Microbes as Weapons

• “Fighting in a battle, he should not kill his enemies with weapons that are concealed, barbed, or smeared with poison”
• So say the Laws of Manu, an ancient Brahmin text on moral conduct

• Man is a moral animal…
• Our cultural evolution has spanned over two thousand years of philosophy and theology
• Darwin says in the Descent of Man that our moral sense is the highest product of human evolution

• And yet, for all our grand philosophies, for all our lofty moral codes, we’ve warred against one another for centuries - in the name of government, in the name of religion, or merely for the pursuit of plunder
• We are not the only animal to do so…

• Although coexistence often prevails, nature runs red with blood
• Animals fight with horns, with hooves, with tooth and claw – they fight over territory, they fight over mates…

• Even plants fight their own quiet battles, as do fungi and bacteria
• But plants don’t have fangs, fungi don’t have claws, and microbes are sadly lacking in horns and hooves

• Each one of them, however, can make exotic chemical compounds that will stop an enemy in its tracks
• It’s no accident that so many of our most powerful antibiotics have come from fungi and bacteria

• We are latecomers in their long running evolutionary arms race with one another
• But we’ve done a lot more than just look for ways to keep them from attacking us
• We’ve started using them to attack one another

• As we’ll learn in our next two lectures, biological and biochemical warfare is as old as human conflict
• As animals go, let’s face it – we’re a bit on the weak and puny side…
• No fangs or claws, no toxins or venom sacs – no wonder the other animals won’t even talk to us!

• But we’ve more than made up for it, by using our intellect to imitate the adaptations of all the other predators
• We don’t have sharp fangs and slashing claws, but we can forge knives and swords
• We can’t secrete venom, but we quickly learned to borrow venom from other animals
For centuries, primitive tribes in Amazonia have used poison dart frogs to coat their arrowheads with toxins.

Homer describes the use of poisoned spears and arrows in his epic poems, speaking of “black blood”, commonly associated with snake bite and poisoned wounds.

Hercules started the ball rolling, by dipping his arrows into the Hydra’s venom, and using the poison arrows to slay the centaur Nessus.

And in the process, he learned an important lesson, that biological weapons often turn upon those who wield them.

His wife was later tricked into smearing the venom on his cloak, and when he donned the cloak he died a horrible and painful death.

The Greek word for arrow poison is toxicon, derived from toxon, which means bow or arrow.

The Romans modified it to toxicum, meaning any kind of poison, from which we get the words toxic and toxin...

Hercules wasn’t the only Greek warrior to resort to poison arrows.

The Oracle of Helenus told Odysseus that he had to recover the poison arrows of Hercules if the Greeks were going to defeat the Trojans.

And in the Odyssey, Homer says: “For there, too, went Odysseus in his swift ship in search of a deadly drug, that he might have herewith to smear his bronze-tipped arrows.”

Like Hercules, the tables turn on Odysseus, who later dies from a poisoned spear.

Telegonus, the son of Odysseus and Circe, accidentally kills his father during a cattle raid, using a spear tipped with a spine from a sting ray, the same deadly venom that recently killed the naturalist Steve Irwin.

But the award for the most imaginative use of natural toxins must certainly go to Hannibal.

Remember the movie Snakes on a Plane?...

Hannibal, in 184 AD, was fighting the naval forces of Eumenes II, king of Pergamum.

Eumenes had a much larger fleet, and the outcome seemed hopeless.

The Roman biographer Cornelius Nepos, in his Lives of Eminent Commanders, tells us that Hannibal ordered his troops to catch as many poisonous snakes as they could, and stuff them into clay pots.

In order to determine which vessel to attack, he sent a herald in a boat, with a fake message for the king, filled with vile insults.

Once Hannibal had identified his target from the King’s reaction, he ordered his ships to catapult the pots filled with snakes onto the deck of King Eumenes’ ship.
• Well, the enemy burst out laughing when they saw the clay pots come sailing through the air, but once the pots broke and the snakes came pouring out, the laughter quickly turned to confusion and terror, and Eumenes’ fleet beat a hasty retreat.

• The Arabian city of Hatra, in the Second Parthian War, around 198 AD, repulsed a siege by the Roman legions of Emperor Septimius Severus by using the same trick, substituting angry scorpions for snakes.
• To the battered Romans, bombs filled with stinging insects and scorpions were probably the last straw.

• The Romans themselves acquired a fondness for catapulting bee hives into the midst of their enemies.
• The historian John Ambrose, an expert on the use of insects in warfare, suggests that the decline in the number of bee hives in the late Roman Empire might be due to their frequent use as guided missiles!

• Centuries before we had any inkling of the existence of microscopic creatures, we were already using them in combat.
• The first known use of germ warfare was during the Anatolian War, 1320-1318 BC, when the Hittites drove sheep and donkeys infected with tularemia into enemy territory.

• But the true masters of microbial mayhem were the Scythians.
• Herodotus tells us that the Scythians, in the Fourth Century BC, coated their arrows with a home brew that must have been swarming with nasty microbes, including those that cause tetanus and gangrene.

• They started by extracting the venom of freshly killed vipers, which were left to decompose, while they carefully separated the serum from human blood.
• They mixed the blood serum with animal dung, and buried the mixture underground in a leather pouch until it was sufficiently putrid.

• The dung and serum mixture was then combined with the snake venom and the rotted snake tissue.
• It must have been incredibly potent, and the historian Strabo tells us that “Even people who are not wounded by the poison projectiles suffer from their terrible odor.”

• The Romans and Persians used to poison their enemies by dumping dead animals into their wells.
• In 1155, the Holy Roman Emperor Barbarossa poisoned the wells of Tortona with the bodies of dead soldiers.

• The Turks came up with an interesting variation on this age-old scheme in 1346.
• The Crimean city of Caffa, on the Black Sea, (modern day Feodosiya), was then held by Genoa.
• The Genoese had acquired it from the Mongols in 1266, and were using it as a base to dominate trade in the Black Sea

• The Genoese and the Mongols didn’t always get along, and in 1343 Jani Beg, the new Kahn of the Golden Horde, attacked Caffa with his Turkish mercenaries

• After three years of siege, the Turks were fed up and suffering from plague, so they decided to use their own dead as weapons
• They used catapults to launch plague infected corpses into the city, until the defenders sickened and died

• The contemporary historian Gabriele de’ Mussi tells us:
  “What seemed like mountains of dead were thrown into the city, and the Christians could not hide or flee or escape from them, although they dumped as many of the bodies as they could in the sea. And soon the rotting corpses tainted the air and poisoned the water supply... Moreover one infected man could carry the poison to others, and infect people and places with the disease by look alone.”

• The Genoese scattered to ports all across the Mediterranean, spreading the Black Death to Europe, and igniting a series of pandemics that would devastate the population

• The Tunisians, in 1785, flung infected clothing, rather than corpses, into the besieged city of La Calle
• The British used a similar strategy against native tribes in colonial America, giving them blankets infected with smallpox

• The very first use of biological warfare in the New World, however, may have been by the Indians, against the British
• The French historian Pierre-François-Xavier de Charlevo writes of a band of Iroquois in the early 1700’s who poisoned a stream used by English troops

• They threw all their recently skinned animal pelts into the stream, and succeeded in killing over a thousand British troops who drank the tainted water
• But it didn’t take the British long to seize the initiative…

• Lord Jeffrey Amherst, for whom the town of Amherst is named, supposedly hatched a plot to give smallpox to the Indians
• Now, there’s little doubt that Amherst proposed giving them smallpox-infected blankets - the note in question is penned JA, and the handwriting seems to match

• Amherst was then the British commander-in-chief at Fort Pitt
• He writes to Colonel Henry Bouquet, in charge of the Pennsylvania troops:
  > “Could it not be contrived to send the small pox among those disaffected tribes of Indians? We must, on this occasion, use every stratagem in our power to reduce them.”
• There’s also no doubt that smallpox broke out among the local tribe at that time
  But there’s a great deal of controversy over whether Amherst actually caused it

• The evidence is a bit more solid where his contemporary, Captain Simeon Ecuyer, is concerned
  Ecuyer commanded Fort Pitt during Pontiac’s Indian rebellion

• In May of 1763, Pontiac’s allies besieged the Fort, and in June they sent two Delaware Indians, Turtle’s Heart and Mamaltee, to urge the British to surrender
  After an unsuccessful parley, the Indians asked for supplies to see them home

• The British obliged, and included two blankets and a silk handkerchief from the Fort’s smallpox-infested hospital
  Ecuyer signed a company invoice which lists the items as: “Sundries got to Replace in kind those which were taken from people in the Hospital to Convey the Smallpox to the Indians”

• Unbelievable – like a stupid criminal leaving a to-do list at the scene of the crime – stalk victim, check…write ransom note, check….give smallpox infected blankets to the Indians – check…

• Shortly after the Delaware Indian diplomats returned home, a smallpox epidemic broke out among the local Delaware and Shawnee tribes, and raged for several months
  It’s hard to say whether these outbreaks would have occurred anyway
  But there are many similar accusations of deliberate smallpox infection by the British

• A group of deserters in 1775, for example, accused their superiors of inoculating British refugees from Boston with the dreaded disease
  Other reports corroborate their story

• One refugee confessed in the Boston Globe to being infected with smallpox, and ordered to board a crowded American vessel when the pustules broke out
  Washington, for one, found it hard to believe that the British could be that cruel

• He writes to John Hancock:
  > “The information I received that the enemy intended spreading the smallpox amongst us, I could not suppose them capable of – I now must give some credit to it, as it has made its appearance on several of those who last came out of Boston”

• Virginia Governor John Murray, Earl of Dunmore, also resorted to germ warfare
  Some eight hundred escaped slaves had rallied to the British cause in return for Dunmore’s promise of freedom
• Dunmore wrote an emancipation proclamation for his “Ethiopian regiment”, as he called it, in November of 1775
• The small band of hopeful soldiers, camped on the water near Norfolk, was intended to spearhead Dunmore’s attack on the American colonists
• But by May of 1776, it was being decimated by a smaller and more relentless enemy, smallpox
• As Dunmore fled from Norfolk Harbor, he sent two inoculated men from the Ethiopian regiment ashore, posing as deserters, to spread smallpox to the Americans
• But his plan was a failure
• Reduced by smallpox to 150 men, Dunmore’s “Ethiopian regiment” had to withdraw from Virginia
• Given how often the British resorted to germ warfare, why didn’t the American commanders retaliate in kind?
• Was it because they were morally superior to their British counterparts?
• I’d like to think so…But, truthfully, they probably knew it would backfire
• Americans were much more susceptible to smallpox than their British opponents
• Smallpox was so widespread in urbanized Europe that virtually everyone was exposed to it at an early age, and developed immunity
• American populations, on the other hand, were much more rural, and relatively isolated, and many people had grown up without ever being exposed to the disease
• Lacking any immunity, they were highly vulnerable
• And this left George Washington with a real dilemma …
• He could inoculate his troops, so they would only suffer a mild case but gain immunity
• But this would briefly incapacitate his entire army, and leave them wide open to an attack, if the British got wind of it
• He compromised by only inoculating the new recruits
• Despite his caution, at the peak of the epidemic about a third of his army was down with the disease or with the inoculation
• This tiny virus nearly cost us the Revolutionary War!
• It certainly cost us the Battle of Quebec…
• Smallpox broke out among the American troops shortly after they arrived outside the city walls in 1775
• The first attack, on Dec. 31st, failed amidst a Canadian blizzard, and the siege that followed left the troops sick and miserable
• Several people accused the British commander, Sir Guy Carleton, of deliberately infecting the American troops
• The Continental Congress held an investigation, and as Thomas Jefferson’s notes reveal, several witnesses testified that Carleton was responsible

• Jefferson writes to a French historian:
  > I have been informed by officers who were on the spot, and whom I believe myself, that this disorder was sent into our army designedly by the commanding officer in Quebec. It answered his purposes most effectually.”

• These crude tactics of our ancestors pale before our modern day ability to cultivate the deadliest microbes on the planet
• But before the discovery of antibiotics, there was no way of preventing the microbe from turning on the army that released it

• Any microbe on the battlefield would kill without regard to national identity
• In World War I, gas was the preferred weapon, though fickle winds sometimes turned it back on those who used it

• Gas attacks by the Germans in World War I cost 91,000 allied casualties, and an unknown number of German casualties from allied counter attacks
• The use of chlorine gas, phosgene, nerve gas, and mustard gas killed or maimed millions of soldiers and civilians

• One of the victims of the Allied gas attacks was a young German corporal named Adolph Hitler
• Hitler was temporarily blinded by an Allied mustard gas attack on the Belgian village of Wervick, during the closing days of the war

• This may explain why the otherwise ruthless dictator was hesitant to use biological or chemical weapons during World War II

• The Germans employed a limited form of biological warfare in World War I, mostly cultivating anthrax, and a cattle disease called glanders, a disease of horses and mules that can also be fatal to humans
• One of their germ warfare masterminds was Dr. Anton Casimir Dilger

• Dilger was an American citizen who moved to Germany as a young boy
• His father was a Civil War hero, winning the Medal of Honor at the Battle of Chancellorsville

• Dilger, however, was dedicated to the German cause
• He returned to the US in 1915 as a German spy, carrying cultures of anthrax and glanders
• He set up a secret laboratory in Chevy Chase, near downtown Washington DC, about 20 miles from where I’m standing right now, where he cultured anthrax and glanders for use against American horses
• The Germans wanted to keep the US and other non-allied countries from supplying horses and cattle to the Allied troops
• The FBI gradually became suspicious, but Dilger managed to escape to Mexico, finally ending up in Madrid, where he died of the 1918 Flu – a bit of microbial justice!
• The Nazis ran a secret germ warfare program in World War II, though it wasn’t nearly as ambitious as the Allies feared at the time
• The Nazis experimented with malaria at Dachau, exposing inmates to malarial mosquitoes or injecting them with mosquito extract to try out various treatments on the victims
• 50% of the 1,000 infected inmates died…
• They conducted similar experiments with Hepatitis A and Rickettsia bacteria
• Chemical and biological weapons were outlawed by the Geneva Protocol of 1925, which set the ground rules for World War II
• The Geneva Protocol was a good idea, but the actual treaty was completely toothless
• While it outlawed the use of biological weapons, you could still own them and do research on them
• And many nations still reserved the right to retaliate in kind
• The U.S., incidentally, didn’t sign the Protocol until 1975!
• Ironically, it was the Geneva Protocol that started our modern biological arms race
• It gave a Japanese microbiologist named Shirō Ishii the idea that biological weapons might actually be both feasible and powerful
• Shirō Ishii was a brilliant, if disturbed student, a graduate of Kyoto Imperial University
• He became the proverbial mad scientist, eager to try any experiment, no matter how gruesome, with total indifference to the agonies of his victims
• Most of us are familiar with the atrocities committed by the infamous Nazi butcher Josef Mengele
• But few people are aware that Shirō Ishii not only equaled Mengele in cruelty, but greatly exceeded him in the scope and savagery of his experiments
• Ishii became the mastermind behind the Japanese biological weapons program
• In 1932, he was placed in command of the Army Epidemic Prevention Research Laboratory
I’ll spare you the grisly details of his legacy of human tragedy and despair – it made me sick just to read about it - but the final death toll is staggering.

As many as 12,000 victims died from his bizarre experiments and vivisection.

A mass grave of Ishii’s victims, found in 1945 at Hailar, held the remains of 10,000 Chinese and Mongolian men, women, and children.

He started his experiments at Zhongma Fortress in 1932, until bad publicity forced him to relocate.

In 1936 he opened the infamous Unit 731 in Manchukuo, China.

Unit 731 was a sprawling complex of 150 buildings, scattered over six square kilometers. Its was ironically disguised as the Anti-Epidemic Water Supply and Purification Bureau.

His experiments duplicated most of the Nazi atrocities, but he went them one better when it came to germ warfare.

His tool kit included cholera, typhus, dysentery, salmonella, typhoid fever, botulin, gas gangrene, smallpox, tuberculosis, and anthrax!

His subjects were originally Japanese political prisoners or common criminals.

Later on, he took advantage of the war to experiment on Chinese POWs and civilians, and American POW’s.

Three members of Unit 731 later confessed to using typhoid to contaminate the Horustein river, hoping to infect nearby Soviet troops.

Plague infected animals, released during the Russian advance in 1945, may have caused the deaths of over 30,000 Chinese civilians.

He designed a bomb made out of porcelain, and stuffed with cotton wadding, wheat, rice, and plague-infected fleas.

From October of 1940 to November of the following year, he bombed several Chinese cities, including Chü Hsien, Ningbo, and Changteh.

Although 150 people died from these attacks, there were no major outbreaks of plague.

His repeated use of biological weapons backfired in 1942, when Japanese troops retook Chekiang Province from the Chinese.

Under Ishii’s instruction, they had previously salted several areas with cholera and other microbes to deter the Chinese.

10,000 Japanese soldiers fell ill, mostly from cholera – and 1,700 of them died.

The final death toll from Ishii’s microbial warfare is estimated at over 400,000 people.

He had also drawn up plans to attack the West coast of the US with balloon bombs loaded with anthrax.
• But Ishii and the other doctors who conducted these grisly experiments never paid for their crimes.
• In 1945, General MacArthur secretly gave them limited immunity in return for the results of their research, which he didn’t want to fall into Russian hands.
• 30 people from Unit 731 were finally hauled before the Allied war crimes tribunal in 1948, and several were sentenced to death or lengthy imprisonment.
• But MacArthur commuted or shortened their sentences in 1950, and by the late 1950’s they were all free.
• Several doctors from Unit 731 went on to prominent careers in Japanese medicine or the pharmaceutical industry.
• Shirō Ishii himself died at home of cancer at the age of 67.
• The Japanese refused to even admit the existence of this program until 1997, when the Japanese supreme court finally ruled in a textbook suit that its existence was accepted as fact in academic circles.
• To this day, they have refused any compensation for the survivors or their families.
• Unit 731 made the news again in 2010, when the Japanese government announced it would excavate the grounds of a former medical school associated with Unit 731.
• A retired nurse broke 60 years of silence to confess that after the Japanese surrender, she and others were forced to bury many bodies before American troops arrived.
• The Japanese worked hardest at producing an anthrax bomb.
• For many reasons, anthrax has been a perennial favorite in every nation’s biological arsenal.
• As we’ll learn in our next lecture, it has also been recently adopted as a tool of bioterrorism.
• Anthrax is caused by the bacterium *Bacillus anthracis*.
• Anthrax isn’t just a disease of sheep, but occurs in a wide range of mammals, including lions and elephants!
• It’s an ancient disease, mentioned in the Iliad, and familiar to Hippocrates.
• The bacterium forms a spore that is surprisingly durable.
• Anthrax is acutely infectious to sheep, cattle, and humans.
• It can be inhaled, enter through the skin, or enter the gut through eating infected meat.
• But most “normal” cases of anthrax involve those who work with raw wool - very raw wool…the kind that goes *baahhhhh*…
• If the anthrax bacterium is inhaled, the victim will begin to cough in a few hours.
• Symptoms progress to shortness of breath, high fever, convulsions, bleeding from bodily orifices, and a rapid and painful death within 12-24 hours of the first symptoms!
• Anthrax spores can remain viable up to 40 to 80 years in the soil
• It can persist in the dirt for decades, patiently awaiting its next victim
• Remember, from our lecture on virulence, that this evolutionary strategy of durability allows anthrax to be highly virulent

• The discovery of Ishii’s work late in the war drew attention to the threat of germ warfare
• Convinced that the Nazis were also developing biological weapons, and fearful that their V-1 and V-2 rockets could deliver them, the U.S. began to organize its own research program

• The program officially began in 1942, under the auspices of the Chemical Warfare Service (CWS), later called the Army Chemical Corps, but several sources allege that clandestine biowarfare research was already underway in 1941
• The U.S. biological warfare program began at Fort Detrick, the Army Medical Research Institute of Infectious Diseases, where it is still located today
• Britain and Canada later joined the program

• In 1942, the British military used Gruinard Island, off the coast of Scotland, to test anthrax
• The tiny island, only one mile wide and one and a half miles long, ended up thoroughly contaminated

• Anthrax spread to the mainland, probably in the floating corpse of a dead sheep
• It killed several pets and farm animals, but fortunately no people…
• It took 47 years to clean up the mess

• Anthrax is often used in germ warfare thanks to its high virulence and durability
• In our next lecture, we’ll learn how anthrax and other microbes have been weaponized and used by terrorists

• We’ll look at the full extent of the US and Russian germ warfare programs, and join the CIA in searching for weapons of mass destruction in Iraq
• And we’ll reveal the secret experiments that have been carried out by the federal government on U.S. civilians – I can already hear the black helicopters in the distance…