

Health Education

CTE in Sports Injuries

Victor Hsu, Edward Kang, Alvin Li, Sahaj Patel, Hridank Shukla, Leo Toake

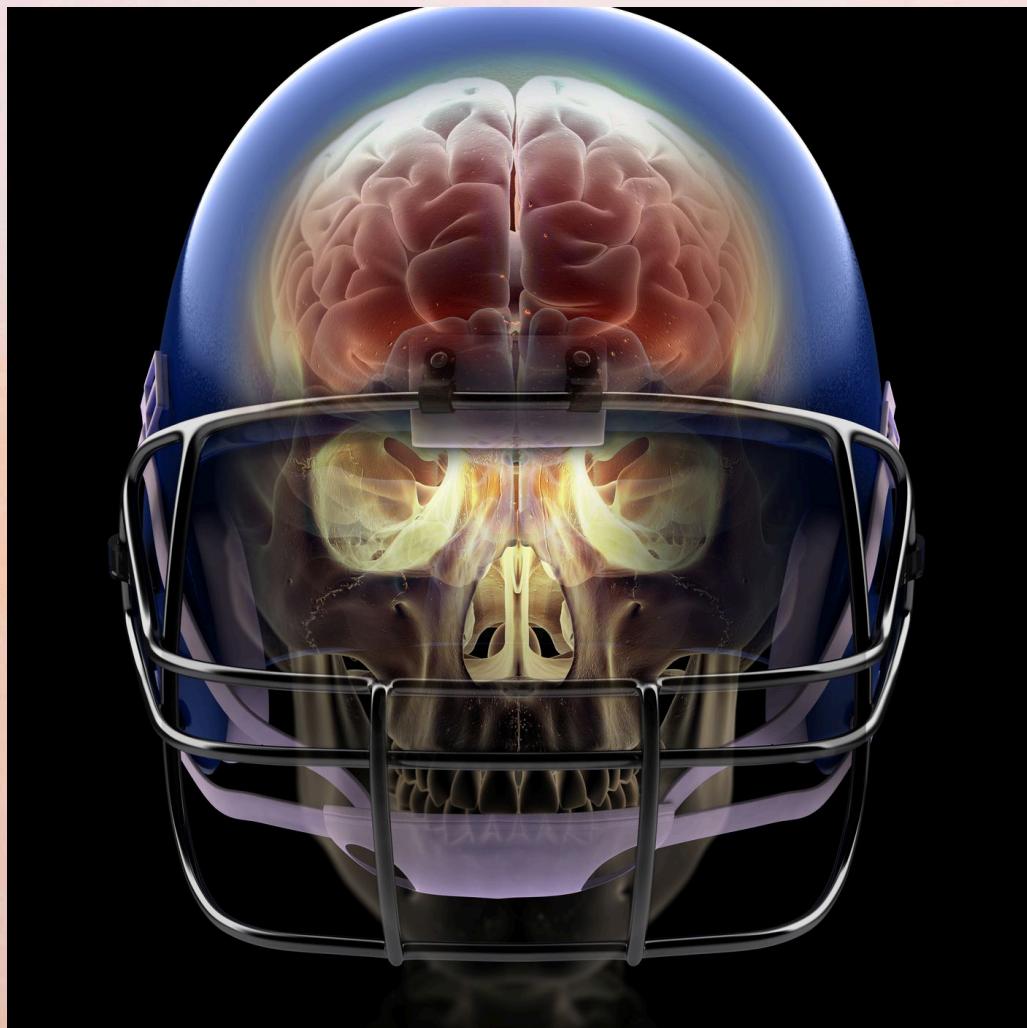
Grades 9-12, Ages 14-18, 329 Participants

Secondary Division

Chapter #12099

Bergen County Academies

New Jersey HOSA



Lesson Plan Narrative

Goal:

This lesson aims to **equip high school students with the knowledge to understand Chronic Traumatic Encephalopathy (CTE)**. Students after this lesson should be able to apply the knowledge that they have learned to their own athletic experiences. We hope to give insight into the disease's development and causes. In the end, students should feel encouraged to raise awareness about CTE among peers.

Plan for Instruction:

- Open the lesson with a 5-minute **preliminary test** to understand the audience's **base knowledge** of the topic.
- 8-minute **group activity** where students share their own knowledge and experience on the causes and limitations in the diagnosis of **CTE**.
- 8-minute **Real-life Examples** using movies and sports video clips from sources such as the movie *Concussion*.
- 15-minute **Hands-On Activity - The Egg Helmet Experiment** - allows the audience to visualize the effect of repeated collisions on the brain.
- 5-minute **Think-Pair-Share** activity where students talk amongst themselves regarding the causes of **CTE**.
- Develop and answer the question: **How can we make sports practices safer and raise awareness about CTE?**
- 5-minute **post-test** through Blooket to assess the **learning curve** before and after the lesson.

→ 5-minute **Feedback segment** (through a Google Form) for the audience to share their **new understanding of CTE** and our performance as educators.

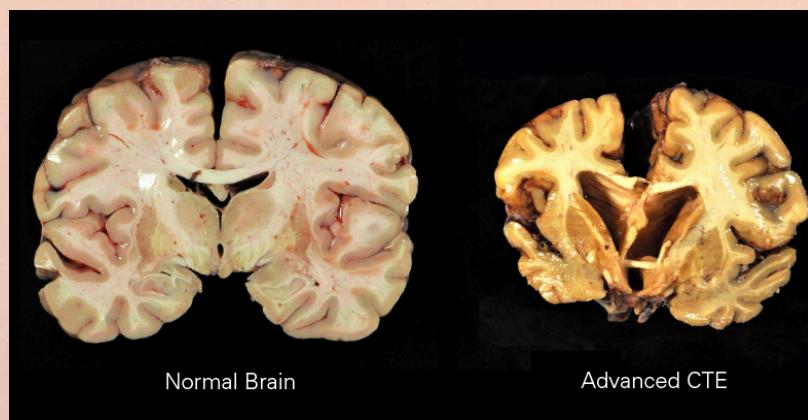
Supportive Information:

But first, what is Chronic Traumatic Encephalopathy (CTE)?

Chronic traumatic encephalopathy, or CTE, is a common brain disorder in athletes that is caused by repeated head injuries. The injuries result in a progressively degenerative death of crucial nerve cells in the brain over several months and years, depending on the severity of the disease. This may result in the atrophy (shrinking) of some regions of the brain and swelling or enlargement of others. Thus, patients diagnosed with CTE suffer from severe brain trauma and mental instability. Currently and unfortunately, the only way to conclusively diagnose CTE is an autopsy after death.

The symptoms of CTE can be devastating, impacting every aspect of a person's life.

Impulse control becomes a challenge and some people with CTE struggle with substance abuse or risky behaviors. In the most severe cases, suicidal thoughts and actions can emerge. **Thus, it is important that we educate everyone on CTE.**



Causes of CTE:

- CTE is predicted to be caused by repeated head injuries, most commonly seen in patients who engage in sports contact or military combat.
- However, researchers are still not exactly sure how repeated head injuries contribute to CTE and the number of head injuries that one must experience to acquire CTE is still unknown.

Symptoms During the 4 Stages of CTE:

The four stages of CTE increase in severity and based on the stage of CTE that the patient is currently in, patients will show different symptoms:

- **1st:** Patients are often asymptomatic or report mild memory loss and headaches
- **2nd:** Patients exhibit depressive symptoms and behavioral instabilities
- **3rd:** Patients start showing memory loss, poor spatial awareness, and lack of cognitive skills
- **4th:** Patients struggle with profound memory loss, speech impairment, loss of motility, and psychotic problems; this can result in other mental conditions such as dementia

Statistics:

- ❖ “A 2009 analysis of 51 people who had chronic traumatic encephalopathy (CTE) found the **average lifespan** of those with the condition was [only] **51 years**” (Cunha).
- ❖ The person on the right is “Dave Duerson, a former safety for the Chicago Bears, who committed suicide in 2011 at age 50. [He was later diagnosed with moderately severe CTE]” (Moran).



- ❖ “A trial by the Boston University’s CTE center confirms 40% of athletes younger than 30 years old showed early signs of CTE” (CNN).
- ❖ “[CTE] may be more common among football players than previously thought” (*Journal of the American Medical Association / JAMA*).

% of players who acquire CTE in football (According to Boston University)

Level of football	% of players that acquire CTE
High School	21%
College	91%
National Football League (NFL)	99%

Discussion:

The analytics of chronic traumatic encephalopathy show an increasing trend in the probability of acquiring this brain disease starting from the high school level to the national level, in terms of football. From this, it can be extrapolated that increasing the difficulty of a sport may also increase the chance of acquiring CTE.

CTE as a neurodegenerative disorder causes a buildup of a protein called p-tau in the blood vessels within the brain. The accumulation of such protein is still not fully understood and current research is allowing scientists to comprehend CTE pathology slowly. High-contact sports like football give players a higher chance of developing this disease over time as their career progresses due to repetitive stress on brain neurons

and the accumulation of these p-tau proteins. Usually, it is diagnosed posthumously, or after the affected athlete or military combatant has passed away. Therefore, many patients suffering from CTE may not even know that they have the disease throughout their entire lifetime!

However, new advances in diagnosing technology related to CTE are allowing scientists to discover such internal injury before the patient's death, saving countless lives by limiting brain degeneration. Although various projects are being done toward furthering the understanding of traumatic brain degeneration, the mechanism for degeneration is still unclear. A recent study suggests that a new technique to diagnose CTE pre-mortem is feasible with fluid biomarkers and advanced neuroimaging techniques involving radionuclides. This will allow many athletes and military personnel to discover if they are affected by CTE and whether they should take action to benefit their health.

CTE has become the center of debate for families when deciding whether or not they want their child to play a sport. With the market of competitive youth sports increasing, families have felt "forced" to send their kids to play at a highly competitive level; by doing so, they increase the risk of their child acquiring CTE. Most families overlook this brain disease altogether, so minimal focus has been put on raising awareness about CTE. However, after looking at the statistics from various medical institutions, it can be concluded that CTE is a big problem in the sports community and its detrimental effects must be communicated to ensure the safety of our next generations.

Lesson Outline

(Approximately a 1-hour 6-minute Presentation)

Set-up (2 minutes)

- Get the PowerPoint Presentation, pre-test papers, and materials for the activities and demonstrations ready.

Introducing Ourselves and HOSA (3 minutes)

- Introduce who we are and what we are doing.
- Describe HOSA and its purpose as an organization.

Pre-Test (5 minutes)

- Give students a pre-test to identify preliminary knowledge before teaching the subject to them.
- Used to quantify the results of the presentation.

Introduction to CTE (8 minutes)

- Engagement Question: Ask students what they know about sports injuries and introduce CTE as a serious concern in contact sports.
- Causes & Symptoms, Statistics, and Recent Advancements

The History of Dr. Bennet Omalu (8 minutes)

- Story Presentation: Show a significant clip from the movie “Concussion” that bases its story around Dr. Bennet Omalu who was the first to discover CTE. Share the story of Mike Webster, the Pittsburgh Steelers' center, known as one of the first NFL players diagnosed with CTE posthumously. Highlight his achievements, struggles with CTE symptoms, and the impact on his life and family.

- Discussion: Discuss Omalu's past, giving a brief history of his struggles and how he was able to discover CTE. Afterward, analyze the detrimental symptoms of CTE in football players and how it may cause the players to commit suicide.

Interactive Activity #1: The Egg Helmet Experiment (15 minutes)

- Objective: To simulate how the impact on the skull affects the brain
- Materials: Raw egg (brain), DIY cushioning materials, plastic container (skull), and a height from which to drop them.
- Explaining: Explain the correlation between a water-filled jar and the brain. The use of a jar filled with water as a metaphor for the brain can help illustrate certain principles related to the brain's protection and function.
- Activity: Students will place a raw egg in a clear plastic container and fill it with water, representing the cerebrospinal fluid surrounding the brain. They will then cover the plastic container with a helmet, simulating a helmet protecting the skull. From different heights, students drop the helmet containing the plastic container and discuss observations with peers.

Educational Segment: The Science of CTE (10 minutes)

- Lecture: Explain how CTE develops from repetitive head trauma, including subconcussive impacts. Use diagrams and animations to illustrate the progression of the disease and its symptoms.

Interactive Activity #2: Think-Pair-Share (5 minutes)

- Put students into even groups and give the topic about the symptoms of CTE.
- Allow them to think about it, collaborate with their group, and then share with the class.

- Each group will give one symptom of CTE and its related stages.
- This will allow all students to fully grasp the severity of CTE in its early and late stages.

Prevention and Advocacy Workshop (5 minutes)

- Group Activity: Students brainstorm and propose strategies for reducing head injuries in sports, focusing on education, protective equipment, and rule changes. The question prompt for the students to answer is: What can you add to your current athletic program at school to help prevent CTE for athletes who compete on your school's sports teams?
- Students also come up with different experiments that can be conducted to test their theory.
- Presentation: Each group presents their strategies, fostering a discussion on practical implementation and advocacy for safety in sports.

Conclusion and Reflection (5 minutes)

- Recap: Summarize key learnings about CTE, the importance of protective measures, and the role of advocacy in sports safety.
- Reflection: Students share their thoughts on how they can contribute to raising awareness and promoting safety in sports within their communities.

Post-test (5 minutes)

- Online Blooket with questions and different game modes.
- Interactive, fun post-test for the audience to withhold the information.
- Allows teachers to assess improvement before and after the lesson.

Feedback (5 minutes)

- Each student completed an online evaluation form to assess their thoughts on the presentation.
- It will consist of questions and boxes numbered 1 through 10, which they check according to whether they agree or disagree on the effectiveness of the presentation.

Materials

- ★ **Preliminary Test - Pencils, Erasers, Papers**
- ★ **PowerPoint Presentation - TV, Notebooks**
- ★ **Website - On Personal Device**
- ★ **Egg Helmet Experiment - Egg, Helmet, Plastic Bag**
- ★ **Blooket Post-Test - On Personal Device**
- ★ **Online Feedback Evaluation Form - On Personal Device**

Preliminary Test:

<p>Name: _____ Date: _____</p> <p>CTE Lesson Pre-Test Answer the following questions to the best of your ability.</p> <p>1. Which of the following is not a cause of Chronic Traumatic Encephalopathy (CTE)? a. Vehicular accident b. Heavy sports impact c. Repeated concussions d. Playing basketball</p> <p>2. What percentage of NFL players acquire CTE through football? _____</p> <p>3. What physical effect on the brain does this disease have? a. Shrinking of size b. Enlarging of size c. Loosening of parts d. Smoothening out of ridges</p> <p>4. Name a symptom and its respective stage in CTE. _____</p> <p>5. Who was the doctor who first discovered this disease? a. Dr. Jack Smith b. Hippocrates c. Dr. Jacob Wepfer d. Dr. Bennet Omalu e. Dr. Alton Ochsner</p> <p>6. Name three ways to protect yourself from getting CTE. a. _____</p>	 <p>b. _____</p> <p>c. _____</p> <p>7. Buildup of which protein is usually associated with the development of CTE? a. Actin b. Myosin c. Keratin d. P-Tau</p> <p>8. Give an example of a recent advancement in CTE research. _____ _____ _____</p> <p>9. Why is CTE relevant in today's time? a. To progress sports medicine b. Affecting a vast majority of athletes c. It is very harmful to the patient diagnosed and almost always leads to death d. Both a & b. e. All of the above.</p>
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CTE PowerPoint Presentation:

Chronic Traumatic Encephalopathy in Sports Injuries

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01
Introduction

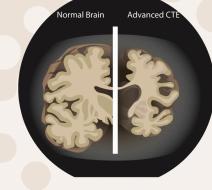


02
Pre-Test!

Introduction Question: **How many of you play a sport?**

Engagement Question:
What do you already know about sports injuries?

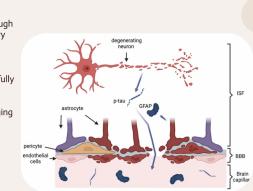
Normal Brain Advanced CTE



What is Chronic Traumatic Encephalopathy?

Science of CTE

- Repeating head injuries (RHI) causes p-tau protein buildup in the blood vessels in the brain.
- Process:
 - Head impact causes **neuron degeneration**
 - P-tau is emitted from the neuron and leaks through the blood-brain barrier (BBB) into the cerebrospinal fluid
 - Also found in Alzheimer's disease and dementia - why CTE can lead to these diseases
- Why p-tau causes symptoms of CTE is still not fully understood
 - Shows the importance of this disease in today's world as an important and emerging research topic



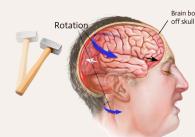
Causes & Symptoms

Causes:

- Repeated head impacts (RHI)
 - Sports
 - Military Service
 - Number of injuries required still unknown

Symptoms related to stage of CTE:

- Stage 1: Mild memory loss & headaches
 - Mostly asymptomatic - downside
- Stage 2: Depressive Symptoms & Behavioral Instabilities
- Stage 3: Memory Loss, Poor Spatial Awareness, Lack of Cognitive Skills
- Stage 4: Profound Memory Loss, Speech Impairment, Loss of Mobility, Psychotic Problems, all possibly leading to Dementia



Recent Advancements

Detection

Originally, post-mortem analysis was the only way to identify CTE, but a new method of doing so was found using fluid biomarkers and advanced neuroimaging techniques involving radionucleotides.

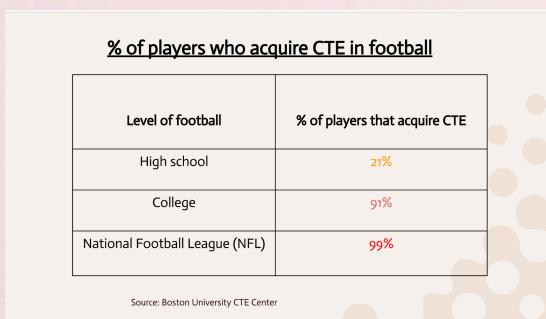
Clinical findings

A study done in 2024 showed that p-tau density in the brain can be used to inform future iterations of the traumatic encephalopathy syndrome criteria.

Statistics

"A 2009 analysis of 51 people who had chronic traumatic encephalopathy (CTE) found the **average lifespan** of those with the condition was [only] **51 years**." (Cunha).

"A trial by Boston University's CTE center confirms **40%** of athletes younger than **30 years old** showed early signs of CTE." (CNN).



Dr. Bennet Omalu



- Founder of CTE research and discovered CTE
- Challenged NFL's widely accepted concussion safety protocols and research
- Declined government position
- Establishes **genuine connections** with football players and their families

Mike Webster:

- 1952 - 2000
- **Steelers center** (acclaimed legend)
- Pro Football Hall of Fame inductee
- Only **50 years old** when he died with CTE
- First NFL player to become diagnosed with CTE

Clip from the movie "Concussion"

▶



Think-Pair-Share Activity



Prevention & Advocacy

What can sports players do to prevent CTE?

- Most important: Wear Protective Equipment
 - Although it might seem insignificant, wearing proper equipment can severely impact the outcome of the damage on neurons during a collision
- Be aware of CTE in respect to the amount you are playing
 - Taking a break during a game or practice can help in reducing cerebral damage
 - Allowing time to rest

09



Post-Test!

Conclusion - What did we learn?

Define CTE Raise your hand!	Causes? Shout it out!	Who is Dr. Omalu? What did he do to benefit scientific research in CTE? How has he helped millions of athletes worldwide?
Recent Advancements? What are current problems researchers are trying to solve?	Prevention? Give some ideas.	Significance? What is the purpose of learning about this disease? Any other questions?

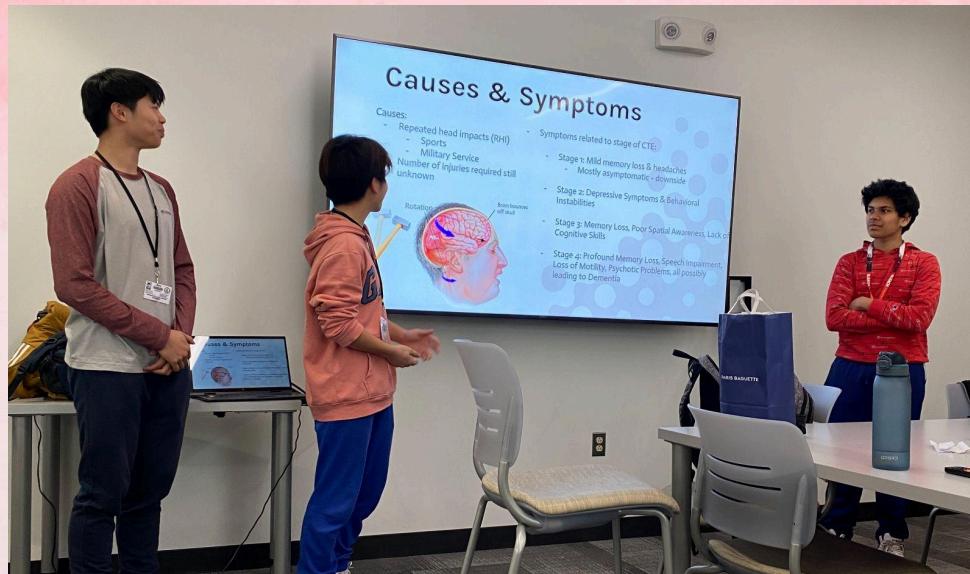
Feedback

Tell us how we did and how we can improve for next time!

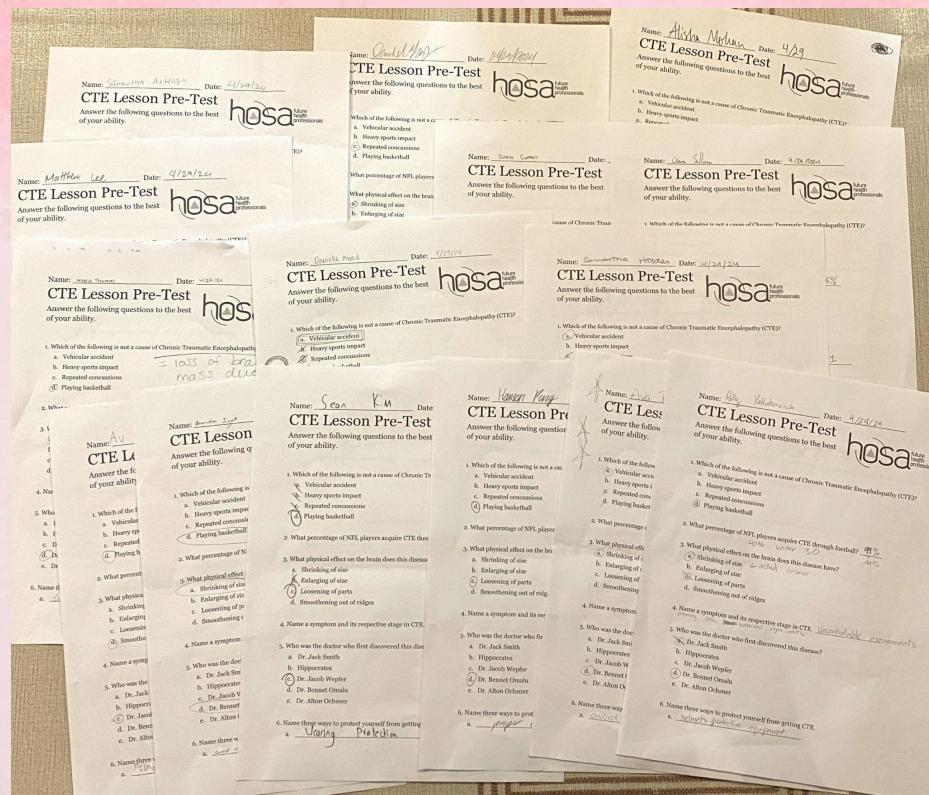
- Please scan the QR code or use the link:
<https://forms.gle/pFRpU5rgBkoWmgGg> to visit the Google Form
- Please be as honest as possible!
- Any feedback is greatly appreciated!



Website:

Photos During Presentation:



Completed Preliminary Tests:

Name: Angela Thomas Date: 4/29/24

CTE Lesson Pre-Test

Answer the following questions to the best of your ability.

1. Which of the following is not a cause of Chronic Traumatic Encephalopathy (CTE)?

- a. Vehicular accident
- b. Heavy sports impact
- c. Repeated concussions
- d. Playing basketball

2. What percentage of NFL players acquire CTE through football?

= loss of brain mass due to trauma high school: 21% college: 91% NFL: 99%

3. What physical effect on the brain does this disease have?

- a. Shrinking of size
- b. Enlarging of size
- c. Loosening of parts
- d. Smoothening out of ridges

4. Name a symptom and its respective stage in CTE. headaches

5. Who was the doctor who first discovered this disease?

- a. Dr. Jack Smith
- b. Hippocrates
- c. Dr. Jacob Wepfer
- d. Dr. Bennet Omalu
- e. Dr. Alton Ochsner

6. Name three ways to protect yourself from getting CTE.

- a. helmet

7. Who was the doctor who first discovered this disease?

- a. Dr. Jack Smith
- b. Hippocrates
- c. Dr. Jacob Wepfer
- d. Dr. Bennet Omalu
- e. Dr. Alton Ochsner

8. Name three ways to protect yourself from getting CTE.

- a. helmet

9. Why is CTE relevant in today's time?

- a. To progress sports medicine
- b. Affecting a vast majority of athletes
- c. It is very harmful to the patient diagnosed and almost always leads to death
- d. Both a & b.
- e. All of the above.

Egg Helmet Experiment:

↓ Egg drop in helmet	↓ Egg is in a container of water to simulate conditions of the human brain
	

Post-test Blooket:

Question 1
Which of the following is not a cause of Chronic Traumatic Encephalopathy (CTE)?

✖ Vehicular Accident ✖ Repeated Concussions

✖ Heavy Sports Impact ✓ Playing Basketball

Question 2
What percentage of NFL players acquire CTE through football?

✖ 21% ✓ 99%

✖ 5% ✖ 72%

Question 3
Who was the doctor who first discovered this disease?

20 sec

<input checked="" type="checkbox"/> Dr. Jack Smith	<input checked="" type="checkbox"/> Dr. Alton Ochsner
<input checked="" type="checkbox"/> Hippocrates	<input checked="" type="checkbox"/> Dr. Bennet Omalu

Question 8
Give an example of a recent advancement in CTE research.

Typing 20 sec

diagnosis, p-tau, fluid biomarkers, radionucleotides

Question 4
What physical effect on the brain does this disease have?

20 sec

<input checked="" type="checkbox"/> Shrinkage of Size	<input checked="" type="checkbox"/> Loosening of Parts
<input checked="" type="checkbox"/> Enlarging of Size	<input checked="" type="checkbox"/> Smoothening out of Ridges

Question 9
Why is CTE relevant in today's time?

20 sec

<input checked="" type="checkbox"/> To progress sports medicine	<input checked="" type="checkbox"/> It is very harmful to the patient diagnosed and almost always leads to death
<input checked="" type="checkbox"/> affects a vast majority of athletes	<input checked="" type="checkbox"/> All options are correct

Question 5
Name a symptom and its respective stage in CTE.

20 sec

<input checked="" type="checkbox"/> depressive symptoms; stage 3	<input checked="" type="checkbox"/> poor spatial awareness; stage 4
<input checked="" type="checkbox"/> Mild memory loss; stage 1	<input checked="" type="checkbox"/> speech impairment; stage 2

Question 10
Who would benefit the most from CTE research?

20 sec

<input checked="" type="checkbox"/> Military Personnel	<input checked="" type="checkbox"/> doctors
<input checked="" type="checkbox"/> Football players	<input checked="" type="checkbox"/> engineers

Question 6
Name three ways to protect yourself from getting CTE.

Typing 20 sec

wearing helmet, less sports, less contact, wearing protective equipment, being aware of CTE



Question 7
Buildup of which protein is usually associated with the development of CTE?

20 sec

<input checked="" type="checkbox"/> actin	<input checked="" type="checkbox"/> myosin
<input checked="" type="checkbox"/> keratin	<input checked="" type="checkbox"/> p-tau

Feedback Tools

Feedback Evaluation Form:

<p>CTE Feedback Form</p> <p>Thank you for listening to our presentation today! Please let us know how we did in this form below:</p> <p>What was something new that you were able to take away from today's presentation? *</p> <p>Long answer text</p> <p>What do you think we could have done better throughout the presentation? *</p> <p>Long answer text</p> <p>On a scale from 1-10, grade our egg-helmet experiment: *</p> <p style="text-align: center;">1 2 3 4 5 6 7 8 9 10</p> <p style="text-align: center;"><input type="radio"/> <input type="radio"/></p>	<p>Could you explain why you chose the number that you did above? *</p> <p>Long answer text</p> <p>On a scale from 1-10, grade our presentation skills: *</p> <p style="text-align: center;">1 2 3 4 5 6 7 8 9 10</p> <p style="text-align: center;"><input type="radio"/> <input type="radio"/></p> <p>Could you explain why you chose the number that you did above?</p> <p>Long answer text</p> <p>Did you enjoy the presentation? If so, explain why. If not, also explain why. *</p> <p>Long answer text</p>
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Sample Response from Anonymous Student:

<p>What was something new that you were able to take away from today's presentation? *</p> <p>I learned that I should be more careful in my sport. I have learned just how much of an impact CTE can have on a sports career, so I will do my best to be cautious and stay out of it.</p> <p>What do you think we could have done better throughout the presentation? *</p> <p>Everything was really amazing. I think people were even watching through the windows! But maybe, there could have included things like putting us into the perspective of an actual footballer (for those who don't play) so everyone can sort of start in the same shoes.</p> <p>On a scale from 1-10, grade our egg-helmet experiment: *</p> <p style="text-align: center;">1 2 3 4 5 6 7 8 9 10</p> <p style="text-align: center;"><input type="radio"/> <input checked="" type="radio"/></p> <p>Could you explain why you chose the number that you did above? *</p> <p>It really helped me understand the process of what actually happens in the injuries. Rather than just talking about it or doing some weird hand movements to show what happens, this egg experiment really opened my eyes on more of the specifics on CTE.</p>	<p>Could you explain why you chose the number that you did above? *</p> <p>It really helped me understand the process of what actually happens in the injuries. Rather than just talking about it or doing some weird hand movements to show what happens, this egg experiment really opened my eyes on more of the specifics on CTE.</p> <p>On a scale from 1-10, grade our presentation skills: *</p> <p style="text-align: center;">1 2 3 4 5 6 7 8 9 10</p> <p style="text-align: center;"><input type="radio"/> <input checked="" type="radio"/></p> <p>Could you explain why you chose the number that you did above?</p> <p>Everything was great! Everyone had interested in the topic- people around me were even taking notes! The visuals of the presentation were also nice to look at, and adding the words and explanations helped clarify the content for me.</p> <p>Did you enjoy the presentation? If so, explain why. If not, also explain why. *</p> <p>I enjoyed the presentation. The egg experiment really showed me what exactly happens with these football/collision injuries. Seeing the concept illustrated through real football players was also really cool and helped me understand the severity of CTE.</p>
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