and fingers especially after getting up in the morning.  Carpal tunnel syndrome and joint pain in cases of acromegaly are attributed to the water-retaining effect of growth hormone.

 Not all people with carpal tunnel syndrome have acromegaly, but some people with acromegaly may have the syndrome.

## 3) Growth Hormone and Cancer:

- The most worrisome effect of GH for researchers and physicians is the possibility of cancer occurring.
- That replacement therapy with GH or abuse of GH can cause cancer is not well known, but the development of the blood cancers, leukemia and lymphoma, as a result of excess GH is probable.

- Large doses of GH and IGF-I have produced cancer in laboratory animals.
- Because the effects of GH are mediated in large part by somatomedin-C (also termed IGF-I), some research and investigation indicate that elevated levels of IGF-I may increase the risk of breast and colon cancers.



The relationship of growth hormone and cancers is not well known and it is the subject of investigations.

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# 4) Hypothyroidism:

- The main reason for using GH in medicine is children with GH deficiency, manifesting with short stature and delayed bone age.
- In children who undergo treatment with GH, hypothyroidism occurs later; it is a condition that develops because of decreased function of the thyroid gland.

# 5) Slipped Capital Femoral Epiphysis (SCFE):

- SCFE is defined as displacement of growth plate of the neck of femoral bone.
- Displacement involves a shift in direction from horizontal to oblique during the early adolescent growth spurt.

- SCFE occurs most often in obese children 10-17 years of age, predominantly in boys in a ratio of 3:2.
- It almost never occurs in girls after they begin menses.
- Although the exact cause of SCFE is not known, mechanical and constitutional factors such as being obese or overweight may act as a predisposing agent.

- Administration of growth hormone is one of the causes attributed to SCFE.
- Children with SCFE often complain of knee pain referred from the hip area and of limping.
- An obese child treated with GH who suddenly has pain in hip area and limps must be regarded as having SCFE until proven otherwise.

# 6) Acromegaly-Like Changes:

- Abuse of synthetic GH by athletes can cause changes that mimic the symptoms and signs of acromegaly.
- The person's appearance and size alter to the extent that larger rings, gloves and shoes are needed.

The person will also develop bony deformities.

# **Homework:**

- 1) Describe how growth hormone affects the metabolism of carbohydrates and fats.
- 2) Describe the consequences of excess GH, internally or externally.

