INE INSTITUTE OF NUTRITIONAL ENDOCRINOLOGY

# Sleep:
# The Endocrinology of Sleep

Dr. Ritamarie Loscalzo



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## Sleep and Hormone Interactions

### Beneficial Effects During Slumber

- ✓Growth Hormone
- ✓Melatonin
- ✓Leptin
- ✓Estrogen
- ✓Progesterone
- ✓Testosterone

### Undesirable Effects During Slumber

- ✓Cortisol
- ✓Insulin

## Sleep and Insulin Resistance

- ✓ The effect of sleep deprivation on hormones, mental function, blood sugar metabolism, energy, and weight
- ✓ How to adopt a bedtime ritual that encourages sound sleep, including activities, herbs, and supplements that improve sleep
- ✓ Understanding sleep cycles and how to choose a bedtime that optimizes deep sleep duration
- ✓ Understanding the hormone interactions during sleep that contribute to energy, focus, fitness, and a flat belly
- ✓ Optimizing hormones during sleep to assure balanced blood sugar, mental clarity, a fit body, and high energy



## Sleep Deprivation, Insulin Resistance, and Growth Hormone

- ✓ Sleep debt causes impairment in endocrine, cardiovascular, and immune systems
- ✓ **Glucose clearance rate depressed by 40% after 4 days** of restriction of sleep to four hours a night, comparable to gestational diabetes
  *Spiegel K, Leproult R, Van Cauter, E Impact of sleep debt on metabolic and endocrine function. Lancet 1999 354: 1435-1439*
- ✓ **Glucose tolerance is decreased during sleep debt**
  *Scheen AJ, Van Cauter E. The roles of time of day and sleep quality in modulating glucose regulation: clinical implications. Horm Res 1998;49(3-4):191-201*
  *Scheen AJ, Byrne MM, Plat L, Leproult R, Van Cauter E. Relationships between sleep quality and glucose regulation in normal humans. Am J Physiol 1996 Aug;271(2 Pt 1):E261-70*

- ✓ **3 days of 10 - 12 hours of sleep can normalize fasting glucose**
- ✓ Sleep deprivation disrupts normal pattern of growth hormone surge during first three hours of sleep
  *Spiegel K, Leproult R, Colecchia EF, L'Hermite-Baleriaux M, Nie Z, Copinschi G, Van Cauter E. Adaptation of the 24-h growth hormone profile to a state of sleep debt. Am J Physiol Regul Integr Comp Physiol 2000 Sep;279(3):R874-83*



## Sleep and Growth Hormone

- ✓ Increases protein synthesis in every cell
- ✓ Promotes the release of fat from cells
- ✓ Shifts cell fuel from glycogen and glucose to fat
- ✓ Promotes insulin sensitivity

**Secreted in response to:**

- ✓ Empty or emptying stomach, via **ghrelin**
- ✓ Amino acids
- ✓ Exercise: increases with exercise intensity
- ✓ Deep sleep

## Cortisol/Growth Hormone

- ✓Cortisol surge before bed inhibits growth hormone surge
- ✓Cortisol reduces the rate of fat burning
- ✓Growth hormone added to the mix increases the rate of fat burning



## Leptin

- ✓Secreted by the fat cells – the white adipose tissue
- ✓Signals the hypothalamus and pancreas "we are full"
- ✓Hypothalamus response is to turn off appetite
- ✓Pancreas response is to stop producing insulin
- ✓Has a 24-hour circadian rhythm and is controlled by eating
- ✓Pancreas and hypothalamus become leptin resistant



## Normal Leptin Function

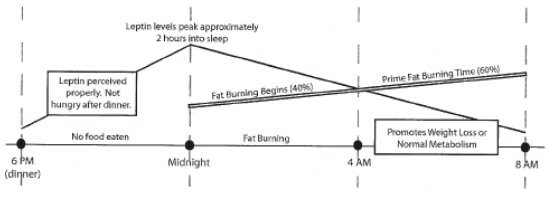



Chart from: Richards BJ. *Mastering Leptin.* Minneapolis: Wellness Resources Books, 2004

## Leptin Resistance

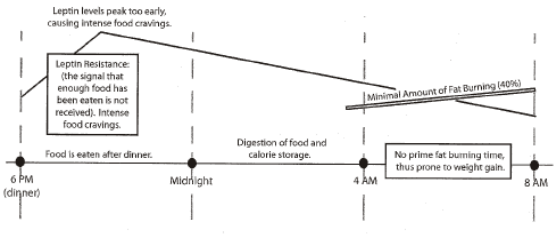



Chart from: Richards BJ. *Mastering Leptin.*Minneapolis: Wellness Resources Books, 2004



## Guidelines for Managing Leptin and Insulin

- ✓Never eat after dinner
- ✓Eat only three meals a day
- ✓Allow five to six hours between meals
- ✓Do not eat large meals
- ✓Eat slowly
- ✓Eat a breakfast containing protein
- ✓Reduce the intake of starchy carbohydrates



## Ghrelin and Sleep

- ✓ Ghrelin is secreted by cells in the stomach wall
- ✓ Eating suppresses ghrelin
- ✓ Ghrelin stimulates appetite
- ✓ **Sleep deprivation increases ghrelin and hunger**
  http://www.drritamarie.com/go/PMID18564298
- ✓ Ghrelin is a potent stimulator of growth hormone
- ✓ Waiting to eat until you are very hungry and your stomach is empty **stimulates fat burning and muscle sparing**

## Sleep Deprivation and Hunger

- ✓ Sleep deprivation decreases leptin, increases ghrelin, and stimulates hunger
- ✓ A reduction of sleep duration to 4 hours for two consecutive nights has recently been shown to decrease circulating leptin levels and to increase ghrelin levels as well as self-reported hunger

http://www.drritamarie.com/go/PMID18564298



## Melatonin

- ✓ Produced by pineal gland
- ✓ Turned on by low light conditions
- ✓ Turned off by bright light
- ✓ Promotes deep sleep
- ✓ **Protects from tumor growth**
- ✓ Reduced by computer and TV at night
- ✓ Inhibited by eating too close to bedtime
- ✓ Produced from the amino acid tryptophan and requires vitamin B6 for synthesis



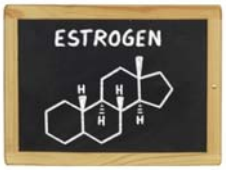
## Progesterone

- ✓ Promotes deep sleep
- ✓ **Prevents lipid peroxidation**
- ✓ Blocks the atherogenic effects of cortisol

- ✓ **Anti-inflammatory and antioxidant effects**
  - ➢ Reduces NK cells, TNF-alpha, and Th1 cytokines
  - ➢ Stimulates the production of IL-4 and IL-10 and increases levels of reduced glutathione and superoxide dismutase
- ✓ Suppresses excess estrogen
- ✓ Activates the GABA receptor sites - calming
- ✓ Involved in regulation of hypoglycemia

## Estrogen

- ✓Significantly increases the amount of time patients had REM sleep
- ✓Reduces the time spent awake from 20 to 12 minutes during the first two sleep cycles of the night
- ✓Deep sleep promoting effect is beyond hot flash control






## Testosterone

- ✓Diminished testosterone linked with snoring and sleep apnea
- ✓Sleep can increase testosterone
- ✓Sleep deprivation decreases testosterone
- ✓An extra few hours of sleep can double testosterone

http://www.drritamarie.com/go/PMID17520786
http://www.drritamarie.com/go/PMID19684340