

# Sports Concussion Assessment and Management

**Brian D. Greenwald, MD**  
brian.greenwald@mountsinai.org

Medical Director of  
Brain Injury Rehabilitation  
Mount Sinai Medical Center

Asst Professor Rehabilitation Medicine  
Mount Sinai School of Medicine



MOUNT SINAI  
SCHOOL OF  
MEDICINE

# Disclosure

- New York-Traumatic Brain Injury-Model System- NIDRR grant H133A070083
- CDC grant 1R49CE001171
- Department of Rehabilitation Medicine  
Mount Sinai School of Medicine, New York  
City.

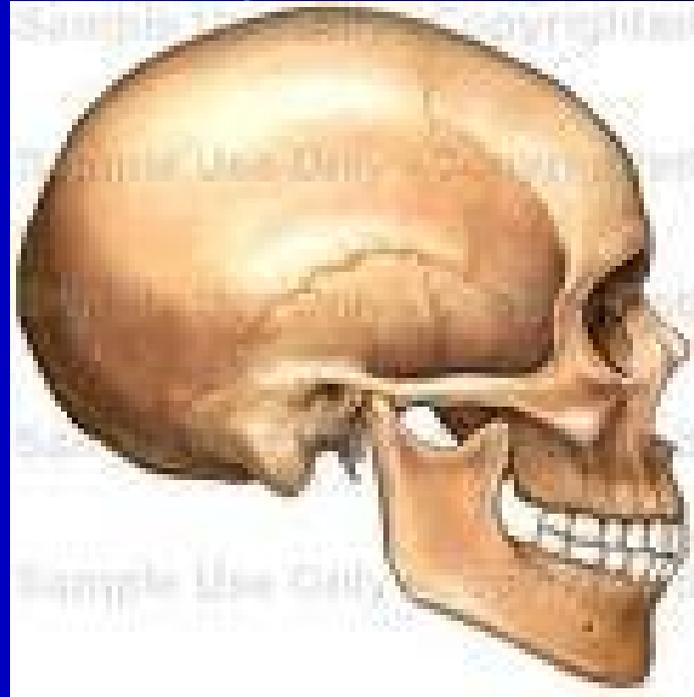


# Overview:

- Definitions
- Epidemiology
- Mechanism and Pathophysiology
- Assessment and Diagnosis
- Risks and Prognosis
- Management and Return to Play
- Military and NFL







“I’ve got the brain of a four year old. I’ll bet  
he was glad to be rid of it.”

Groucho Marx



MOUNT SINAI  
SCHOOL OF  
MEDICINE

“The brain is a wonderful organ; it starts working the moment you get up in the morning and does not stop until you get into the office.”

Robert Frost



MOUNT SINAI  
SCHOOL OF  
MEDICINE

# Your Brain = Who You Are

- Memory
- Emotions
- Movements
- Vision
- Hearing
- Personality
- Motor
- Sensory
- Etc



# Mild TBI (concussion)

- According to the Center for Disease Control and the World Health Organization the term “concussion” has officially been replaced by the term “mild traumatic brain injury”



# Definition

- American Academy of Neurology:
  - trauma-induced alteration in mental status that may or may not be associated with loss of consciousness
- Zurich consensus statement:
  - complex pathophysiological process affecting the brain, induced by traumatic biomechanical forces.



# Epidemiology

- 1.4-1.7 million traumatic brain injury related deaths, hospitalizations, and emergency department visits
- 75%-90% are concussions
- Approximately 1.6 – 3.8 million sports and recreation-related TBIs occur in the United States each year.
- Most of these are MTBIs that are not treated in a hospital or emergency department



# Epidemiology

- Direct medical costs and indirect costs such as lost productivity from:
  - MTBI totaled an estimated \$12 billion in the United States in 2000.



# Concussion- Sports

- Football
- Skiing
- Snowboarding
- Horseback Riding
- Boxing
- Soccer
- Hockey
- Lacrosse
- Bicycling
- Skateboarding
- Swimming

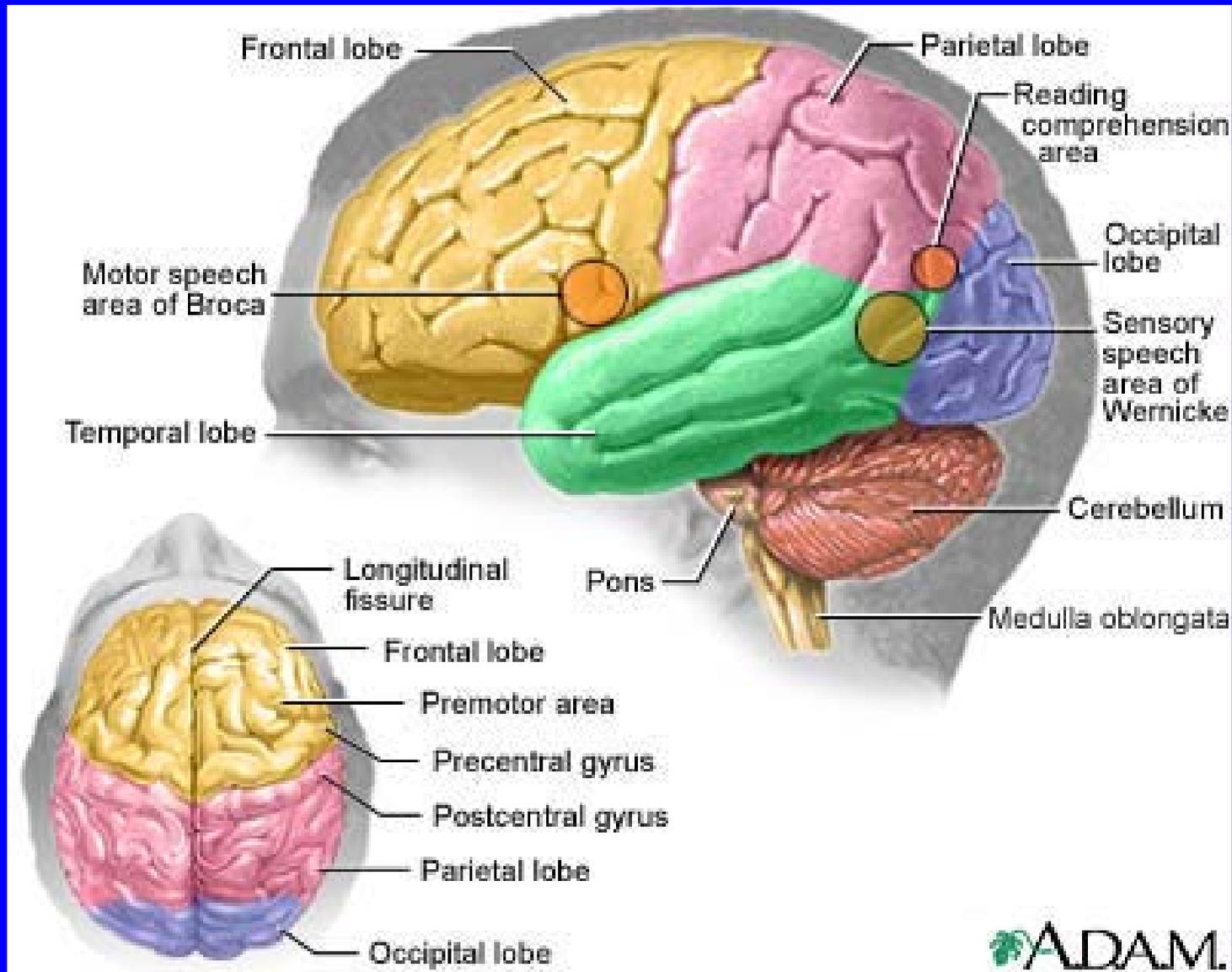


“I try to catch them right on the tip of the nose, because I try to punch the bone into the brain.”

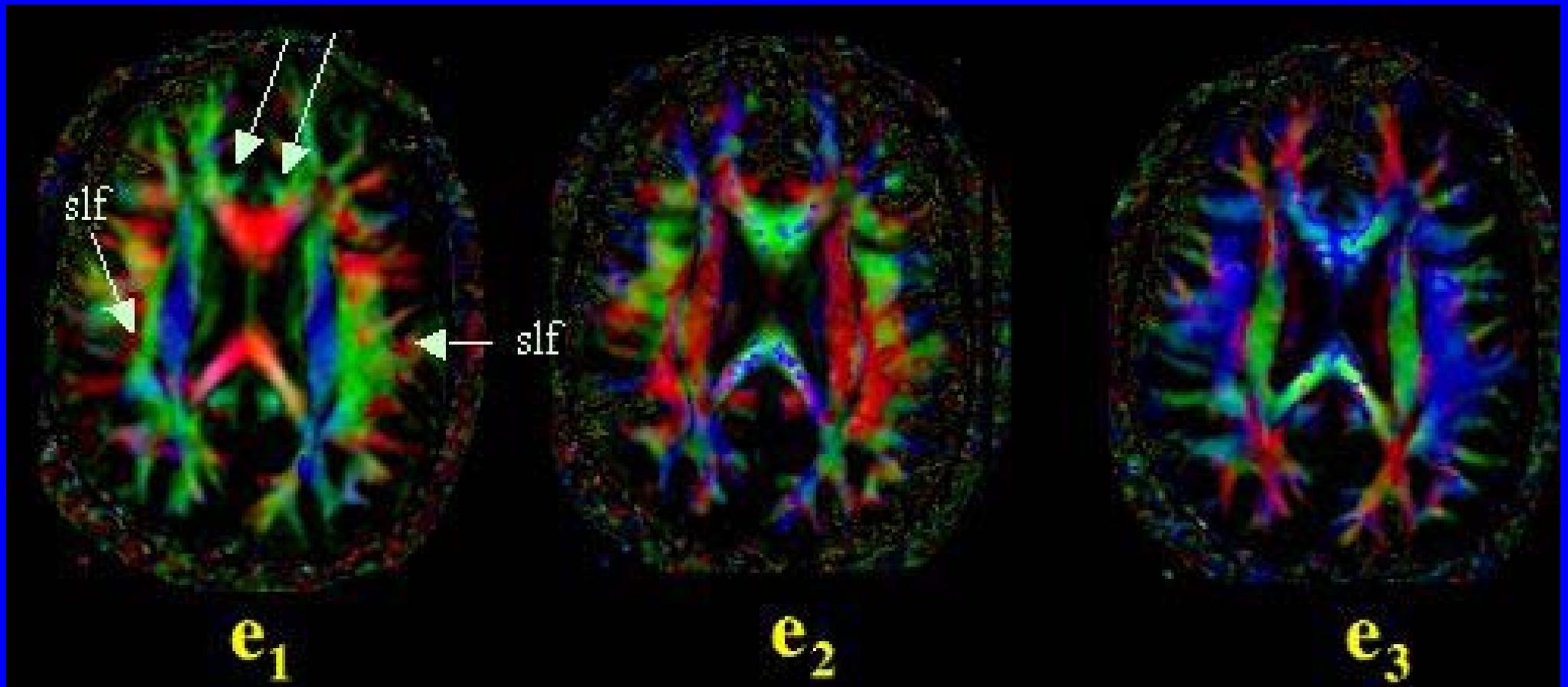
Mike Tyson

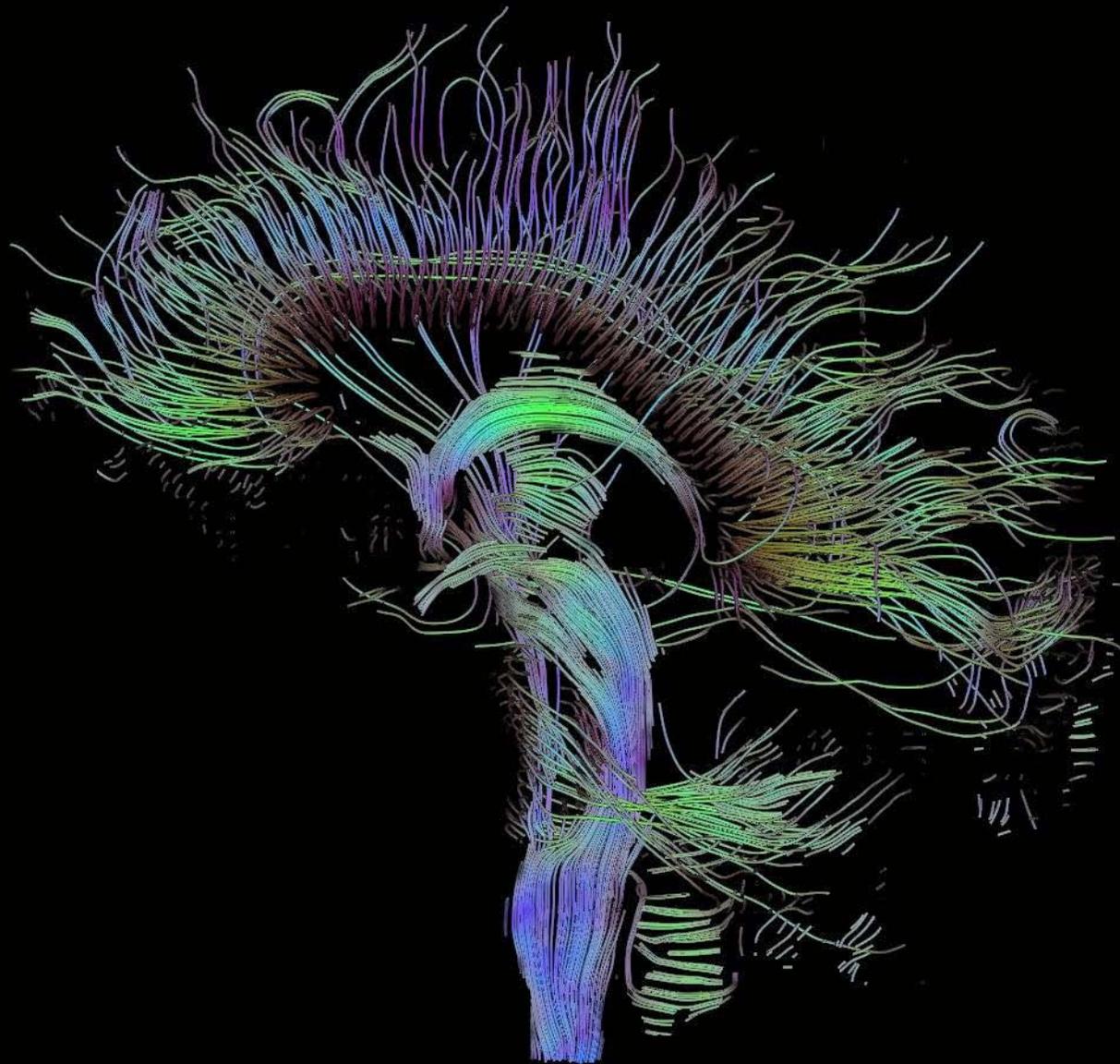


MOUNT SINAI  
SCHOOL OF  
MEDICINE

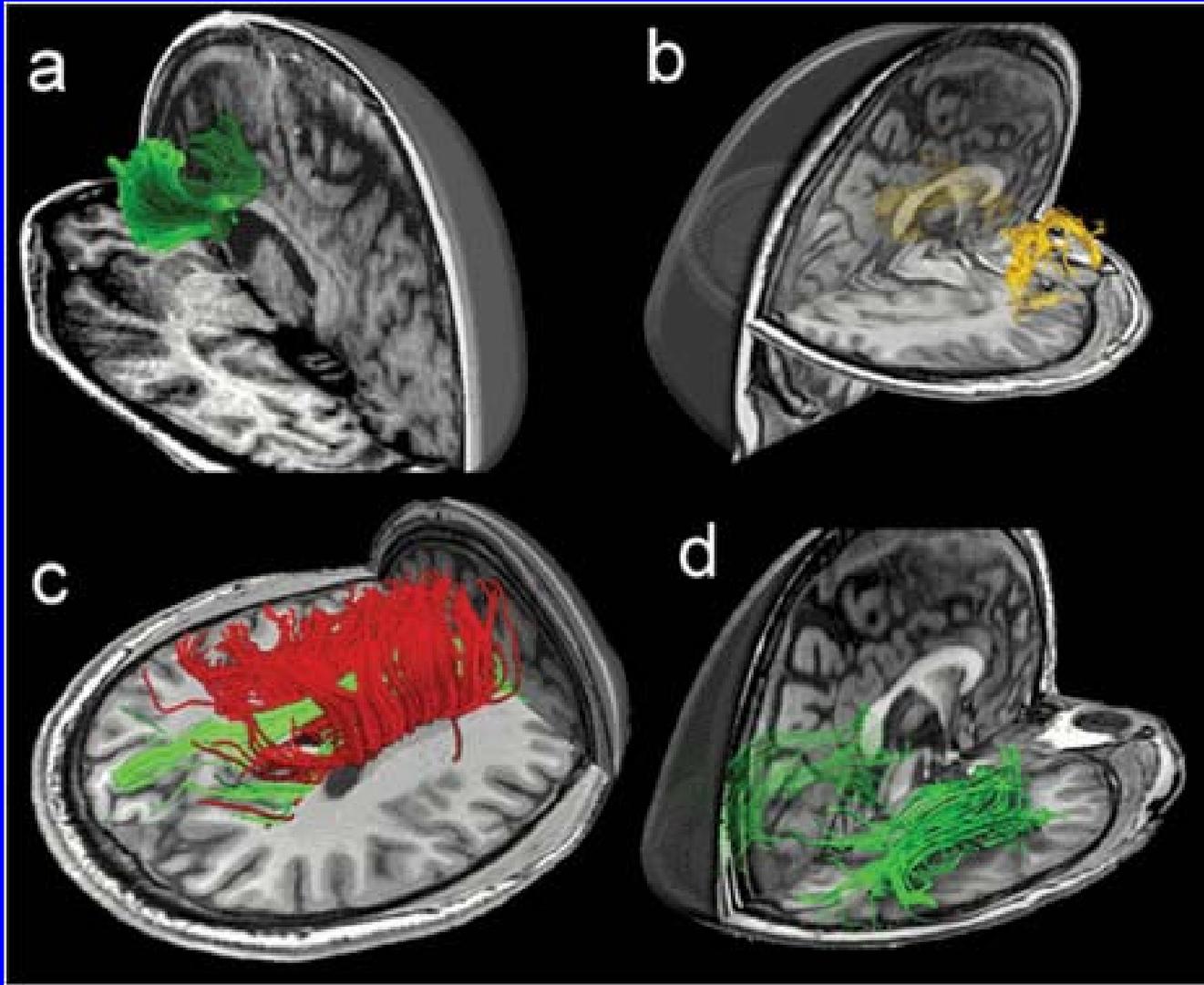


# Diffusion Tensor Imaging





Tractography

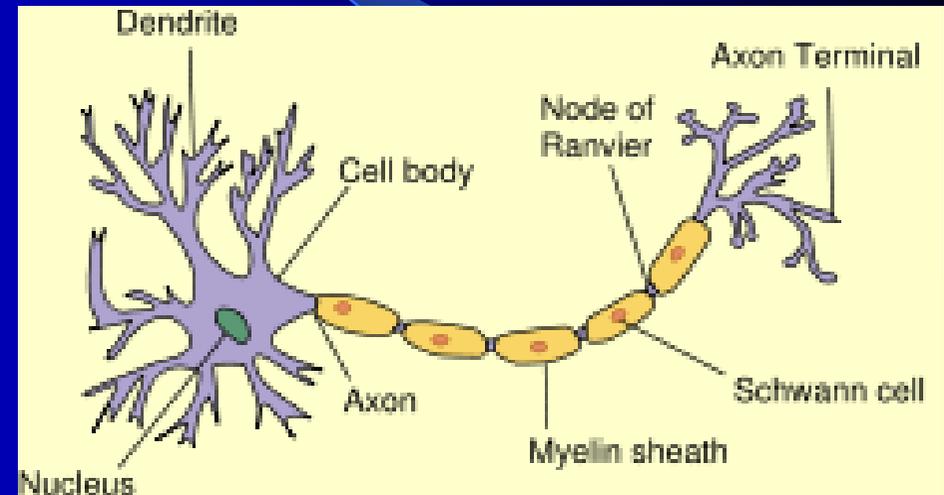


Niogi SN, et. J Head Trauma Rehabil, 25(4), July/August 2010

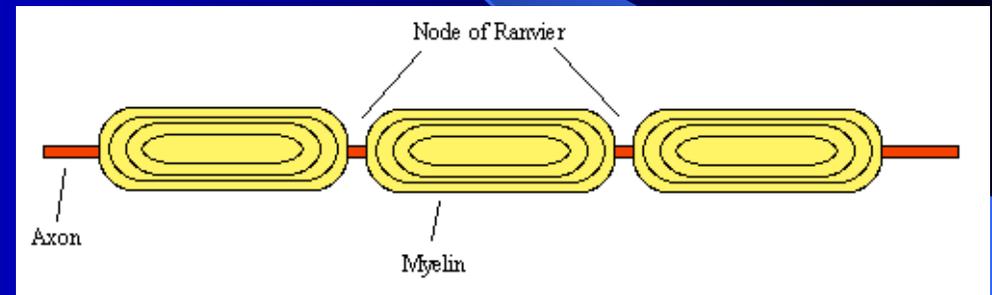
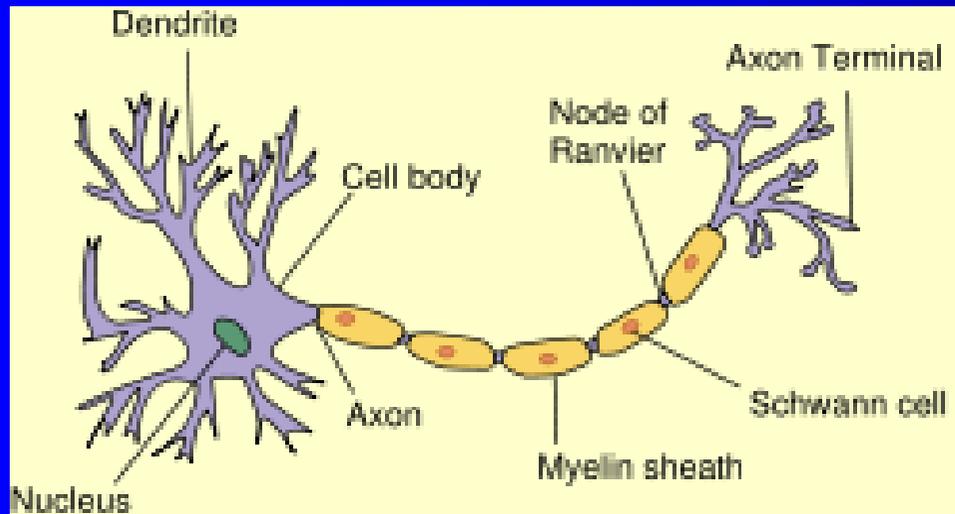
# Understanding the brain

- Neuron

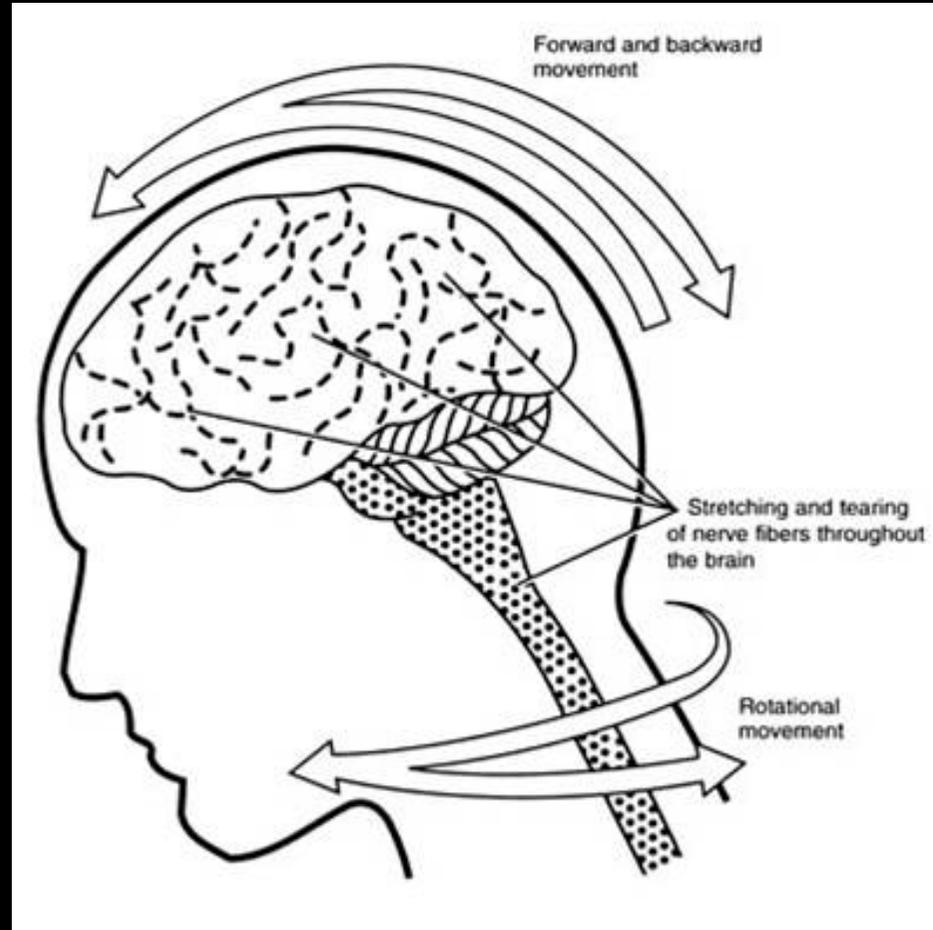
- A specialized cell designed to transmit information
- basic working unit of the brain.
- Human brain 100 Billion neurons



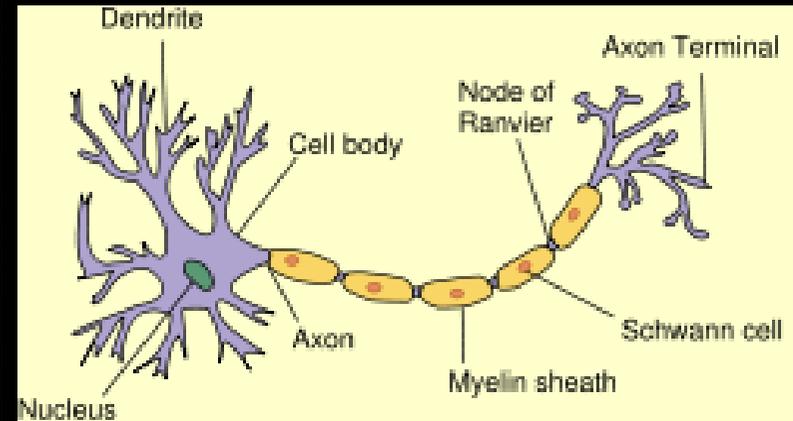
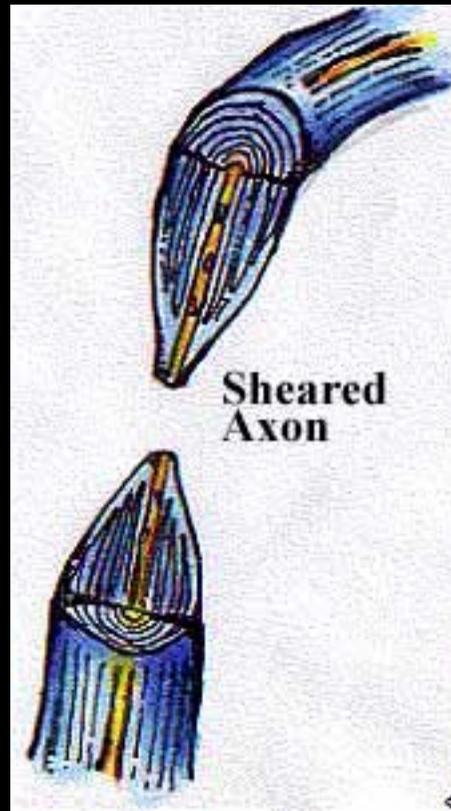
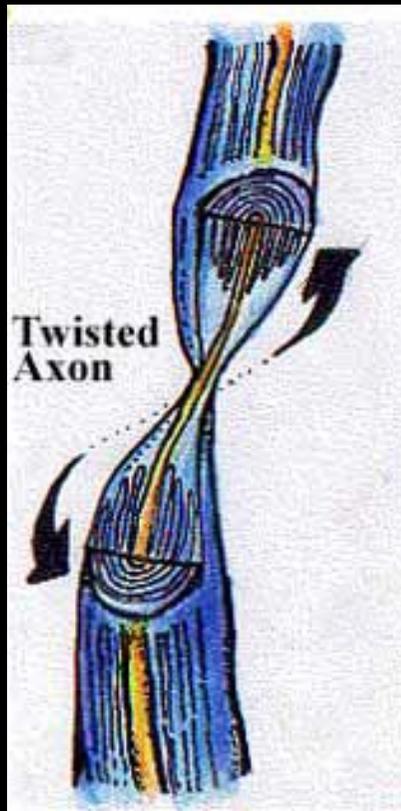
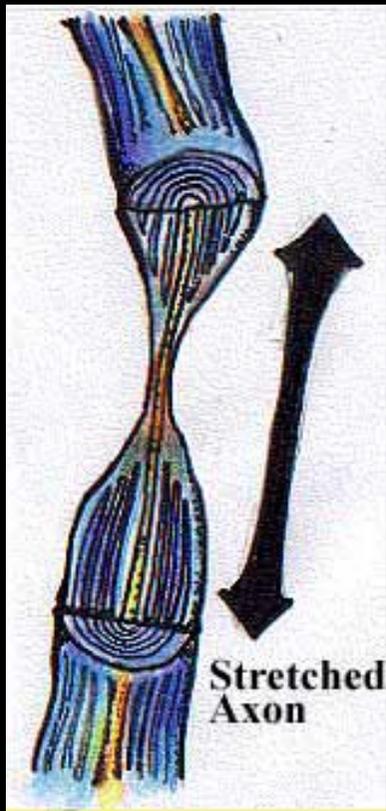
# Understanding the brain



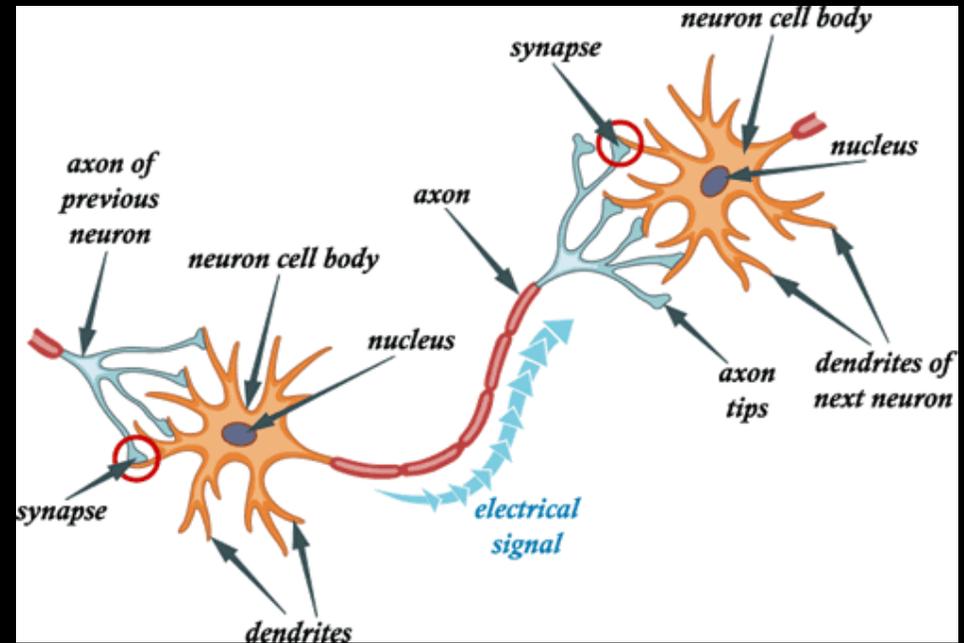
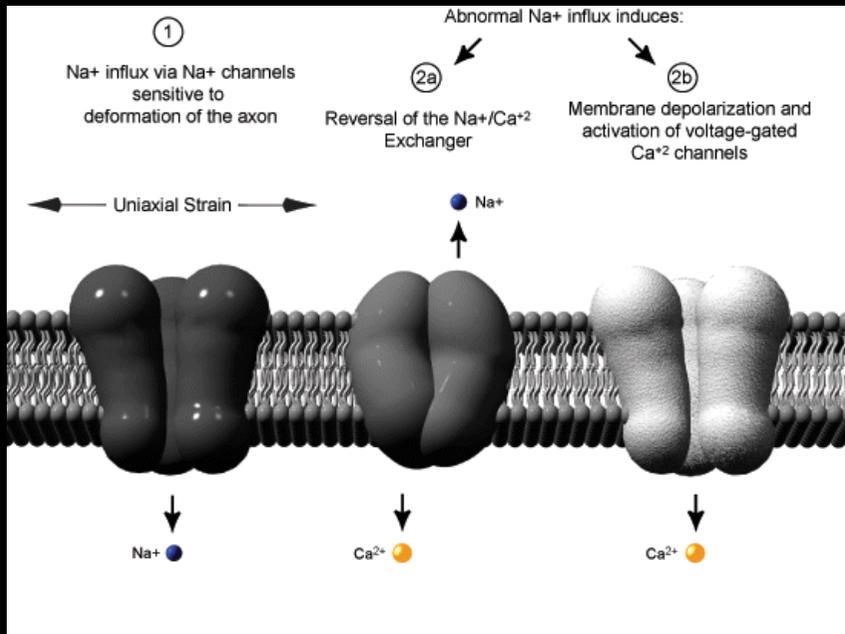
# Concussion



# Concussion



# Concussion



# Pathophysiology of concussion

- Dysfunction of brain metabolism rather than to structural injury or damage.
- Neuronal dysfunction involving a complex cascade of ionic, metabolic and physiologic events.



# Concussion symptoms

- headaches
- dizziness
- fatigue
- noise intolerance
- irritability
- emotional lability
- depression
- anxiety
- memory complaints
- insomnia
- personality changes



# How Do You Recognize a Possible Concussion?

- Watch for the following two things:
  - A forceful bump, blow, or jolt to the head or body that results in rapid movement of the head.
  - AND
  - Any change in the athlete's behavior, thinking, or physical functioning.



# Symptoms of Concussion

- **Signs Observed by Coaching Staff**
  - Loses consciousness (*even briefly*)
  - Appears dazed or stunned
  - Is confused about assignment or position
  - Forgets an instruction
  - Is unsure of game, score, or opponent
  - Moves clumsily
  - Answers questions slowly
  - Shows mood, behavior, or personality changes
  - Can't recall events *prior* to hit or fall
  - Can't recall events *after* hit or fall



# Symptoms of Concussion

- **Symptoms Reported by Athlete**
  - Headache or “pressure” in head
  - Nausea or vomiting
  - Balance problems or dizziness
  - Double or blurry vision
  - Sensitivity to light
  - Sensitivity to noise
  - Feeling sluggish, hazy, foggy, or groggy
  - Concentration or memory problems
  - Confusion
  - Does not “feel right” or is “feeling down”



# Evaluation

- \*\*\*\*REMOVAL FROM THE GAME\*\*\*\*
- A number of on-site tools
- Sports Concussion Assessment Tool 2 (SCAT2)
  - Symptoms
  - Cognitive and Physical Evaluation

International Conference on Concussion in Sport, 2008



MOUNT SINAI  
SCHOOL OF  
MEDICINE

# Neuroimaging

- loss of consciousness greater than a few seconds
- focal neurologic signs
- those with progressively worsening symptoms and signs
- failure of clinical resolution of symptoms (typically more than 2 weeks)
- severe acute headache



# Baseline screening

- Immediate Measurement of Performance and Cognitive Testing (ImPACT)
- Brain Injury Screening Questionnaire (BISQ)
- Automated Neuropsychological Assessment Metrics (ANAM)
- CogSport (formerly Concussion Sentinel)
- Concussion Resolution Index (CRI)
- Standardized Assessment of Concussion (SAC) and its electronic version eSAC



# NFL baseline screening

- Comprehensive neuropsychological evaluation



# Concussion Management

- Individualized approach
- Athlete should be symptom free before beginning the return-to-play stepwise protocol, most in practice consider
- At least 7 to 10 days of rest for adolescent athletes before beginning the protocol.



# Concussion Management

- The Zurich conference consensus statement stepwise approach:
  - (1) No activity; complete physical and cognitive rest
  - (2) Light aerobic exercise
  - (3) Sport-specific exercise (skating in hockey, running in soccer)
  - (4) Non-contact training drills
  - (5) Full-contact practice following medical clearance
  - (6) Return to unrestricted sport participation

McCrorry P, et al. Clin J Sports Med 2009



MOUNT SINAI  
SCHOOL OF  
MEDICINE

# Educational accommodations for athletes recovering from concussion

- Reduce the number of work assignments
- Allow more time to complete class work
- Allow more time for tests
- Outline and break complex tasks into simple steps
- Provide written instructions for student athletes
- Provide distraction-free areas for work
- Provide a note taker
- Incorporate less stressful course work



# Physicians and Concussion

- Most physicians have little or no knowledge of the evaluation and management of concussion
- ED physicians
  - 50% of patients who present to emergency rooms with concussion are missed

Powell JM, et al. Arch Phys Med Rehabil 2008.



MOUNT SINAI  
SCHOOL OF  
MEDICINE

# Physicians and Concussion

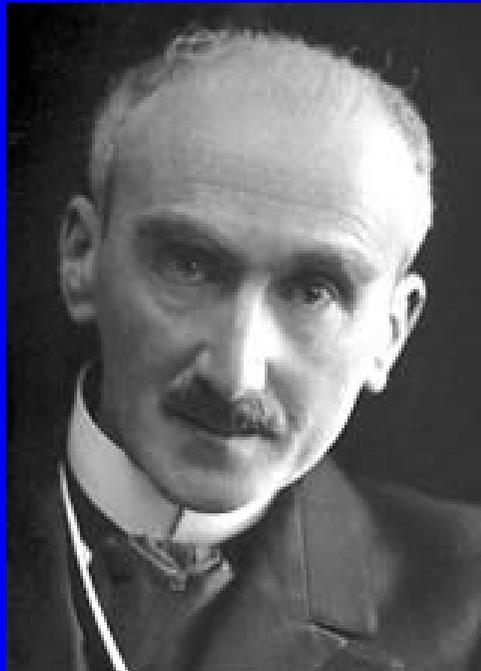
- Survey of primary care physicians:
  - <50% were knowledgeable about concussion guidelines
- Patients admitted for concussion
  - 9% were allowed to return to play to quickly
  - 60% were given no advice regarding return to play.
- Survey of members of the American Society for Sports Medicine:
  - 30% of sports medicine physicians treated concussions per established guidelines.

Chrisman SP. Clin Pediatr 2011



MOUNT SINAI  
SCHOOL OF  
MEDICINE

“The eye sees only what the mind is prepared to comprehend.”



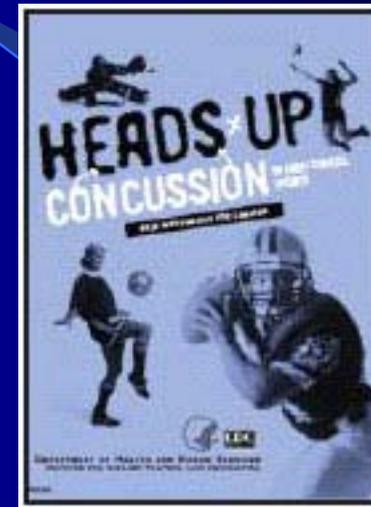
Henri Bergson (French  
Philosopher 1927 Nobel  
Prize in Literature)



MOUNT SINAI  
SCHOOL OF  
MEDICINE

# CDC “Heads Up” Toolkit

- Information for clinicians
- Athletes
- Coaches
- Parents
- Recommends :
  - “Ensure that the athlete is evaluated by a health care professional experienced in evaluating for concussion”



CDC, 2005



MOUNT SINAI  
SCHOOL OF  
MEDICINE

# Prognosis After First Concussion

- 90% of those with concussion show clinical neuropsychological deficits 1 day after injury
- Single concussion recovery to baseline within 7 to 10 days and approximately 80% recover within 3 weeks
- Brain activity may still not be normal and more susceptible to injury for a longer period



# Prognosis After Second Concussion

- Recurrent concussions:
  - slower recoveries from subsequent head injuries
  - history of concussion increases risk of a second concussion by a factor of 3 to 5.8
  - more than 3 concussions- risk factor for depression and neurocognitive sequelae
  - key factor is time between concussions



# Second-impact syndrome

- second concussion that occurs soon after the initial concussion, resulting in profound brain swelling and vascular dysregulation
- high mortality (approximately 50%) and morbidity (approximately 100%)



Derek Sheely died August 2011



# Prognosis when concussion is missed:

- Invisible Injury
- Need to monitor for recovery or obtain treatment
- Cognitive, behavioral, emotional, physical symptoms may be misinterpreted
- Impairments may not present until older when workload is increased- “Grow into the injury”
- Leads to academic and social failure



So why all the recent interest in  
concussion?



MOUNT SINAI  
SCHOOL OF  
MEDICINE

# Concussed Kids: Headbanger Nation



Time Magazine Feb. 03, 2011

# Reports of Concussions From Youth Sports Rise Along With Awareness of the Problem



Mitka M. JAMA 2010 Oct 27.

# Concussions

- from 1997 to 2007, US emergency department visits for concussions occurring in organized team sports almost doubled in children aged 8 to 13 years
- more than tripled among youths aged 14 to 19 years

Mitka M. JAMA 2010 Oct 27.



MOUNT SINAI  
SCHOOL OF  
MEDICINE

# Mild TBI- Military

- TBI is the signature injury in the Afghanistan and Iraq wars
- The RAND Corporation has calculated that 19% of Iraq/Afghanistan veterans, or over 300,000 individuals suffered a TBI.





**Sergeant David Emme**  
NEJM 5/19/05



MOUNT SINAI  
SCHOOL OF  
MEDICINE

# Veterans and TBI

- Better care of soldiers with lower casualty rate among wounded soldiers with TBI
- Most brain injuries caused by blast injuries
  - Rapid changes in pressure causing shear injury to brain tissue



# Dementia and the NFL

Telephone based survey\* of 1,063 retired NFL players (>3-4 seasons of playing time) and compared to national norms:

Question: “ Have you been diagnosed with dementia, Alzheimer’s disease or other memory–related disease?”

Age	NFL Retirees	US Norms	Difference
35-49	1.9%	0.1%	19X
50 +	6.1%	1.2%	5X

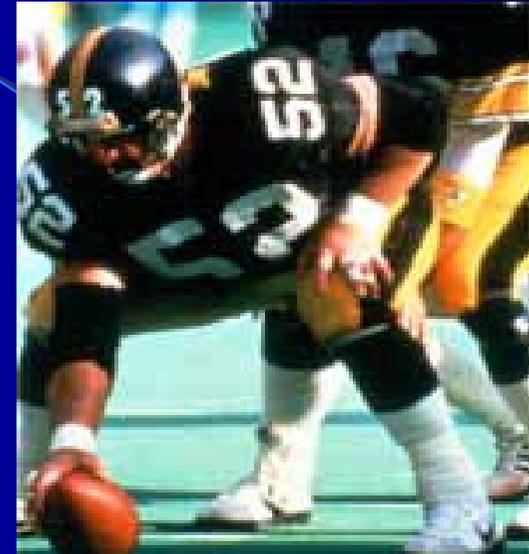
\* By University of Michigan Institute of Social Research, supported by the NFL



MOUNT SINAI  
SCHOOL OF  
MEDICINE

# NFL

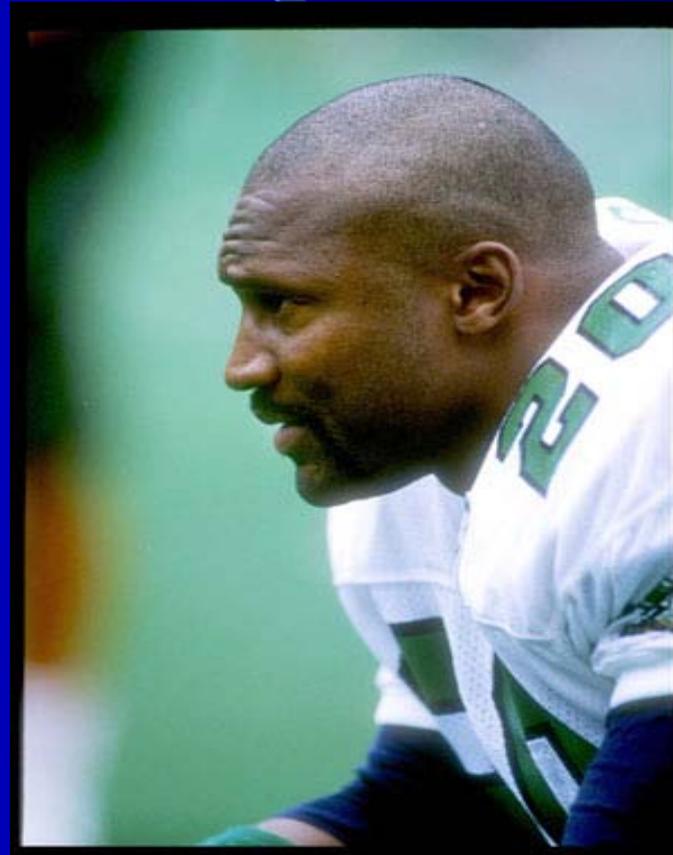
- Mike Webster
  - “Iron Mike”
  - Pittsburgh Steelers
  - Pro Football Hall of Fame 1997
- Ted Johnson
  - New England Patriots
  - ‘I don't want anyone to end up like me’ Boston Globe 2/2/07



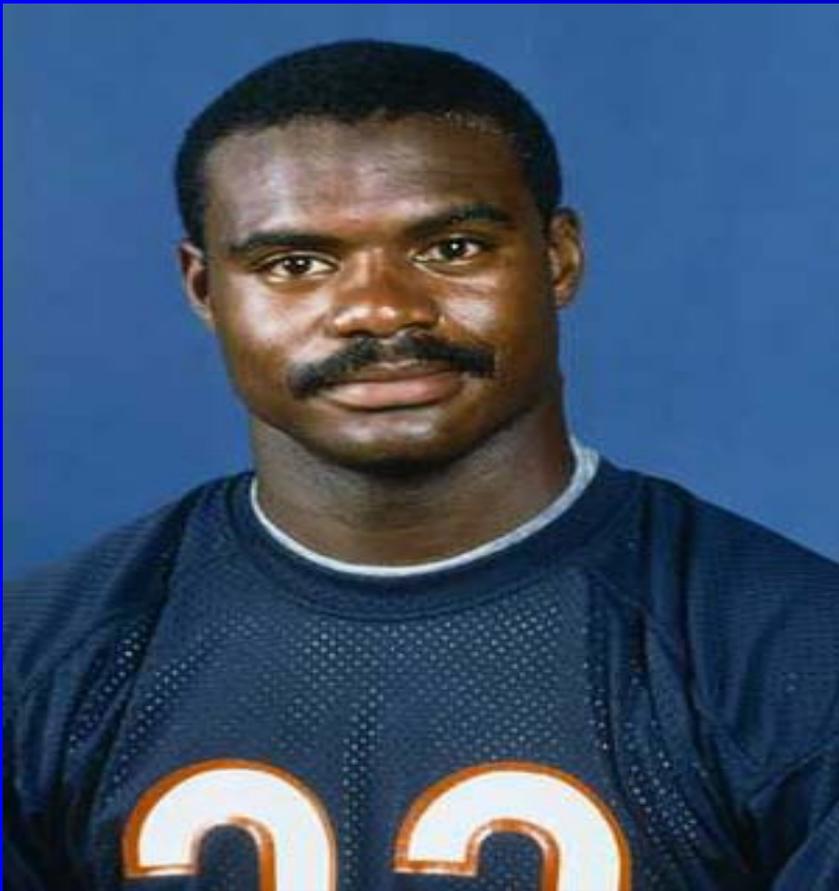
MOUNT SINAI  
SCHOOL OF  
MEDICINE

# Andre Waters

- Philadelphia Eagles
- Suicide 11/20/06
- Repeated Concussion related depression



# David Duerson



- Chicago Bears (1983–1989), the New York Giants (1990), and the Phoenix Cardinals (1991–1993).
- Shot self in chest February 17, 2011
  - Age 50
  - Pre-meditated: told family 1 week earlier to send brain to SLI



# Chris Benoit

- June 24, 2007 (age 40)
- Killed wife Nancy and son, then hung himself
- At time, widely reported to “Roid Rage”
- Autopsy revealed significant Chronic Traumatic Encephalopathy
  - Julian Bailes (NSGY): “Benoit's brain was so severely damaged it resembled the brain of an 85-year-old Alzheimer's patient”



School football player hung himself  
two days after suffering blow to head  
during game



Suffered multiple concussions. Found to have CTE on autopsy

# Chronic Traumatic Encephalopathy



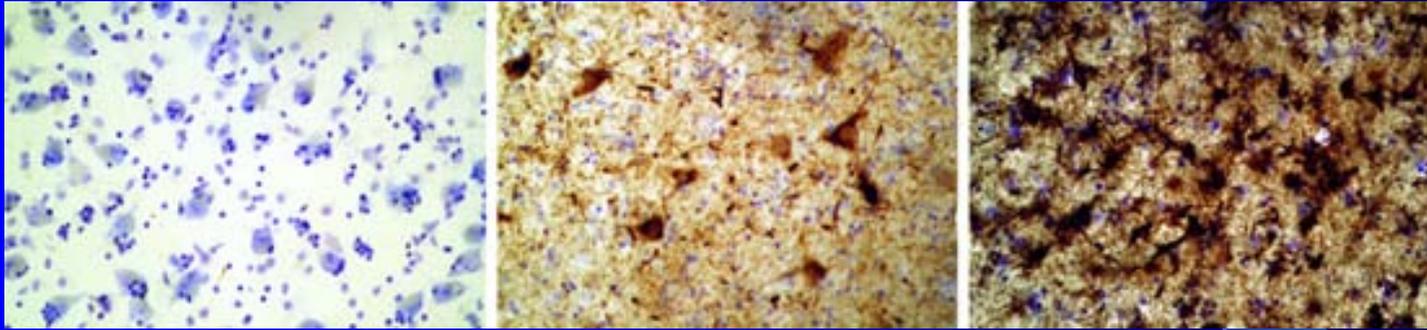
MOUNT SINAI  
SCHOOL OF  
MEDICINE

# Chronic Traumatic Encephalopathy (CTE)

- Dementia Pugilistica- Boxers
  - Described in 1928



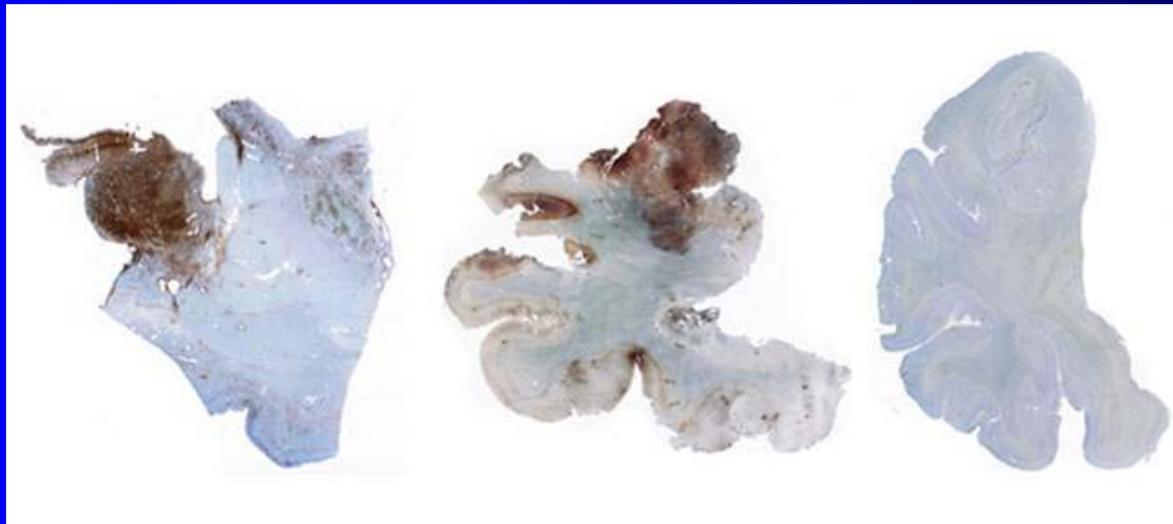
# Tau Protein



65 yo Control

NFL Player-  
Memory problem

Boxer-Advanced  
Dementia



65 yo NFL player



# Unique/ characteristic sites of NFT Formation in CTE:

- CA4 (Endplate) of the Hippocampus
- Insular Cortex
- Mamillary bodies
- Hypothalamic nuclei
- Thalamus
- Amygdala



# CTE

- Can CTE be caused by a single episode of trauma (car accident) or are multiple traumas required (boxers, football)?
- Is the brain pathology we are seeing in CTE related to the behavioral and cognitive changes that are seen in some former NFL players?
- How about all the other sports where concussions are common?





# Recommendations

- Protect of children and make sure they are not returning to play before they are ready
- Educate coaches, gym teachers, school nurses and athletic trainers on concussion
- Making sure physicians involved in concussion evaluation have appropriate experience and training



# Recommendations

- Importance of base line testing
- Concussion management program
- Don't forget children in organized sports outside the school setting



Thank You!



MOUNT SINAI  
SCHOOL OF  
MEDICINE