

A decorative graphic consisting of a horizontal bar with a gradient from olive green on the left to white on the right. A thin yellow circle is positioned behind the bar, partially overlapping it. A thick black bracket is on the left side of the bar, and a thick yellow bracket is on the right side.

# POLYSOMNOGRAPHY

Module J

# OBJECTIVES

## ■ The student will be able to:

- List the stages of normal sleep.
- Distinguish between the stages of normal sleep.
- Given a neurotransmitter, state the effect it has on normal sleep.
- List three factors assessed during a sleep history.
- State one method used to assess patient sleepiness.
- Differentiate between obstructive, central, and mixed sleep apnea.
- State the treatment used for obstructive sleep apnea.
- State the treatment used for central sleep apnea.
- List four instruments used during polysomnography.
- Describe the instrumentation used to assess nasal airflow.
- Describe the instrumentation used to assess chest and abdominal wall movement.
- Differentiate between an arousal and an awakening.
- Differentiate between apnea and hypopnea.
- Describe rest leg syndrome.

# What is Sleep?

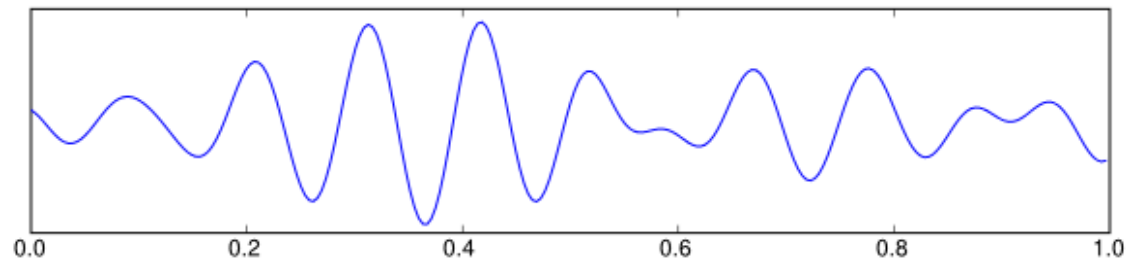
- A balance between three states:
  - Wakefulness
  - Non-rapid eye movement sleep
  - Rapid eye movement sleep
- Each are distinct phases with specific
  - Behavioral aspects
  - Physiological effects
  - Different parts of the brain associated

# Stages of Normal Sleep

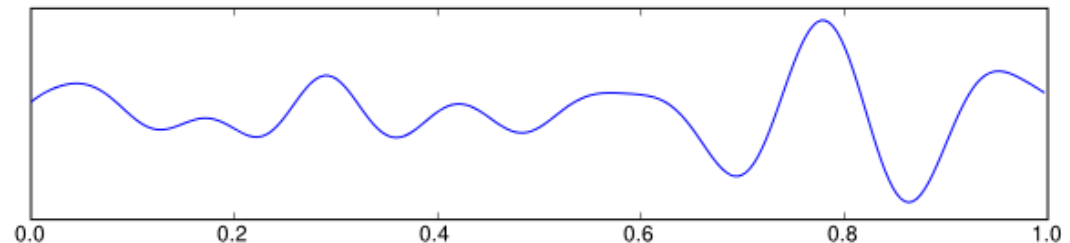
- Sleep Architecture (1929)
- Defined by sets of
  - EEG
  - EOG
  - EMG
- 6 stages:
  - Wakefulness
  - Non-REM Sleep Stages 1-4
  - REM sleep

# Wakefulness

- Great variability.
  - Different pattern with eyes open/closed.
- Alpha rhythm (8-12 Hz)

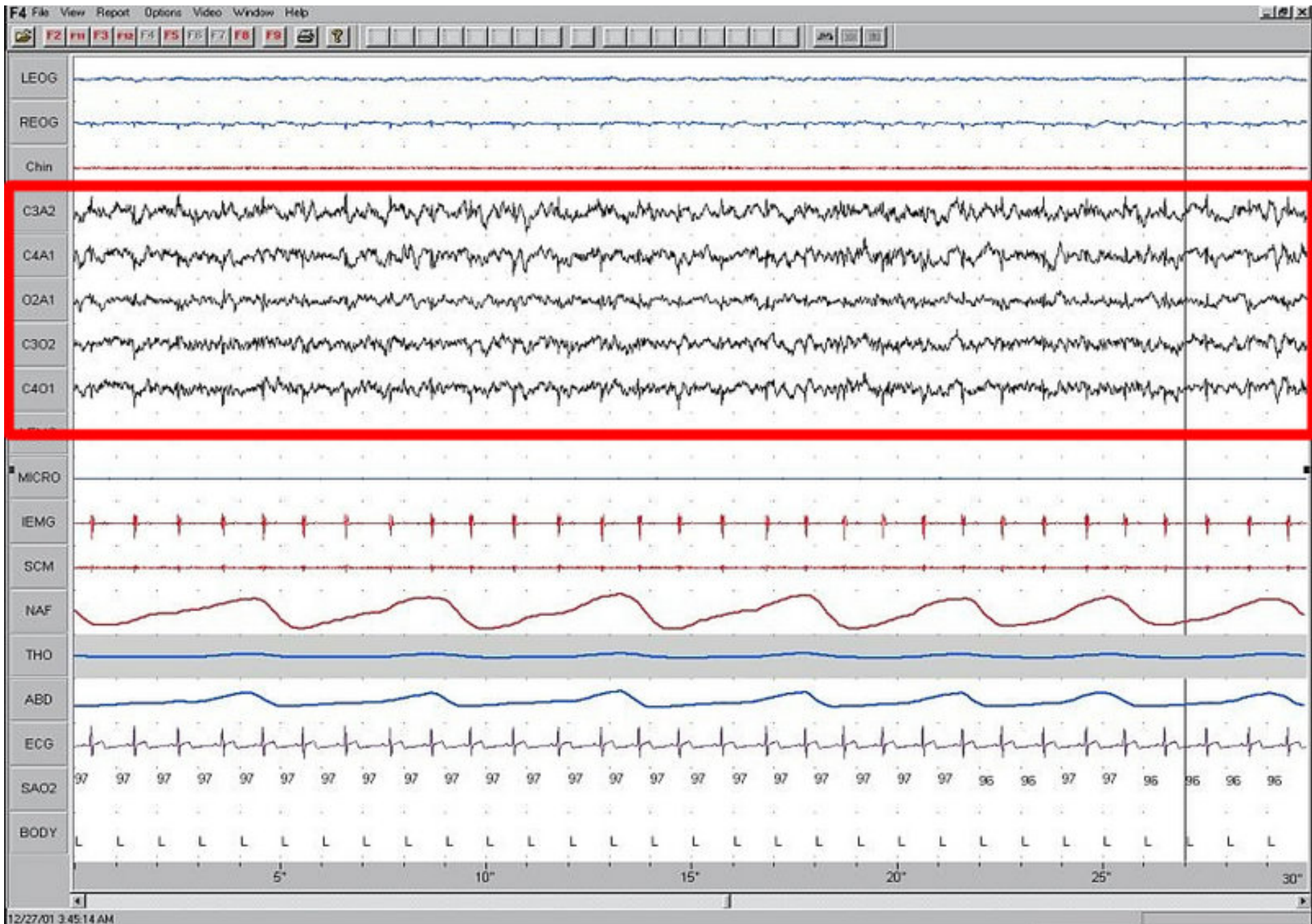


- With the onset of sleep there is a waxing and waning of the alpha waves (attenuation) and presence of theta waves (4-8 Hz)



# Stage I Sleep

- NREM
- Loss of alpha waves.
- Waves of mixed frequency.
- Mostly a transition into Stage II sleep.
  - Gateway between wakefulness & sleep.
- Also known as somnolence or drowsy sleep.
- Some loss of muscle tone.
- Conscious of environment.

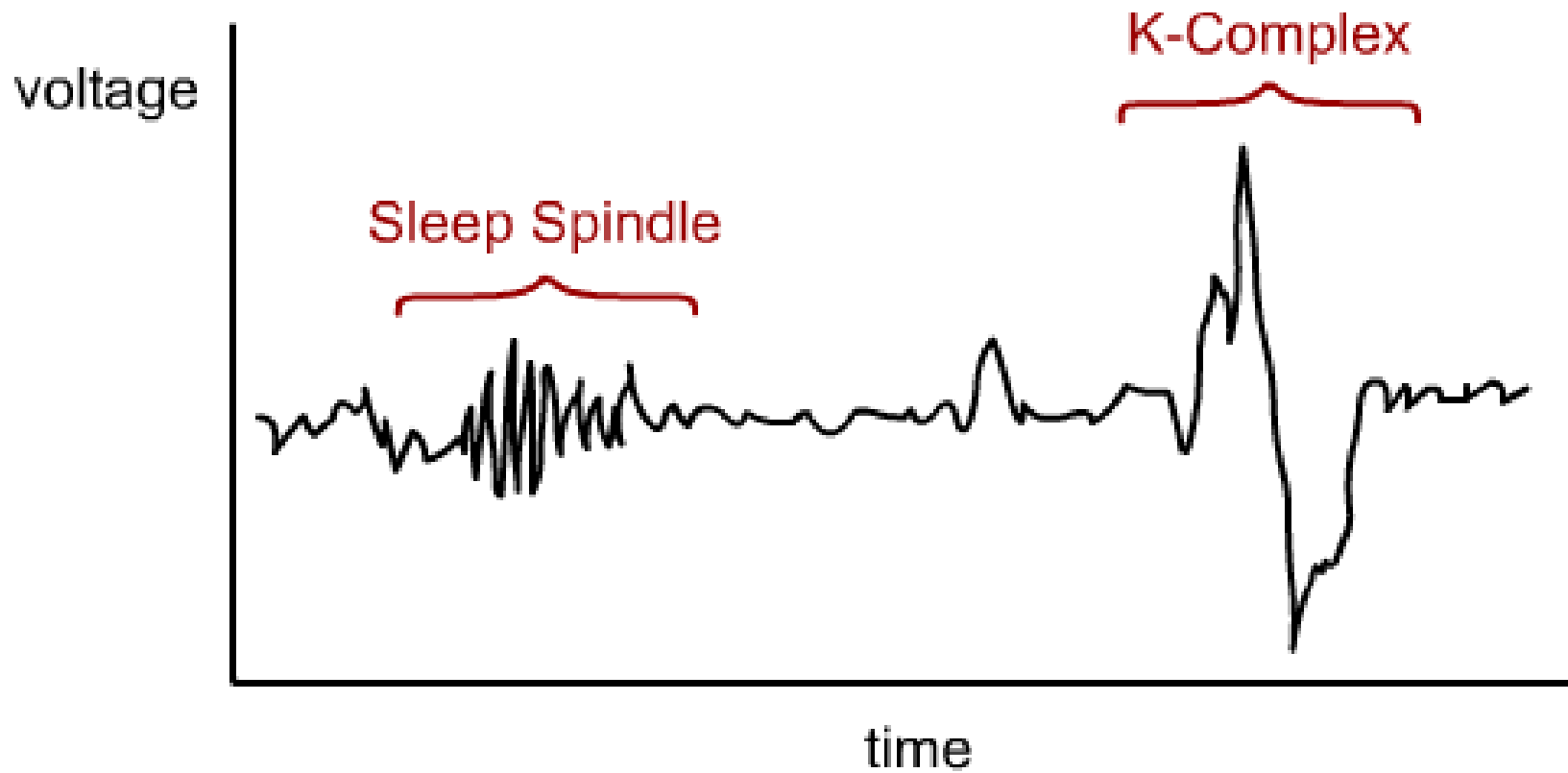


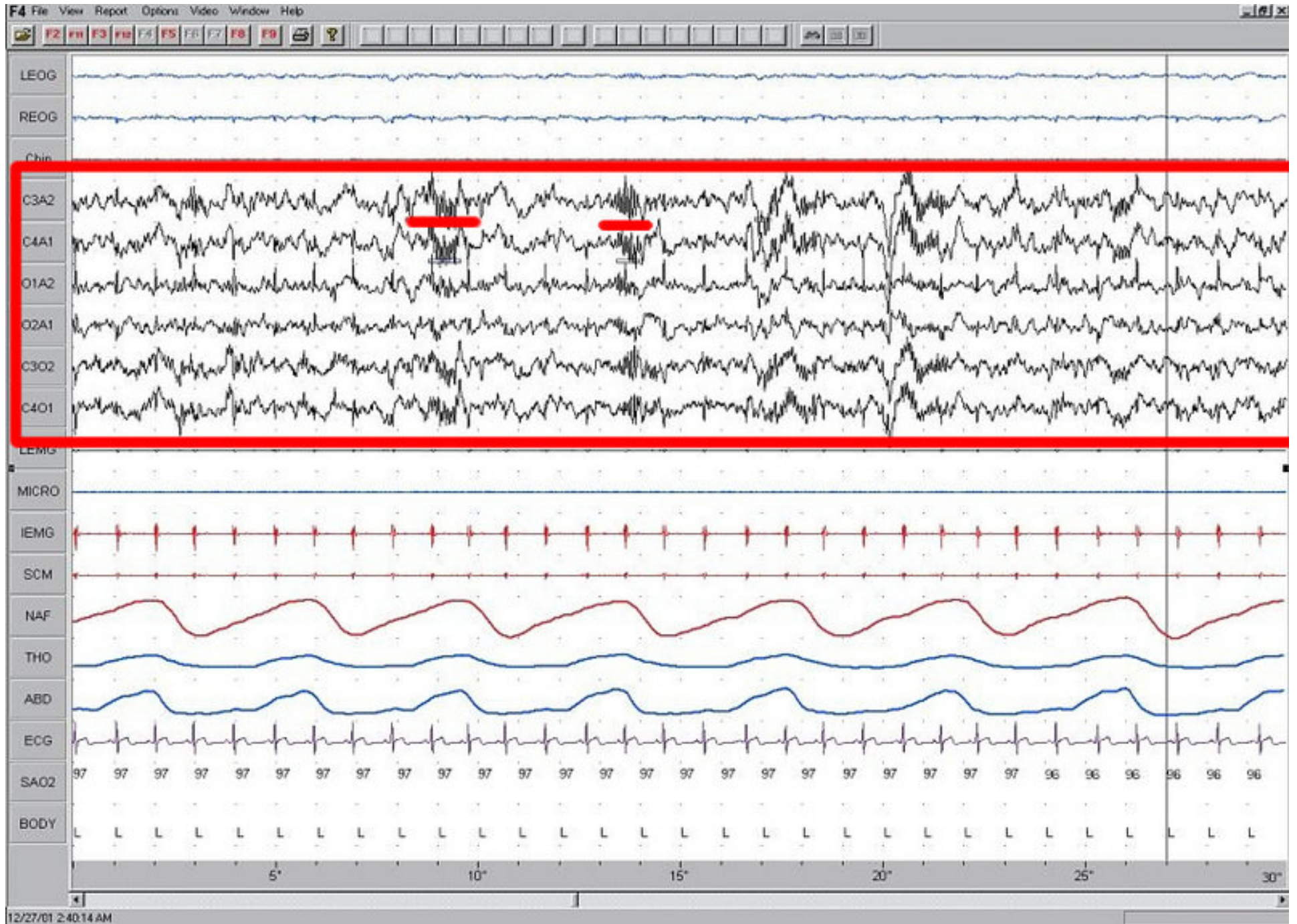
# Stage II Sleep

- NREM
- Deeper sleep.
- Presence of K complexes & spindles.
  - High amplitude, biphasic waveforms.
- Less muscle activity (EMG).
- Less eye movement (EOG).
- Consciousness of environment disappears.
- 45-55% of sleep.



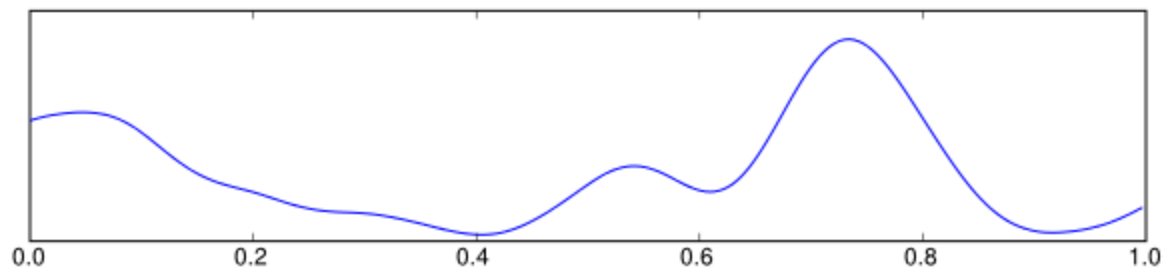
# K-Complexes

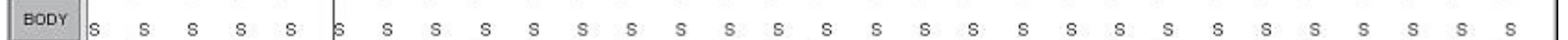
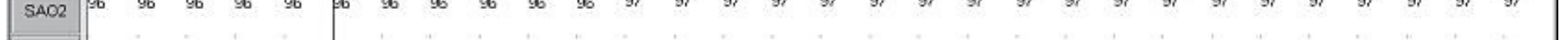
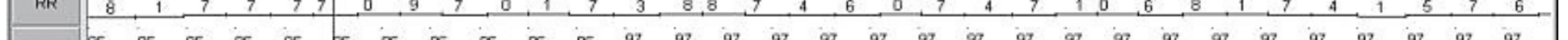
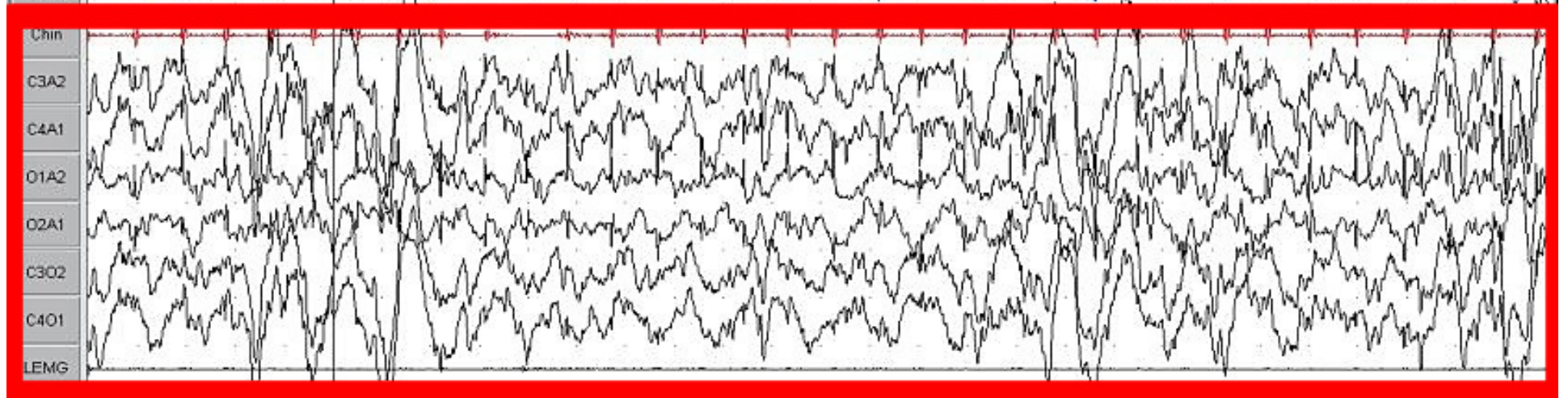
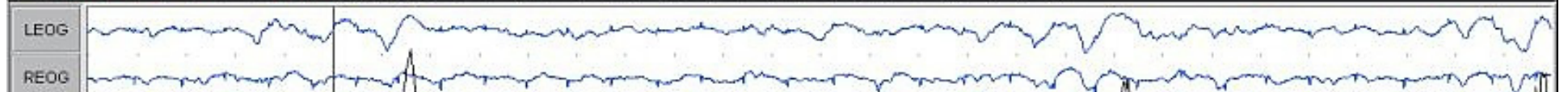




# Stage III & IV Sleep

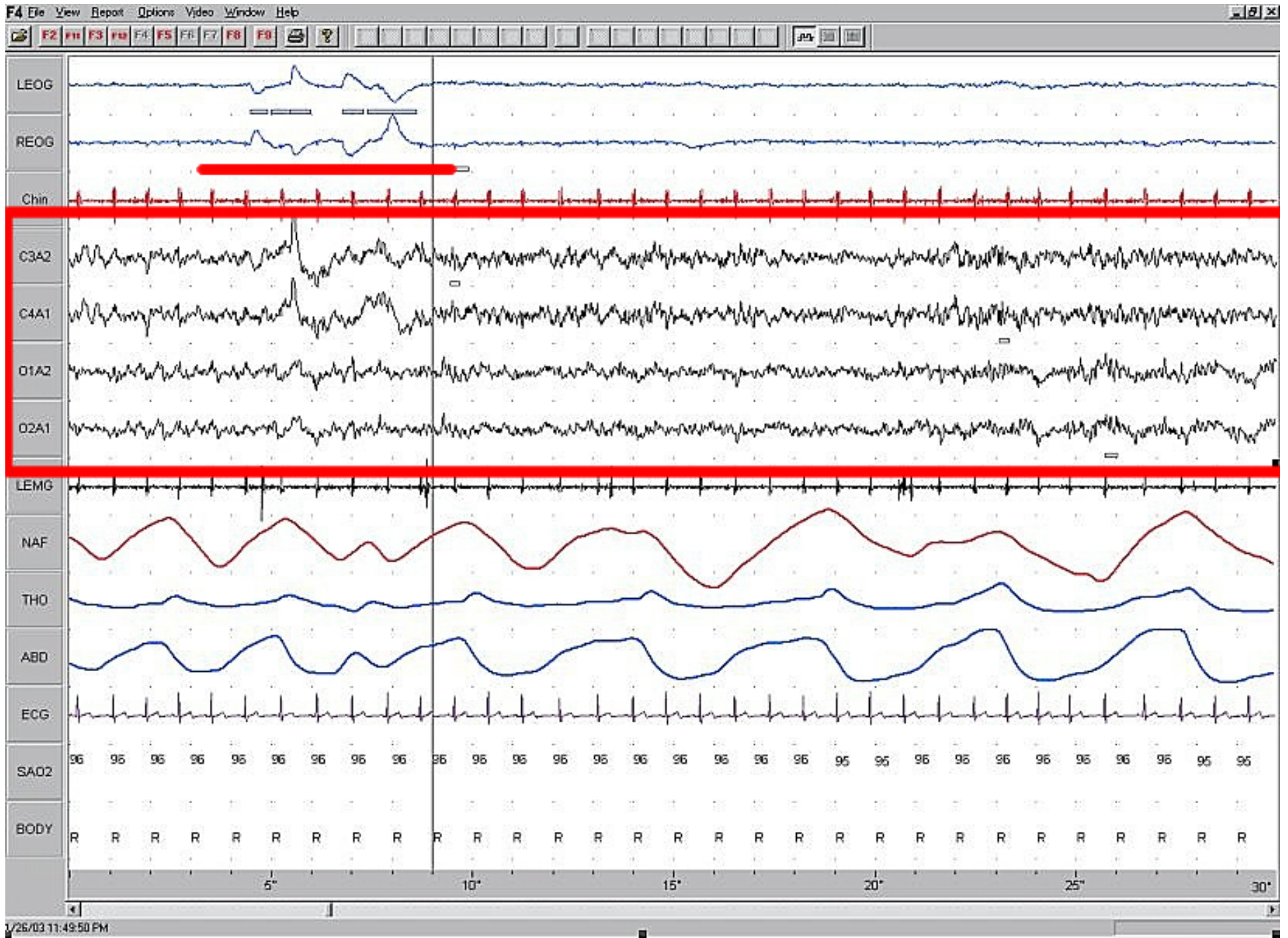
- NREM
- Gradual slowing of frequency of waveforms (delta waves).
- Stage III: 20 to 50%; 3-8% of sleep
- Stage IV: Greater than 50%; 10-15%

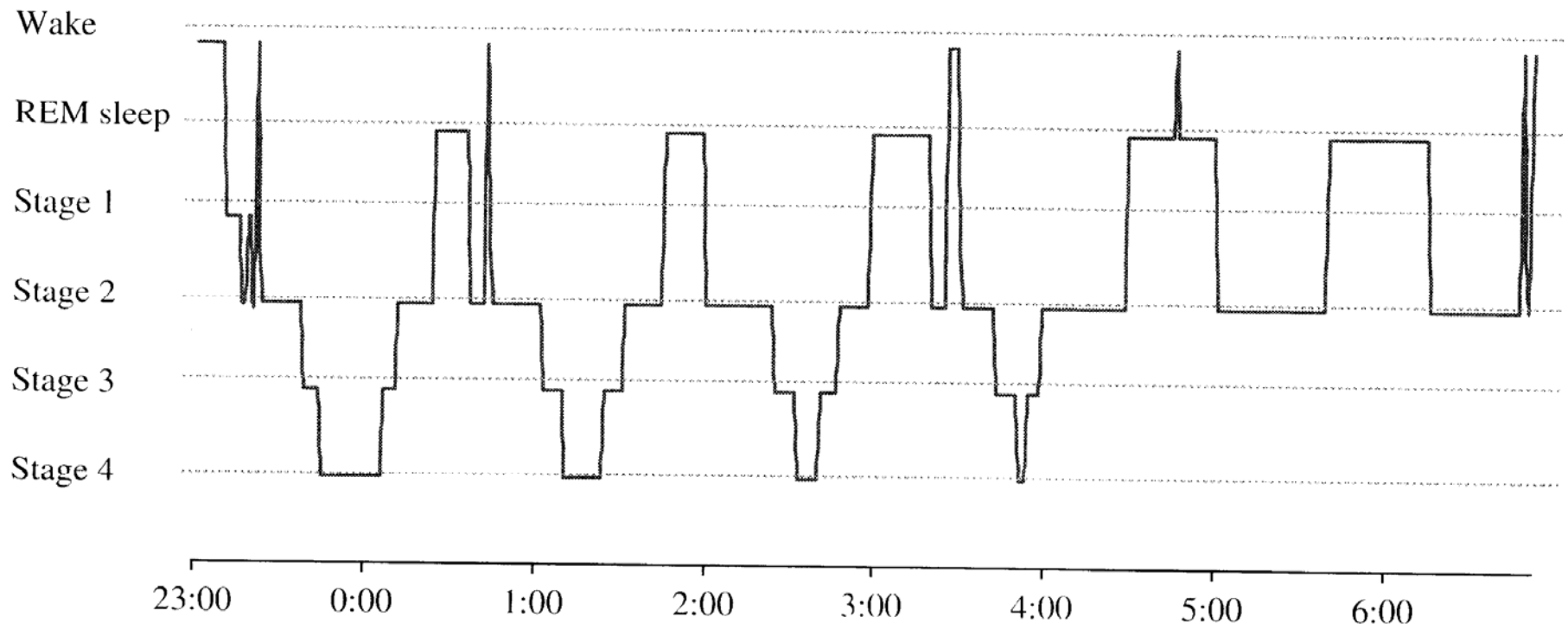




# REM Sleep

- Rapid Eye movement.
- Similar to Stage I in that there are low voltage, mixed frequency EEG waves.
- Saw-tooth waves during periods of REM.
- Associated with dreaming.
- Absence of muscle tone.
  - Mostly atonic; some periodic bursts.
  - Only diaphragm still contracts.





# Physiological Patterns of Normal Sleep

- Pattern of alternating REM & NREM of about 90 minutes.
  - Longer durations of Stage IV at beginning, followed by progressively less time spent there.
- Wakefulness/Onset of sleep
  - Slowing of  $f$
  - Decreasing  $V_t$
  - Airway muscles relax (snoring).
  - Reduction in sympathetic activity.
  - Blunted hypoxic & hypercarbic response.



# Physiological Patterns of Normal Sleep

- NREM Sleep
  - Low sympathetic activity with surges & transient arousals.
  - Regular respiratory rate.
- REM Sleep
  - Rapid eye movements.
  - Parasympathetic tone increases.
  - Voluntary muscles are atonic.
  - Breathing rate becomes irregular.
  - Vivid imagery upon awakening.

# Neurotransmitters and Sleep

- Acetylcholine
  - Cholinergic agent.
  - Associated with triggering REM sleep.
- Catecholamines
  - Dopamine & Norepinephrine
  - Maintenance of wakefulness.
    - Blocked with tranquilizers.
- Serotonin
  - Induces sleep.
- Melatonin
  - Prolongs early REM periods.

# Assessment of Sleep Disorders

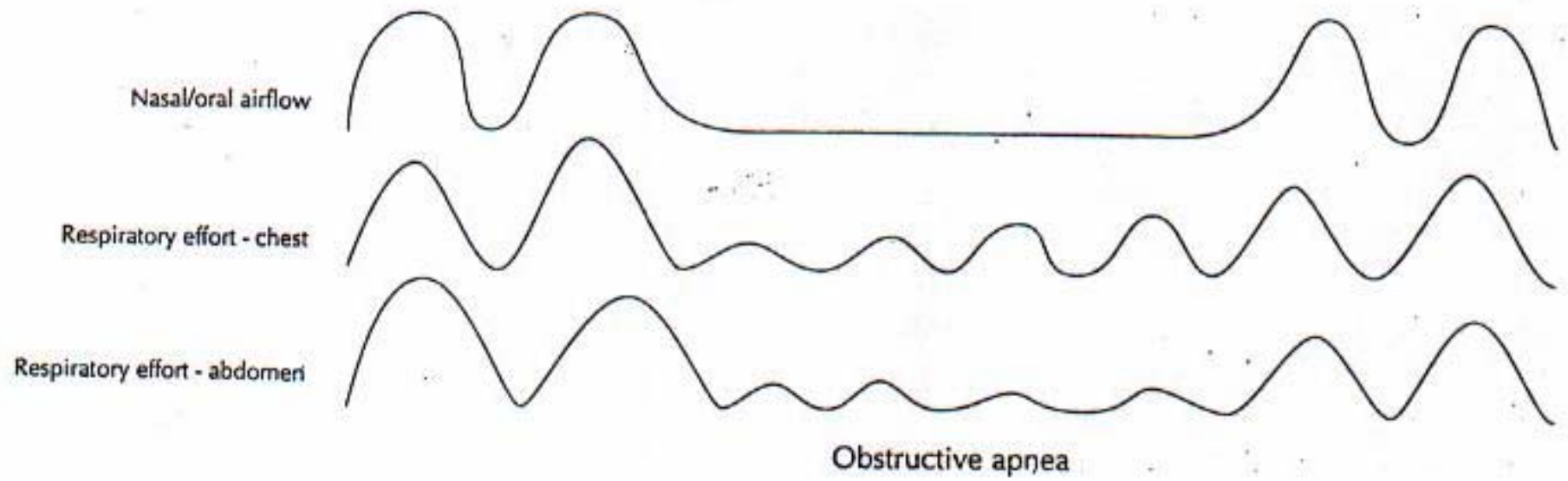
- Over 170 sleep-related disorders.
- Complaints include:
  - Insomnia
  - Fragmented or disturbed sleep.
  - Excessive daytime sleepiness.
- Components
  - Sleep History (time into/out of bed, etc.)
  - Bed partner questionnaire.
  - Sleep questionnaire.
  - Medical History
  - Medications
  - Family History
  - Physical Exam

# Sleepiness Scales

- Epworth Sleepiness Scale
  - Has patient rate the sleep from “would never doze” to “high chance of dozing” for various activities from “sitting & reading”, to “watching TV” to “in a car while stopped for a few minutes in traffic”.
- Stanford Sleepiness Scale
  - Has patient choose from a series of statements which best describes their level of sleepiness right now.

# Obstructive Sleep Apnea

- Most common of the sleep apneas.
- Partial or complete obstruction of the upper airway during sleep.
- **Absence of airflow at the nose/mouth but inspiratory efforts are present; O<sub>2</sub> desaturation.**
- **Can develop Cor Pulmonale.**



# Obstructive Sleep Apnea

## ■ Symptoms

- Loud habitual snoring, choking/gasping/snorts
- Morning headaches
- Daytime sleepiness (hypersomnolence)
- Obesity
- Hypertension
- Nocturnal enuresis
- Impotence
- Personality changes/depression

# Obstructive Sleep Apnea

- Profile

- Upper body obesity
- Neck size #17 or larger in men
- Neck size #16 or larger in women
- Hypertension
- C/O daytime sleepiness



# Pickwickian Syndrome

- Obesity
- Excessive daytime sleepiness
- Sleep apnea
- Decreased pulmonary function
- Chronic ventilatory failure
  - Hypoxic drive

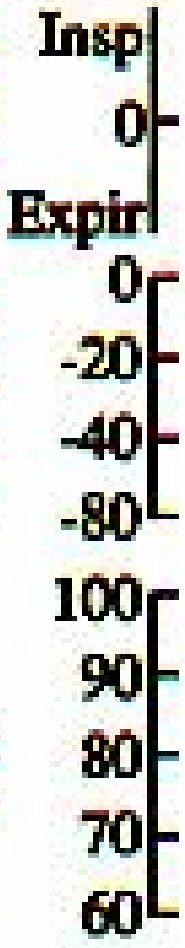
ARTERIAL ESOPHAGEAL

O<sub>2</sub> SATURATION PRESSURE

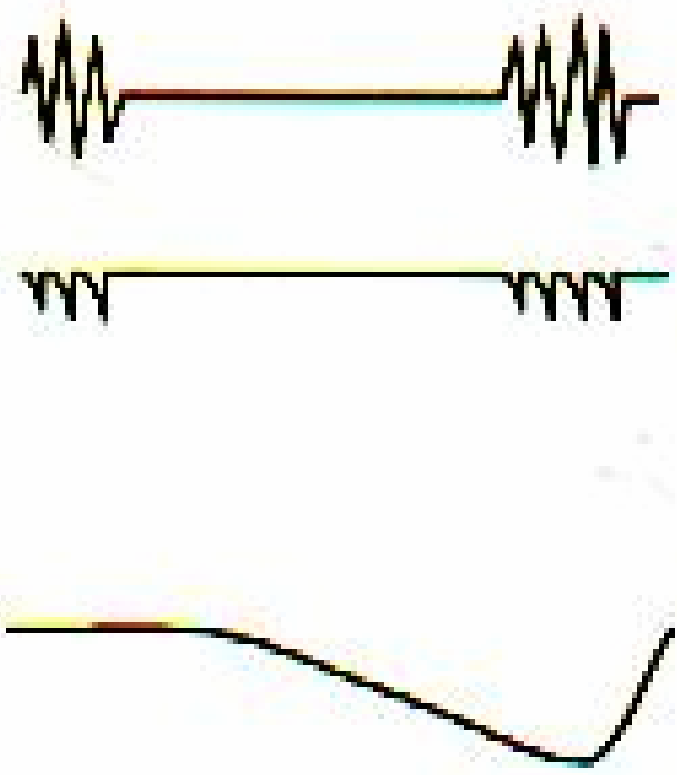
(%)

(cm H<sub>2</sub>O)

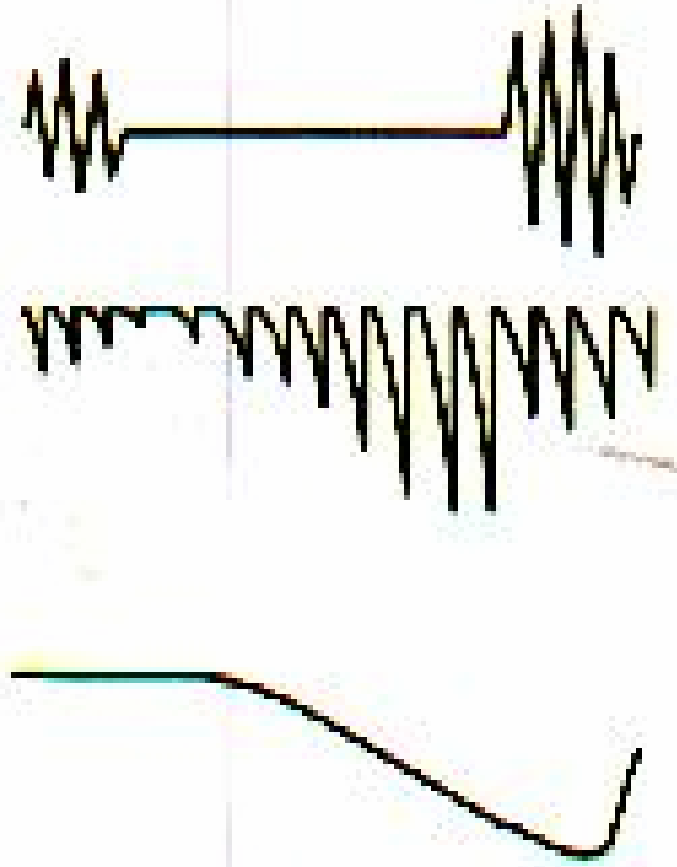
AIRFLOW



### CENTRAL APNEA

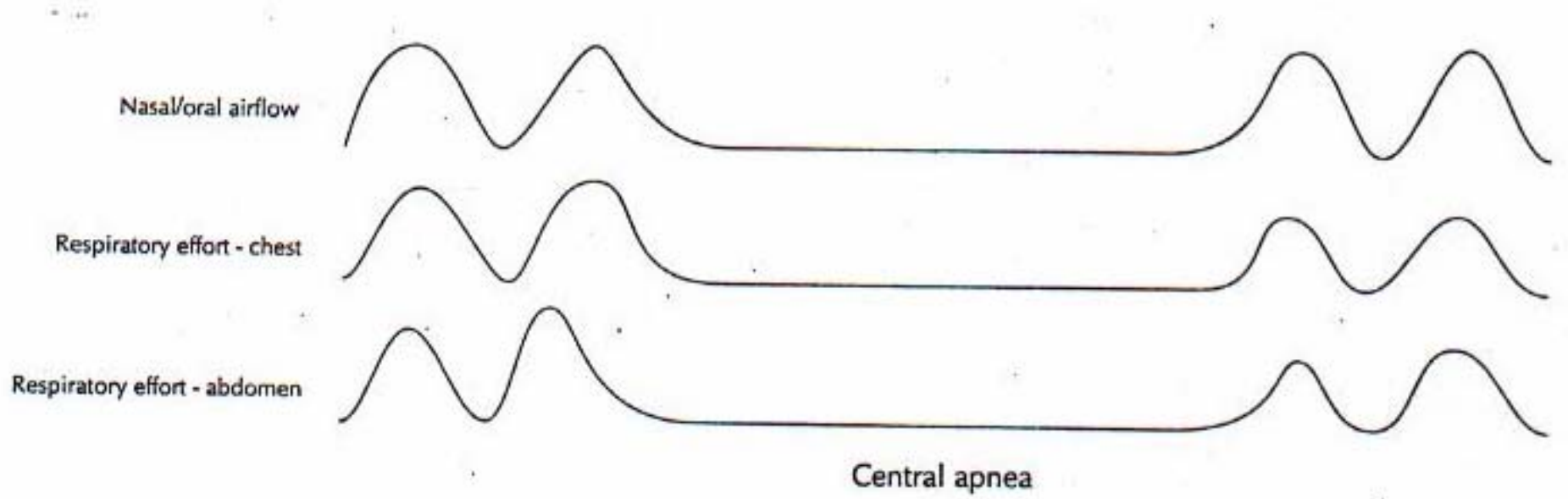


### OBSTRUCTIVE APNEA



# Central Sleep Apnea

- Respiratory centers of the medulla fail to send signals to the respiratory muscles.
- **Cessation of airflow at the nose and mouth, no inspiratory efforts & desaturation of hemoglobin.**
- **Associated with CNS disorders.**
- **Accounts for 10% of all sleep apneas.**



# Mixed Apnea

- Combination of Obstructive and Central.
- Begins as central apnea followed by obstructive apnea.
- Often found in Down's Syndrome.

# Polysomnography Equipment

- Respirations (nasal air-flow)
- SpO<sub>2</sub>
- Respiratory Effort
  - Inductive plethysmography or esophageal balloon
- Brain wave activity - electroencephalogram
- Eye movement – electrooculogram
- Muscle movement - electromyogram
- Heart activity - electrocardiogram
- Body position (video)

# Sleep Event Scoring

- Arousals
  - Different than awakenings (EEG criteria)
  - Associated with an event (respiratory/leg movement)
- Hypopnea
  - No apnea
  - Decreased depth and rate of breathing
- Apnea
  - No respiratory efforts
- Monitor Respiratory Disturbance Index (RDI)
  - Number of respiratory events per hour of sleep
  - Includes both apneas and hypopneas
  - Usually 10 – 15 events/hour is significant

# Leg Movements

- Different than sleep starts
  - Leg jerks at onset of sleep.
- Restless Leg Syndrome (RLS)
  - Unpleasant or painful sensations in the body's extremities and an overwhelming urge to move them.
  - Awake phenomenon
- Periodic Limb Movement Disorder (PLMD)
  - Nocturnal myoclonus
  - More pathologic.
  - Repetitive movements lasting 0.5 to 5 seconds.



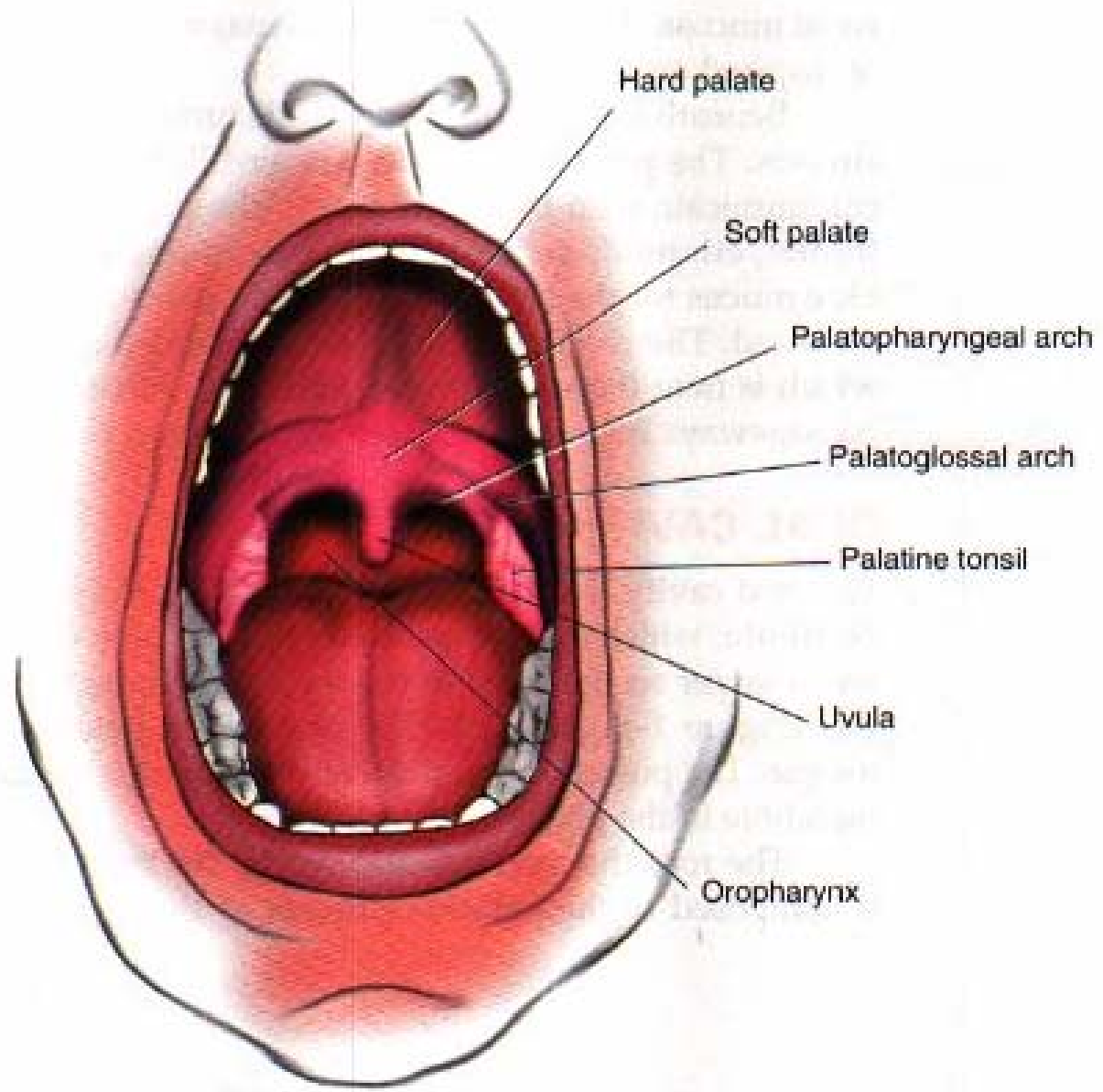
# [ Consequences of Sleep Apnea ]

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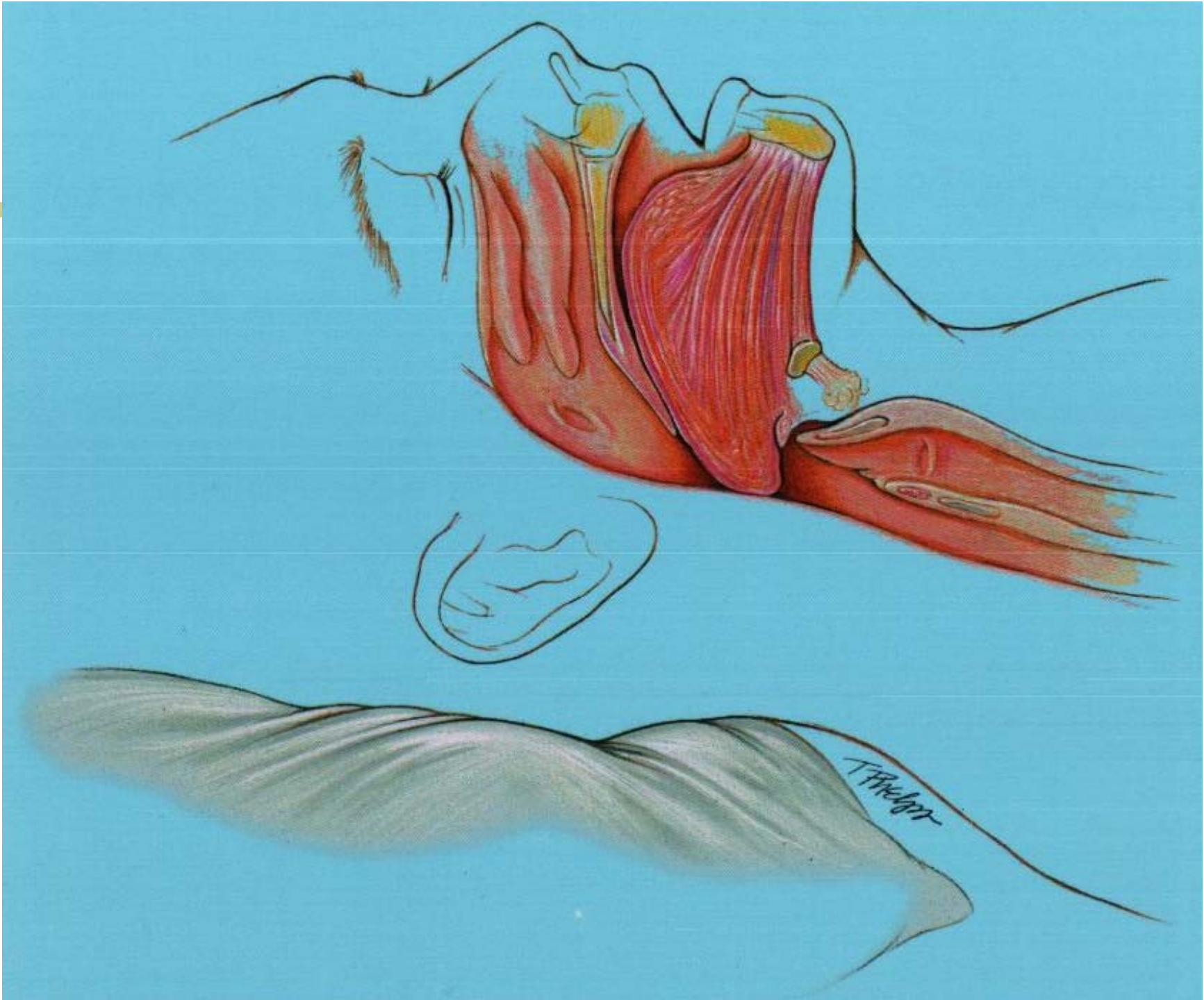
- Increase MVA's
- Increase work related accidents
- Poor job performance
- Depression/Inability to concentrate
- Family Discord
- Decreased quality of life

# Sleep Apnea Management

- Weight Reduction
- Behavior modification
  - Avoid alcohol, sedation, smoking
- Sleep Posture
- Oxygen therapy
- Oral Appliance
- Surgical Procedures
  - Uvulopalatopharynoplasty (UPPP or LAUP)
  - Mandibular advancement
  - Nasal operation
  - Tonsillectomy
  - Tracheostomy

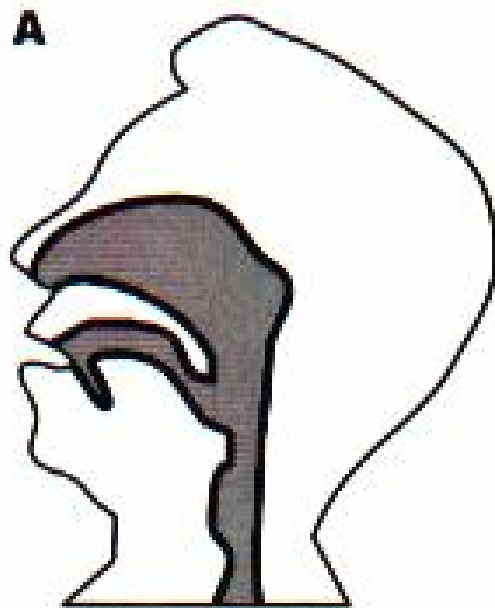


**Figure 1-6.** *Oral cavity.*



# General Management

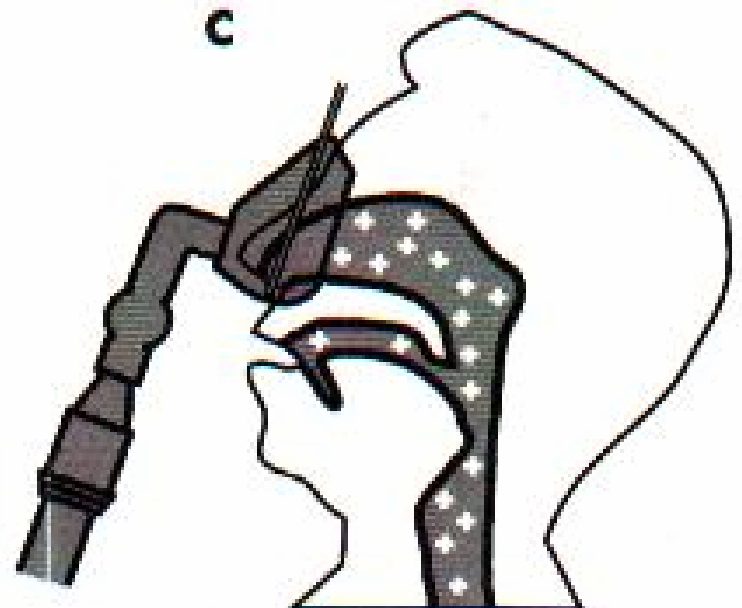
- Non-invasive Ventilation
  - CPAP – most frequently prescribed therapy
  - BiPAP
  - NPV – Central Apnea
- Continuous mechanical ventilation
- Medication – REM Inhibitors
- Phrenic Nerve Pacemaker – Central Apnea



**NORMAL**



**OBSTRUCTED**



**NASAL CPAP**

**FIG 28-3**

**A**, Normal airway. **B**, Obstructed airway during sleep. **C**, Nasal CPAP generates a positive pressure and holds airway open during sleep.

