Name: _____Period:_____Date:_____
Ms. Randall Anatomy & Physiology
Phineas Gage

Sources: biologycorner.com http://en.wikipedia.org/wiki/Phineas_Gage
http://neurophilosophy.wordpress.com/2006/12/04/the-incredible-case-of-phineas-gage/

Phineas Gage (1823-1860) is one of the earliest documented cases of severe brain injury. Gage is the index case of an individual who suffered major personality changes after brain trauma, at a period in history where very little was known about how the brain worked and how the brain repaired itself after a traumatic event.

Gage was foreman of a crew of railroad construction workers who were excavating rocks to make way for the railroad track. This involved drilling holes deep into the boulders and filling them with dynamite. A fuse was then inserted, and the entrance to the hole plugged with sand, so that the force of the explosion would be directed into the boulder. This was done with a crow bar-like tool called a tamping iron.

On 13th September 1848, 25-year-old Gage and his crew were working on the Rutland and Burlington Railroad near Cavendish in Vermont. Gage was preparing for an explosion by compacting a bore with explosive powder using a tamping iron. While he was doing this, a spark from the tamping iron ignited the powder, causing the iron to be propelled at high speed straight through Gage's skull. It entered under the left cheek bone and exited through the top of the head and was later recovered some 30 yards from the site of the accident.

Whether or not Gage lost consciousness is not known, but, remarkably, he was conscious and able to walk within minutes of the accident. He was then seated in an oxcart, on which he was transported three-quarters of a mile to the boarding house where he was staying. Here, he was attended to by Harlow, the local physician. At the boarding house, Harlow cleaned Gage's wounds by removing small fragments of bone and replaced some of the larger skull fragments that remained attached but had been displaced by the tamping iron. He then closed the larger wound at the top of Gage's head with adhesive straps and covered the opening with a wet compress. Gage's wounds were not treated surgically but were instead left open to drain into the dressings.

Within a few days of his accident, one of Gage's exposed brain became infected with a "fungus", and he lapsed into a semi-comatose state. His family prepared a coffin for him, but Gage recovered. Two weeks after the accident, Harlow released 8 fluid ounces of pus from an abscess under Gage's scalp, which would otherwise have leaked into the brain, with fatal consequences. By 1st January 1849, Gage was leading an apparently normal life.

Gage did, according to Harlow, retain "full possession of his reason" after the accident, but his wife and other people close to him soon noticed dramatic changes in his personality. It wasn't until 1868 that Harlow documented the "mental manifestations" of Gage's brain injuries, in a report published in the Bulletin of the Massachusetts Medical Society:

One of three figures from Harlow's 1868 paper. The legend reads:

Front and lateral view of the cranium, representing the direction in which the iron traversed its cavity; the present appearance of the line of fracture, and the large anterior fragment of the frontal bone, which was entirely detached, replaced and partially re-united.

[His contractors, who regarded him as the most efficient and capable foreman in their employ previous to his injury, considered the change in his mind so marked that they could not give him his place again. He is fitful, irreverent, indulging at times in the grossest profanity (which was not previously his custom), manifesting but

little deference for his fellows, impatient of restraint of advice when it conflicts with his desires, at times pertinaciously obstinent, yet capricious and vacillating, devising many plans of future operation, which are no sooner arranged than they are abandoned in turn for others appearing more feasible. In this regard, his mind was radically changed, so decidedly that his friends and acquaintances said he was "no longer Gage."]

Thus, the damage to Gage's frontal cortex had resulted in a complete loss of social inhibitions, which often led to inappropriate behavior. In effect, the tamping iron had performed a frontal lobotomy on Gage, but the exact nature of the damage incurred to his brain has been a subject of debate ever since the accident occurred. This is because the damage can only be inferred from the path of the tamping iron through Gage's skull, which in turn can only be inferred from the damage to the skull.

Gage's skull was damaged in three places: there is a small wound under the left zygomatic arch (cheek bone) where the tamping iron entered; another is in the orbital bone in the base of the skull behind the orbit of the eye; and the third, and largest, wound is in the top of the skull, where the tamping iron exited. The exit wound was enormous, and never healed. It can be seen today in Gage's as an irregularly-shaped triangular hole, about 2 inches wide and 4 inches in circumference, and another, nearly 3 inches in circumference. These are separated by one of the flaps of skull that was replaced by Harlow upon arriving at Gage's boarding house. Because the circumference of the wound in the frontal bone is much larger than the maximum diameter of the tamping iron, it is difficult to determine precisely the trajectory of the iron and where it exited Gage's skull.

Gage's case confirmed findings that damage to the prefrontal cortex could result in personality changes while leaving other neurological functions intact. Gage's case is one of the very first which provides evidence that the frontal cortex is involved in personality. Today, the role of frontal cortex in social cognition and executive function is relatively well established; however, this area of research is yet to blossom, and neuroscientists know little more about the relationship between the mind and the brain than did the early neurologists of the 19th century.

So, what of Phineas Gage himself? Unable to return to his previous job as a foreman after his accident, Gage is said to have travelled around New England, and even to Europe, with his tamping iron trying to earn money. It is also said that he even displayed himself as a curiosity at Barnum's Circus in New York. However, the story of Phineas Gage is as much folklore as it is fact. Not only the exact nature of the neurological damage Gage sustained, but also the details of his life after the accident, are disputed to this day.

In 1867, Gage's body was exhumed from its burial place in San Francisco's Lone Mountain Cemetery. Gage's brother-in-law took the skull and the tamping iron to Dr. Harlow, who was then living in Woburn, Massachusetts. They are now housed in the Warren Anatomical Museum at Harvard University School of Medicine.

QUESTIONS

1. How was Phineas Gage's brain damaged?

a. an explosion caused an iron to go through his brain and skull
b. a brawl with coworkers caused damage to his brain
c. he fell from a bridge
d. a hereditary defect resulted in epilepsy

2. Why is Phineas Gage's story important to neuroscientists today?

a. no other case of that type of brain damage has ever been seen
b. it was the earliest recorded case of brain damage affecting personality
c. doctors can compare Gage's brain scans to other patients
d. it forced 19th century doctors to start doing autopsies

3. Compared to Gage's personality before the accident, after the accident Gage was:

a. quiet and reserved
b. unreasonable and impulsive
c. prone to daydream long periods
d. unable to remember events

4. How do neuroscientists today determine the exact damage done to Gage's brain?

a. by viewing the autopsy reports of Dr. Harlow
b. by scanning his preserved brain
c. reading Gage's diary
d. examining the damage done to the skull

5. After the initial accident, Gage almost died due to:

a. excessive bleeding
b. starvation
c. infection
d. surgery

6. Which part of the brain is associated with personality?

a. frontal cortex
b. occipital lobe
c. zygomatic area
d. orbital zone

7. Which statement is an inference?

a. Gage's body was exhumed, and his skull displayed
b. Gage's personality was changed dramatically after the accident.
c. The part of the brain damaged by the iron was the frontal lobe.
d. Gage would have recovered fully had it not been for the infection.

8. What is an abscess?

a. broken bone
b. site of infection
c. tumor
d. section of brain that is damaged