• How does sleep impact society?

• The impact of sleep on public health

• How you can get involved?
Other Organisms have a Daily Rhythm
Sleep can occur at a local level

- Electrical recordings can show cell columns have deeper sleep patterns correlating with use during the previous wake period.
Sleep can occur in a region
Sleep is required for a Being

- Sleep is defined by the function of the whole body system
- Animals that are developing need more sleep.
- Animals die after 3 weeks of total sleep deprivation – of multi organ failure
Sleep State Current Definition

- Many physiological factors vary with sleep stage
- Determined by Physiological Measures
  - EEG (Brain Wave Activity)
  - EMG (Muscle Tone)
  - EOG (Eye Movement)
Ideal Hypnogram

Graph of the sleep stages through the sleep period
Graph of the sleep stages through the sleep period
States of Being

AWAKE

REM Sleep

NREM Sleep

BVV 2017
What Drives Us to Sleep

- Body Clock – Circadian Rhythm
- Length of wake – Homeostatic Drive
Circadian Rhythm

Body Temperature
Circadian
Wakefulness

6:00 AM     Noon     6:00 PM
6:00 AM     MN
Why do We Have a Rhythm?
Circadian Transcription-Translation Feedback Loop

Transcribed

Period

+ REVERB

Cry

Predominantly early day

Translated forms a heterodimer

Intranuclear

Cytoplasm

Predominantly late day

Intranuclear

BMAL1

Clock
SCN lesion disrupts circadian activity in the Squirrel Monkey

Albers et al., 1982, Neuroscience Letters

Normal Rhythm

SCN Lesioned – No Rhythm
Circadian Rhythm

Influenced by Zeitgeber (time givers)
- Bright Light
- Exercise
- Food
- Social Interactions.

24.3 hours

24 hours
How Society influences your body clock
Circadian Influences on Physiology

- Every system cycles in a circadian manner.
- 7-10% of genes are transcribed in a circadian manner.
- Hormones cycle in a circadian pattern, and hormones fluctuate with sleep/wake cycles.
- Liver cycles mRNA, regulator peptides and enzymes for metabolism carbohydrates, lipids, fats and medications (e.g., P450 oxidoreductase).
Circadian Influence on Brain Performance

- Memory
- Cognitive Performance
- Reaction Time
- Mood
- Manual Dexterity
- Strength
Homeostatic Sleep Need

- Longer period awake increase need for sleep.
- Circadian Wakefulness

Homeostatic Sleepiness

Alertness

6:00 AM  Noon  6:00 PM  MN  6:00 AM

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Homeostatic Drive

- Chemical measure in the brain of how long we have been awake and how active we have been

- Adenosine
- Glutamin
- Uridine
- Prostaglandin D2
- GABA-A
- Interleukin IL-1, 2, 6, 8, 15, 18
- Delta Sleep Inducing peptide

- GHRH
- Cortistatin
- Oleamide
- Progesterone
- VIP, CCK
- Nitrous oxide
- Tumor necrosis factor
Homeostatic Drive for Sleep

- Longer period awake increase need for sleep.

Circadian wakefulness

Homeostatic Sleepiness

Temperature/wake

4AM  Noon  1-4 PM  9PM
Time over 24 hrs

4AM  Noon

BVV 2014
Homeostatic Drive for Sleep

- Sleep Deprived

- Circadian wakefulness
- Homeostatic Sleepiness

Temperature/wake

4AM Noon 1-4 PM 9PM 4AM

Time over 24 hrs
Homeostatic Drive for Sleep

- Longer period awake increases need for sleep.

Caffeine Effect

Temperature/wake

4AM Noon 1-4 PM 9PM
Time over 24 hrs

4AM Noon
Is Sleep Important?
What happens when we sleep?

- Brain size reduces
- Clear multiple substances
- Prune unneeded synaptic connections
- Balance the autonomic nervous system output
- Realign the Endocrine system - metabolism
- Repair muscle
- Children grow
What effect do we get from sleep?

- More alert and attentive
- We learn better
- We remember more
- Are bodies work better
So how much sleep do you need?

- How do you know you are sleeping enough?
- Each person is an individual
- Range of normal sleep need is 6-10 hours per night
- You should be getting enough sleep if you wake without an alarm 5/7 mornings and do not get sleepy in the day
Sleep Debt

- Restriction of amount of time devoted to sleep.
- Accumulation of debt.
- May be selectively deprive of Stages of Sleep.
- Growing National Sleep Debt now average adult sleep less than 7 hours/night.
- Similar to Borrowing Money from a Bank

BVV 2014
Sleep Deprivation

- Irritability
- Lower Mood
- Weight Gain
- Higher Blood Pressure
- Vascular Disease

Tony Wright World record holder for sleep deprivation of 11 days
The Effect of Sleep Deprivation on the Body

- Change in Regulation of:
  - blood pressure,
  - heart rate,
  - fat amount,
  - glucose regulation
  - endocrine regulation
  - liver and kidney function
  - immune function
  - Inflammatory markers
Sleep Deprivation Increases Inflammatory markers

Meier-Ewert 2004
Sleep Deprivation and Poor Sleep Promote Weight Gain

- Decreases Leptin, Increase Ghrelin
- Decreases Glucose tolerance
- Increases glucose conversion to fat
- Increases Insulin Resistance
Obesity Trends* Among U.S. Adults

BRFSS, 1985

(*BMI ≥30, or ~ 30 lbs. overweight for 5’ 4” person)
Obesity Trends* Among U.S. Adults
BRFSS, 1986
(*BMI ≥30, or ~ 30 lbs. overweight for 5’ 4” person)
Obesity Trends* Among U.S. Adults

BRFSS, 1987

(*BMI ≥ 30, or ~ 30 lbs. overweight for 5’ 4” person)
Obesity Trends* Among U.S. Adults

BRFSS, 1988

(*BMI ≥30, or ~ 30 lbs. overweight for 5’ 4” person)
Obesity Trends* Among U.S. Adults
BRFSS, 1989
(*BMI \geq 30, or \sim 30 lbs. overweight for 5’ 4” person)
Obesity Trends* Among U.S. Adults

BRFSS, 1990

(*BMI ≥30, or ~ 30 lbs. overweight for 5’ 4” person)
Obesity Trends* Among U.S. Adults

BRFSS, 1991

(*BMI ≥30, or ~ 30 lbs. overweight for 5’ 4” person)
Obesity Trends* Among U.S. Adults

BRFSS, 1992

(*BMI ≥30, or ~ 30 lbs. overweight for 5’ 4” person)
Obesity Trends* Among U.S. Adults

BRFSS, 1993

(*BMI ≥30, or ~ 30 lbs. overweight for 5’ 4” person)
Obesity Trends* Among U.S. Adults

BRFSS, 1994

(*BMI $\geq 30$, or ~ 30 lbs. overweight for 5’ 4” person)
Obesity Trends* Among U.S. Adults

BRFSS, 1995

(*BMI ≥30, or ~ 30 lbs. overweight for 5’ 4” person)
Obesity Trends* Among U.S. Adults

BRFSS, 1996

(*BMI ≥ 30, or ~ 30 lbs. overweight for 5’ 4” person)
Obesity Trends* Among U.S. Adults
BRFSS, 1997
(*BMI ≥30, or ~ 30 lbs. overweight for 5’ 4” person)
Obesity Trends* Among U.S. Adults

BRFSS, 1998

(*BMI $\geq 30$, or ~ 30 lbs. overweight for 5’ 4” person)
Obesity Trends* Among U.S. Adults

BRFSS, 1999

(*BMI ≥30, or ~ 30 lbs. overweight for 5’ 4” person)
Obesity Trends* Among U.S. Adults

BRFSS, 2000

(*BMI ≥30, or ~ 30 lbs. overweight for 5’ 4” person)
Obesity Trends* Among U.S. Adults

BRFSS, 2001

(*BMI ≥30, or ~ 30 lbs. overweight for 5’ 4” person)
Obesity Trends* Among U.S. Adults
BRFSS, 2002

(*BMI ≥ 30, or ~ 30 lbs. overweight for 5’ 4” person)
Obesity Trends* Among U.S. Adults

BRFSS, 2003

(*BMI ≥30, or ~ 30 lbs. overweight for 5’ 4” person)
Obesity Trends* Among U.S. Adults
BRFSS, 2004
(*BMI ≥30, or ~ 30 lbs. overweight for 5’ 4” person)
Obesity Trends* Among U.S. Adults

BRFSS, 2005

(*BMI ≥30, or ~ 30 lbs. overweight for 5’ 4” person)
Obesity Trends* Among U.S. Adults
BRFSS, 2006
(*BMI ≥30, or ~ 30 lbs. overweight for 5’ 4” person)
Performance after wakefulness

- Longer period awake increases need for sleep.
- Circadian wakefulness
- Homeostatic Wakefulness

Graph showing the relationship between mean relative performance and hours of wakefulness. The graph also includes a bar graph showing blood alcohol concentration (%).
Sleep Deprivation

**Acute Sleep Debt**
- Sleepiness is perceived
- Effects more immediate on performance
- Lapses occur
- Risk taking is greater
- Mood is worse
- Short term stress hormones are released

**Chronic Sleep Deprivation**
- Sleepiness is not perceived
- Lapses are less perceived
- Risk taking is greater
- Mood can becomes more affective disorder
- Long term changes in Body and Brain
What tasks are most influenced by sleep?

- Monitoring tasks
- Tasks that require vigilance
- Tasks that require emotional patience

- Verdict is out on peak performance tasks
Falling Asleep on the Job?

- FAA: 48% ATC
- Police: 80% report 1/wk on night shift
- NASA: 80% regional pilots, 71% corporate pilots
- Healthcare: 66% of nurses
Sleep Dysfunction and Major Accidents

15-25% accidents

Salvaggio fell asleep at the wheel in the middle of the afternoon (From WNYT)

$150 Billion/year

11:35 PM

1:23 AM

5:20 AM

4:00 AM
Sleep in Society

- Average American adult sleeps 6.8 hrs per night.
- Air traffic controller before a midnight shift sleeps 4 hr
- Railroad engineers 4.6
- Truck Drivers 3.8-5.3 hr
- Police 6.2 hr
- Fireman 5.1 hr
- 40% of workers note sleepiness interfering with their daytime work

BVV 2014
Does Sleep Deprivation Influence Memory?

Sleep-deprivation affects memory encoding.

Sleep deprivation causes a significant decrease in the posterior hippocampus.

Does Sleep Deprivation Influence Memory?

Happiness in America

- Linear trends to lower degrees of happiness and higher degrees of irritability

Source: General Social Survey 1972-2004
Political Influence
Drowsy Driving Fatalities

- Over 100,000 Drowsy Driving accident/year
- Estimated influences >20%
- 71,000 injuries
- 1500 deaths
- $12.5 Billion
Children and School

- The average high school student sleeps less than 7 hours per night.
- The average high school student needs 9.25 hours/night.
- For every hour/night loss of sleep children lower grade performance by ½ letter grade.
- Children who are sleep deprived have more aggressive outburst and look like ADHAD.

NSF survey 2005
Long Term Outcomes from sleep deprivation

- Health risks
- Poorer cognitive work performance
- Worse mood and interactions
- Frequency of Accidents
- Decrease in Quality of life
THANK YOU

The woods are lovely, dark, and deep,
But I have promises to keep,
And miles to go before I sleep,
And miles to go before I sleep.

Robert Frost

Good Sleep for Good Health
Questions?