

CURIOSITY CHRONICLES



Snapshots of Modern History

Vol. 1

by Vivian Meyers, M.A.

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Globally Minded History

by Vivian Meyers, M.A.

Curiosity Chronicles, an imprint of Drop Dead Studios LLC

Marysville, OH 43040

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Modern History

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Introduction

Modern History

Ted: Welcome back! I'm Time Talking Ted.

Mona: I'm Mystery Mulling Mona.

Arthur: I'm Arty Arthur.

Lily: And I'm Literary Lily.

Ted: We're picking up in 1850 to study modern history. In our study of early modern history, we saw the world change in nearly every way imaginable. We saw global exploration,

Mona: Colonization and the slave trade,

Ted: Pirates!

Lily: The rise of new philosophies,

Arthur: New art styles!

Lily: Evidence-based science,

Ted: Revolution after revolution,

Mona: And the origins of industrialization and globalization.

Ted: We're ready to see all those pieces come together to create the modern world we live in today.

Mona: All these new ideas and events meant people started seeing and thinking about the world differently. People questioned what their life could or ought to be like.

Lily: In early modern history, we learned about the Enlightenment. The Enlightenment championed logic and reason. The Enlightenment introduced the idea that all men had rights and that ordinary men should have a say in their government.

Ted: We also saw that implementing those ideas was messy and didn't always work. Sometimes people fought for the rights of everyone, sometimes they fought for the rights of a select group of people, and sometimes they just wanted power for themselves.

Mona: We also saw that when the Enlightenment said "all men" have rights, all didn't mean all. Race, ethnicity, religion, class, and gender were all used to exclude people from this new era of rights. The modern era will wrestle with questions about who deserves rights and how rights should be granted. If a person was excluded from having legal rights, what options did they have to gain them?

Lily: If people feel they aren't being represented by their government, are they allowed to separate from that government and form their own country?

Mona: The right to create your own country and have representation within its government is called self-determination. Modern history will be full of the question of who is allowed self-determination and how.



Ted: While people are trying to figure out the who and how of equal rights, they will also learn to live in a world full of new technology. New technology made travel and communication faster and easier.

Mona: Scientific breakthroughs and factories meant people had more conveniences and luxuries than ever before.

Lily: New scientific theories will cause humans to reevaluate their relationship with themselves, each other, and the natural world.

Arthur: Photography allowed people to see things they had never seen before. That allowed people to think about and be connected to the world in a whole new way.

Lily: Literacy rates are rising, books are becoming cheaper, and there are more newspapers than ever.

Mona: Newspapers and public opinion will have unprecedented power in this era of history. Public opinion is the general mood and opinions of a large segment of society, and it will change very rapidly as information becomes more readily available. Governments and politicians will have to find the best ways to maneuver ever-changing public opinion.

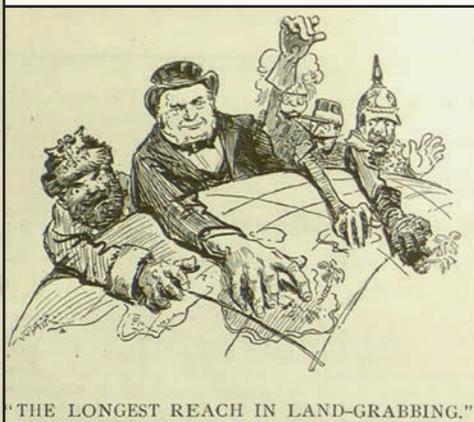
Ted: We'll also see the reach of empires increase as they frantically battle each other for dominance. They don't know it yet, but the world is heading toward war. THE war. The War to End All Wars! In this book, we'll see how these empires, desperate to claim every inch of land they can reach, will affect the lives of people all around the globe and set up what will become the greatest global conflict the world had ever seen.

Mona: When we begin modern history, one country—one empire—is sitting at the center of it all. Great Britain. The British Empire is the largest in history. Money and resources from across the globe are pouring into Great Britain, making it the wealthiest nation in the world. Britain used that money to create the technology that furthered industrialization and globalization, but as all that wealth heads to Great Britain, many areas are left with almost nothing. The balance of wealth and power in the world becomes staggeringly unequal.

Ted: But by the end of this book, we will see the United States, Germany, and Japan all rise up as major industrial powers to rival Great Britain.

Mona: We'll also see the rise of many new nations, inventions that forever change daily life, cultural changes that still define us, the struggle for equality and human rights, and the many complicated wars and politics created by a global world.

Ted: Let's dig in!



Political cartoons from Harper's Weekly on January 27, 1900. The left cartoon shows John Bull (the personification of Great Britain) easily holding the entire ocean. The caption reads "The ocean is a British possession." The right cartoon shows (from left to right) the Russian, British, Austrian, French, and German empires reaching across the globe in a competition to claim the most land. The image is captioned "The longest reach in land-grabbing," acknowledging that the British Empire had been most successful at claiming overseas lands. The article this image accompanied praised the reach of the British Empire and claimed rival empires could never catch up.

Culture Corner

John Stuart Mill

Arthur: Welcome to modern history!

Lily: In the last culture corner of early modern history, we introduced Karl Marx and communism. To start off modern history, I'd like to introduce you to another political philosophy: Classical Liberalism.

Arthur: Liberalism, conservatism, socialism, and communism are the big ideas that will define how the modern world develops.

Lily: To understand Classical Liberalism, let's take a look at the most influential philosopher of the 1800s: John Stuart Mill. In 1859, Mill published his most famous book, *On Liberty*. Mill's wife, Harriet Taylor Mill, significantly contributed to the book before dying in 1858. Her daughter, Helen Taylor, became Mill's chief collaborator after her death. To understand the Mills' ideas about liberalism and liberty, we need to start with utilitarianism.

Arthur: Wowza, that's a big word! The root word of utilitarianism is utility, meaning something that is practical.

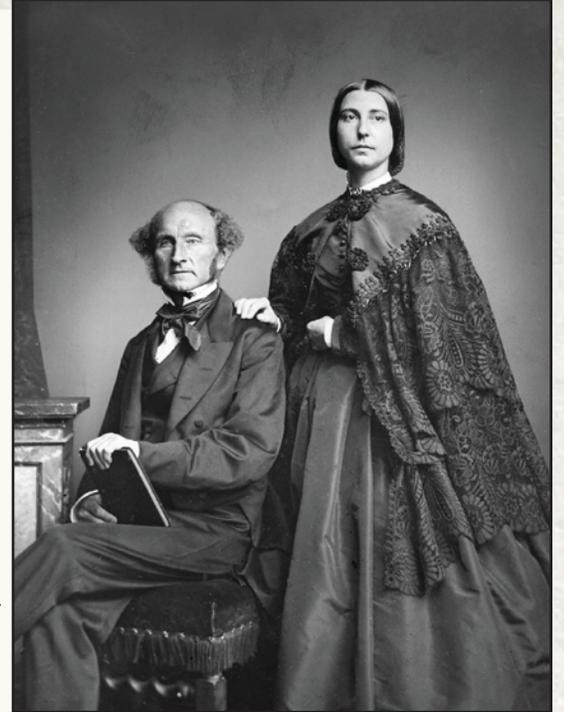
Lily: Utilitarianism is a moral philosophy, meaning it's a system for determining if something is good or bad. Unlike most moral philosophies, utilitarianism is not based on a religious or cultural tradition. It's based on being practical.

Arthur: So liberalism uses utilitarianism to determine if something is good or bad? What things are good according to utilitarianism?

Lily: Utilitarianism says something is good if it produces pleasure or happiness. Something is bad if it produces the opposite of pleasure, like pain or sadness. Mill believed people should be free to make choices that bring them pleasure and allow them pursue "the good life."

Arthur: "The good life" means finding fulfillment in your life. It's the kind of thing Thomas Jefferson meant when he said men are entitled "to life, liberty, and the pursuit of happiness."

Lily: Mill believed that everyone is an individual, so there's not just one way to pursue the good life. BUT, that doesn't mean every approach will work. Mill thought you had to be educated to understand how to live the good life.



Photograph of John Stuart Mill and his step-daughter and collaborator, Helen Taylor.

Arthur: Ah, but there's a big, striped, dancing elephant in the room we need to address. What if one person makes a choice that brings them pleasure, but that choice harms other people? For example, what if I decided to wear a really ugly sweater? It might give me pleasure to wear it, but it also might harm the eyes of everyone around me. According to Mill, is that a good choice or a bad choice?

Lily: You mean, can other people demand you change your behavior if they don't like it? That's the million-dollar question. The answer has two parts. First, in utilitarianism a choice is considered good if it produces the most overall good for the most people.

Arthur: So, according to Mill, people would be justified in outlawing my sweater if lots of people are offended by it?

Lily: No, because of the second part of the answer. Mill believed that people should be free to make their own choices about how they think and act. He called the freedom to control your own mind and body "liberty." The only justifiable reason to limit someone's liberty is to prevent harm to another person. If your actions create harm, others are justified in stopping you. If your actions don't cause harm, then it is unjust to interfere. That means in utilitarianism, the best choice is the one that produces the most good for the greatest number of people without unjustly taking away anyone's liberty.

Arthur: Looks like ugly sweater days are back on the calendar!

Lily: The logic of utilitarianism was used to develop Mill's political philosophy of Classical Liberalism. Mill argued that laws are just if they only exist to prevent harm. Laws are unjust if they impose any unnecessary restriction on how people are allowed to act or think.

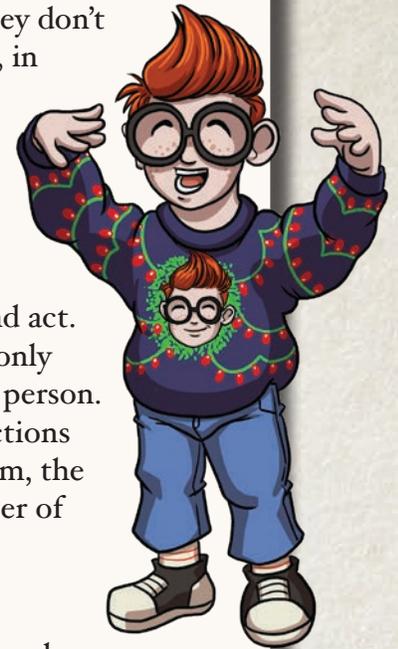
Arthur: So less-restrictive laws equals a more just society. I'm following him so far.

Lily: Mill also believed it was critical for people to have a say in their government. If only a small group of people controlled the entire government, then it would be easy for them to shape laws for their own benefit and (accidentally or on purpose) harm the liberty of others. Mill called this the "tyranny of political rulers." To prevent tyranny, people needed to have a say in their government.

Arthur: So he supported democratically-elected governments?

Lily: Yes, but as always with Mill, there was a catch. He thought people were likely to conform to the most popular ideas in democratic societies. He feared people would try to fit in rather than think for themselves. If that happened, it would be easy for the majority of people to limit the liberty of minorities. They might limit a minority's liberty with laws or restrict them with social pressure. He called this the "tyranny of the majority."

Arthur: Like, if you were the only person who didn't support a politician and everyone bullied you for it, that bullying might pressure you into supporting that politician?



Lily: Yep. Mill believed that kind of social pressure was even more dangerous than legal restrictions because culture is harder to change than laws. He believed the solution was education and free speech.

Arthur: If people are educated, they can decide for themselves if ideas are good or bad. Then they'd be less likely to give in to social pressure. How does free speech help?

Lily: Allowing everyone to openly discuss their ideas would help people become educated.

Arthur: Even discussing ideas that are wrong?

Lily: Yes! Ideas are rarely completely correct or completely incorrect. Mill believed if people were free to discuss ideas, then correct ideas would be proven right, partially correct ideas would be improved, and incorrect ideas would be disproven.

Arthur: Bringing all these threads together, what sorts of ideas did Classical Liberals support in the 1800s?

Lily: Classical Liberals supported free speech, free trade, decreased regulations, and greater personal freedom. They supported education, women gaining more rights, and ending slavery.

Arthur: So I'm guessing they opposed colonization.

Lily: Actually, no. Liberals believed that education was key to liberty and that colonization brought education to "less civilized" parts of the world. Liberals supported colonization because they thought it would ultimately lead to more liberty. Mill even called colonization "benevolent despotism."

Arthur: Well, this is still the era of empires. Throughout the 1800s, liberal politicians gained power in governments across Europe, the Americas, Australia, and New Zealand. The battle between liberal and conservative politicians—along with their fear and occasional alliances with communists and socialists—will determine the course of the modern world.

Lily: Liberalism is one of the cornerstones of modern thought and will profoundly impact how governments are structured and how people live their lives in the modern world.



Section 1: The Mechanics of Empire

♦ ♦ ♦ ♦

Chapter 1:

Albert Builds the Crystal Palace

Ted: To start exploring modern history, we need to get our heads around how people in the era thought. So I've got a question for you. How do you win history?

Mona: Um, that's not a thing, Ted. This isn't a game of Risk. You can't "win."

Ted: Well, that's not what the Victorians thought! Whoever had the biggest empire was winning, so the bigger your empire, the better. If someone else's empire was bigger than yours, you better scramble to catch up before you were toast. For the people in power, empire meant strength, resources, and money. Oodles of money!

Mona: Yeah, European politicians in this era did see empire-building as a way to succeed.

Ted: Not just a way, THE way. There are lots of empires out there. Britain, Russia, France, the Ottomans, Austria-Hungary, Spain, and Portugal had been playing the empire game for a long time. Other places like Germany and Italy were eager to join their ranks.

Mona: During the Revolutions of 1848, we saw the rise of nationalism. Ordinary people were invested in seeing their empire succeed and become the best empire there was.

Ted: Exactly! Empires put that nationalism to use to help them grow their power. If ordinary people supported the empire, then the empire could easily keep growing. As we enter modern history, the British Empire was clearly winning. It was the biggest in the world, its military was the strongest, and its navy controlled the seas. The riches of a massive chunk of the world were pouring into the British Isles. Around the world, people were looking to the British Empire with admiration, jealousy, anger, and aspiration.

Mona: Over the next six chapters, we'll see the many tactics the British used to maintain their spot as the most powerful empire in the world.

Ted: They had their fingers in every pie, and everything they did affected everyone else in the world. So today, let's start with one of their most important but perhaps most overlooked tactics of all—pageantry! Empires are pageantry! Power is a performance. If you want to *be* the greatest empire in the world, you need to *look* like the greatest empire in the world. Britain needed to put on a show!

Mona: Showing off your power is important for two reasons. One, it convinces the people within your empire to serve and support the empire. Two, it convinces people outside your empire that you're as powerful as you say you are.

Ted: You're right, internal support and external admiration/fear are key. We've seen empires use a lot of tactics throughout history to show off their strength. Building cool things is always a solid choice. Creating a big, flashy military is another excellent option. Public spectacles and entertainment are a timeless tactic. We're going to see these methods used over and over in modern history.

Mona: Improved travel and communications meant empires had new methods of showing off.

Ted: Today we're going to look at the biggest pageant of them all that kicked off the modern era. In 1844, France held a fair to show off all the accomplishments of French industry. The fair displayed the many impressive achievements of French inventors. The fair included a new type of drill that could dig deep wells, an automatic counting machine, an improved type of photography, and an early version of the saxophone. All really impressive inventions! Prince Albert was intrigued by the fair. And by intrigued, I mean a little bit jealous but convinced Britain could do it better.

Mona: Prince Albert was Queen Victoria's husband. He spearheaded a project to make a similar fair in Britain.

Ted: But way bigger and better!! Albert wanted to show off the works and industry of ALL nations.

Mona: But with Great Britain, obviously, at the center.

Ted: But of course! Showing off the greatness of Great Britain was the entire point. But first, he needed a properly fancy building to show off all the cool stuff. You can't hold an event like this in a barn and expect it to be a success. You need something big, grand, and awe-inspiring!

Mona: The problem was London didn't have a big, fancy building, that was also empty, to hold the fair in.

Ted: Time to start building!

Mona: London didn't have enough space to build a big, fancy new building either. At least not permanently. The organizers decided to host the event in Hyde Park, but the building would have to be temporary. The building would also have to be built quickly since they wanted to hold the fair soon. And since the building would be temporary, it should be as cheap as possible.

Ted: No problem! They just need to build a massive, cheap, temporary building that is fancy enough to wow the entire world. That should be... easy?

Mona: Haha, nope! The organizers decided to hold a competition to see who could come up with the best design. All the original submissions were rejected for being either too expensive or too complicated. Eventually, the organizers accepted the design of Joseph Paxton. Paxton was an elite garden designer who had begun experimenting with using glass panes to create greenhouses.



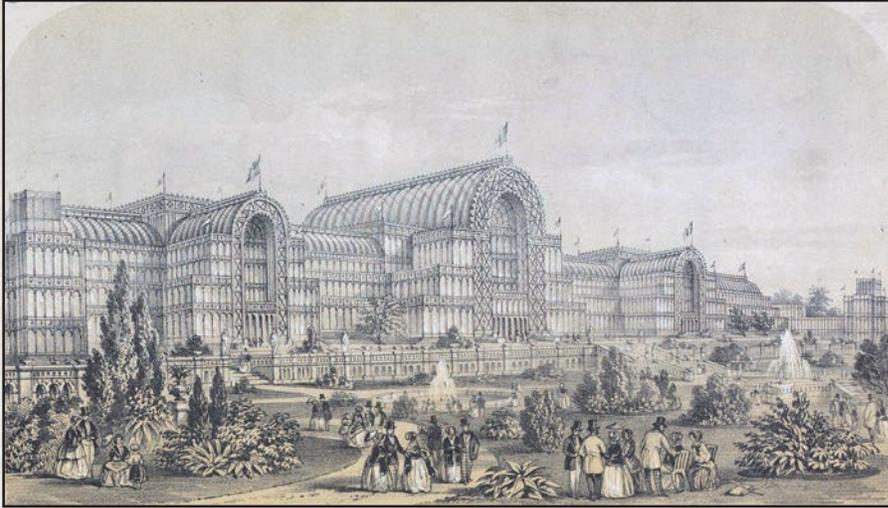


Illustration of the Crystal Palace from of the cover of Polka sheet music to accompany the Exhibition by J. E. Fields.

Ted: A greenhouse sounds like it might be cool! Well, not cool. It sounds hot. But also fancy!

Mona: Paxton proposed using a steel frame and glass panes to create a glittering hall of glass unlike anything the world had ever seen!! Making steel strong enough to support a structure of that size and

enough glass panes to cover it would definitely show off Britain's industrial power. The design was named the Crystal Palace.

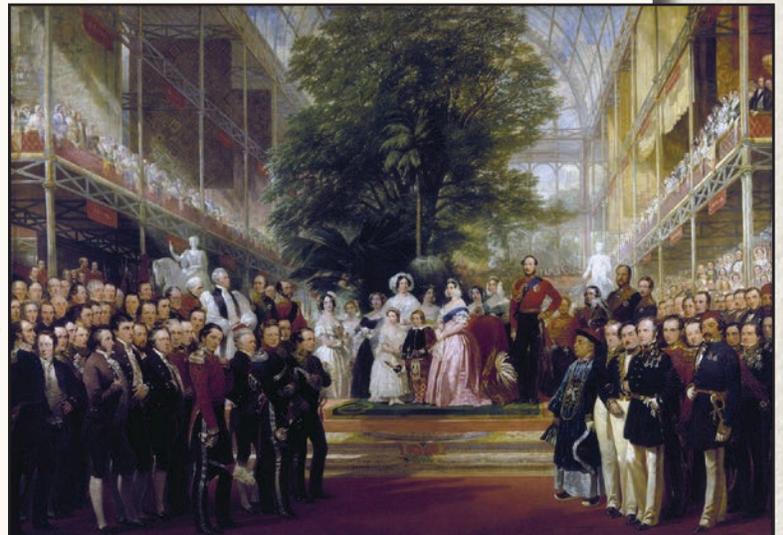
Ted: Just what Albert wanted! The building would show that the British Empire was technologically advanced, creative, modern, and awe-inspiring. Perfect!

Mona: Building a glass building was obviously complicated, but it was finished in less than a year. The finished Crystal Palace was breathtaking!!

Ted: Now it's time to invite the entire world and show off the many wonders of the modern age!

Mona: The Great Exhibition started on May 1, 1851. Half of the exhibitions were British, and half were from the rest of the world.

Ted: The Great Exhibition showed off every wonder the Victorians could imagine. There were machines of every variety! There was a giant telescope, a printing press that could produce 5,000 newspapers in just one hour, a machine that could print and fold enve-

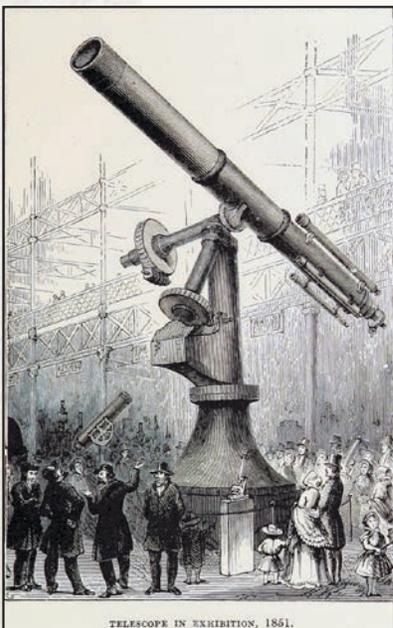


Painting of Queen Victoria, Prince Albert, and their children opening the Great Exhibition. Because the Crystal Palace was temporary, it was built around the trees of Hyde Park.

velopes, a hydraulic press that could lift over 1,000 tons, every sort of steam engine imaginable, and even a barometer operated by leeches! Weird, but cool!

Mona: There was a loom that could automatically weave complex designs, and a steam hammer so powerful and precise that it could forge steamship parts OR neatly crack an egg.

Ted: There was also an adding machine, a cigarette folding machine, an automatic reaping machine, and a voting machine that automatically counted votes. These machines aren't just cool, they're also labor-saving! Just imagine a farmer being able to harvest an entire field by themself in a single day with a reaping machine. It used to take dozens of people to do that!



TELESCOPE IN EXHIBITION, 1851.



Illustrations of various British displays at the Great Exhibition.
 Top left: The Agricultural Court showing farm equipment by Garrett & Son Leiston Works. Middle: Stationary display by Thomas de la Rue and Company showing off the variety of colors and printing technology available.
 Right: Sheffield Hardware displaying different fireplaces.
 Bottom left: A view of the British Department from the second story.
 Courtesy of the Victoria and Albert Museum.



Mona: These types of machines will change what people's jobs look like. Some jobs will be completely replaced by machines. Other jobs will need significantly fewer people to complete them. Machines will also create entirely new jobs.

Someone needs to know how to fix and maintain all these new machines, after all.

Ted: In my opinion, the most world-changing new technology at the Exhibition was Samuel Colt's 1851 Navy Revolver. This is a big moment in the history of guns! The Colt 1851 is a multi-shot pistol.

Mona: Why is that so important?

Ted: It means you can fire multiple times without reloading! This isn't the first multi-shot gun, but it is the one that really polished the process and made it practical. It changes guns from being your *first* line of defense to your *only* line of defense. And THAT is going to change history. After the Exhibition, there was a massive demand for the Colt revolver.

Mona: The Great Exhibition made newspaper headlines around the world. Six million people attended the event. Rich people from across the world traveled to the event, and millions of ordinary British people also attended.

Ted: That is A LOT of people! Hosting events that big is very modern. I do have some uncomfortable questions, though. Like, where is everyone going to go to the bathroom?

Mona: Fortunately, the organizers of the Exhibition were prepared for that. One of the extremely-popular new technologies at the



Illustration of the Foreign Department from the second story.
 Courtesy of the Victoria and Albert Museum.



Illustrations of various foreign displays at the Great Exhibition.

Left: The displays from Persia, Egypt, Turkey, and Greece.

Middle: The display from Tunis, featuring a variety of textiles in the foreground, with Switzerland visible in the background.

Top right: The Canada display, featuring furs, sleds, and a First Nation canoe.

Bottom right: The India display, featuring a variety of textiles in the background, a taxidermy elephant adorned in a golden howdah, and a variety of Indian riches.

Courtesy of the Victoria and Albert Museum.



Exhibition was the first modern public toilets. Over 800,000 people lined up and paid a penny to try out this fascinating new amenity.

Ted: Huh, it's weird to think about toilets being a fancy new machine.

Mona: The Great Exhibition wasn't all machines. It had a lot of cultural and artistic displays as well! Many countries displayed sculptures, paintings, furniture, furs, and jewelry. There was intense competition between exhibits displaying various types of carpets, ribbons, and fabrics to prove who had the world's best weaving and design techniques.

Ted: But the true stars of the show were the diamonds from India: The Koh-i-Noor and the Daria-i-Noor!

Mona: The Koh-i-Noor diamond was acquired by Queen Victoria a year before the Exhibition. It was the largest known diamond in the world!

Ted: The Koh-i-Noor had not yet been cut, so while it was large, it didn't have the glittering magnificence many in the crowds were hoping for.

Mona: Meanwhile, the Daria-i-Noor is a very large, very rare pink diamond. It was once part of the Peacock Throne of Mughal Emperor Shah Jahan. The British acquired the diamond in 1849, and it was the showstopper of the entire Great Exhibition.

Ted: The Daria-i-Noor was exactly what the crowds were hoping to see!

Mona: These diamonds helped reinforce the view of the British Empire the organizers wanted. Both diamonds were from India, but both now belonged to Queen Victoria.

Ted: That is a big flex for an empire.

Mona: The Exhibition was meant to shape how the British public viewed their own empire. One of the Exhibition's goals was to prove that Great Britain was better than other parts of the world.



*Illustrations of the Grand Entrance from the second story.
Courtesy of the Victoria and Albert Museum.*

Ted: I mean, Britain trying to prove they're better than France is just a staple of European history.

Mona: Not just that. The Exhibition tried to prove that Britain colonizing a quarter of the world was a good thing for everyone involved. Artistic and cultural objects—and even people—from other parts of the world were displayed as strange, “uncivilized” oddities. Britain then got to be the hero that brought “civilization” to the world.

Ted: See, this is the pageantry of empire! We might see colonization as bad today, but from the Victorian perspective, all of this looked good. The British public saw all the many impressive accomplishments of the Empire and the Industrial Era. They saw how much good these machines could bring to the world. They saw the wonder and magnificence of the Empire. And they loved it!

Mona: From the British perspective, their Empire made the world more modern, more advanced—more civilized. Showing that other parts of the world were “uncivilized” was essential to maintaining that idea.

Ted: The British public believed they needed to keep the Empire rolling forward for the good of everyone in the world. Individual citizens were awe-inspired and saw it as their duty to serve Queen and Country.

Mona: This belief that Great Britain, other parts of Europe, and the United States were “civilized” and other parts of the world weren't will be a defining feature of modern history. Colonization will continue to spread. Grand displays like the Great Exhibition convinced ordinary people that colonization was a good thing and helped the world.

Ted: Pageantry. If you want to get people to support your power as an empire, you have to convince them your empire is awesome. Reality has nothing to do with it. It's all about appearances.

Mona: The Great Exhibition isn't the last time an event like this is held. It was such a success that in 1855, France hosted another worldwide fair. These events came to be called World's Fairs and are the location of many important historical events. Great Britain, France, the United States, Austria-Hungary, Belgium, and more will host world's fairs to show off their power and prestige. We'll be coming back to World's Fairs later!

Ted: In the meantime, let's go see some of the reality behind all this pageantry.



Culture Corner

Computing

Arthur: Welcome back to Arthur and Lily's Culture Corner.

Lily: Did you catch Ted's oh-so-casual mention of an adding machine at the Great Exhibition? That's actually a huge deal we need to talk about! That machine was the arithmometer created by French inventor Charles Xavier Thomas. It was a mechanical calculator that could do basic arithmetic functions, including addition, subtraction, multiplication, and division. Following the Great Exhibition, it became the first calculator to be mass-produced and available for sale! It was used worldwide for decades.

Arthur: If we're talking about a machine doing math, does that mean we're already to—

Lily: Computers! I bet you didn't think we'd get to computers so soon! While the arithmometer became popular in the mid-1800s, other major innovations were happening in the computing realm that would lay the foundation for the creation of modern computers in the 1930s and 1940s. The first computer was created by Charles Babbage, and the first computer program was created by Ada Lovelace.

Arthur: Lovelace was the daughter of Lord Byron, the famous Romantic poet! Ada's mother, Lady Anna Byron, had a very strained relationship with Lord Byron. She did not want Ada to grow up to be anything like her father, so Anna pushed Ada to study logic and mathematics to counter any Romantic tendencies.

Lily: Babbage and Lovelace met in 1833. Babbage showed Ada his difference engine, which thoroughly captured Ada's imagination! They developed a close friendship over their mutual love of math.

Arthur: The difference engine was Babbage's first attempt at an automated calculator. It was a large machine designed to compute complex calculations and produce tables of numbers required for scientific, engineering, and navigational tasks.



Lily: The technology of the day wasn't good enough to match Babbage's vision. A working model was produced, but a full-scale machine proved impossible. Around 1837, Babbage moved on to planning a general-purpose calculator called an analytical engine.

Arthur: It's considered the world's first computer!

*Left, photograph of Charles Babbage in 1860.
Right, portrait of Ada Lovelace from around 1840,
possibly by Alfred Edward Chalon.*

Chapter 2:

Napoleon III Invades Crimea

Ted: Pageantry is a powerful weapon, but you know what's also a powerful weapon?

Mona: What?

Ted: Weapons! Warfare is changing, and empires are all about using force to push smaller nations around. The Crimean War started for pretty stupid reasons, but it ends up being really important. It's the first chance the empires of Europe had to test out the modern weapons and warfare we'll later see them use to devastating effect as they drastically increase their reach around the world.

Mona: If we're talking about the Crimean War, let's start in the Ottoman Empire. Like many other empires, the Ottoman Empire was facing the difficult problem of transitioning from a medieval empire into a modern one. The Ottoman Empire was diverse and included many different religious and ethnic groups, yet despite this diversity, the empire was officially Muslim. Only Muslims had full rights and participation. In the 1800s, this became a growing source of conflict as nationalist ideas reached the Ottoman Empire. Numerous ethnic groups began protesting for the right to be independent. Greece won its independence from the Ottomans in 1830. Egypt became semi-independent in 1831. In the face of these mounting problems, the Ottomans began an era of reform called the Tanzimat Reforms in 1839.

Ted: This is going to be a theme of modern history. Older empires starting a period of intense reform to try to keep up with the modern, industrial world. How did it go for the Ottomans?

Mona: Fairly well. Many Ottoman officials had been educated in France, so these reforms look pretty similar to French reforms during the Revolutionary and Napoleonic Eras. They introduced a new legal code based on the Napoleonic Code, abolished medieval guilds, created a modern banking system, overhauled the education system, modernized the army, decriminalized homosexuality, expanded women's rights, and so on.



Painting of Abdulmejid I, Sultan of the Ottoman Empire by Konstantin Cretius in 1846.



Painting of Emperor Nicholas I of Russia by Georg von Bothmann in the 1850s.

Ted: All good progress!

Mona: One of the more challenging aspects of the reforms was the treatment of non-Muslims. The empire was moving toward treating all people within the empire as citizens with equal rights instead of subjects with unequal obligations. But after centuries of different religious groups being treated differently (socially and legally) that was a hard transition. Traditionally, non-Muslims had to pay an extra tax and weren't given full equality, but they were also given special religious privileges and exemptions from certain laws.

Ted: So there were both pros and cons to being a non-Muslim in the Ottoman Empire.

Mona: Yes, that's why abolishing that system caused pushback from both Muslims and non-Muslims alike. Religious and ethnic conflicts will continue to grow and lead to disastrous consequences later.

Ted: Religion was also supposedly the cause of today's conflict: the Crimean War! In reality, religion was just the cover story. The real conflict was spheres of influence. See, the Ottoman Empire was in Russia's sphere of influence. The Russian Emperor Nicholas I was the official protector of all the Christians within the Ottoman Empire.

Mona: That means Nicholas also controlled specific holy sites in Jerusalem and Bethlehem.

Ted: Precisely! Technically, the Crusades were fought over those sites, so kind of a huge deal. The problems started when Napoleon III stepped onto the scene.

Mona: The nephew of Napoleon Bonaparte who crowned himself Emperor of France?

Ted: That's the one! He wanted all the swagger of his uncle. What better way to do that than controlling the Holy Lands? He convinced Sultan Abdulmejid I to name HIM the protector of the Ottoman Christians. Russia was super offended by that. The French sent ships to the Black Sea to show off how tough they were. Then Russia invaded the Ottoman Empire in 1853—and BOOM, war. Britain got dragged in because of alliances and their perpetual fear of Russia. The Austrians joined too, despite Russia helping them quash the 1848 revolution a few years before. Piedmont-Sardinia jumped in too, because why not?

Mona: They're a powerful Italian kingdom we'll be seeing more of soon.

Ted: The Ottoman-French-British-Sardinian-Austrian side was called the Allies. Originally, the Ottomans were doing all the fighting, and they were winning.

Mona: When things started to look a bit dicey, the rest of the allies sent their troops in to ensure an Ottoman victory.



French illustration of the leading allies Sultan Abdulmejid, Queen Victoria, and Emperor Napoleon III.

Painting by French painter Henry-Frédéric-Adolphe Yvon showing the Battle of Malakoff Gorge between the French-British and Russians on September 8, 1855. The weaponry shown in the painting illustrates the mixture of medieval and modern weapons used in the Crimean War. The painting is currently housed in the collection at the Chateau de Versailles.



Ted: But then the Ottomans won mostly on their own. Those newly arrived troops didn't have much to do. Rather than waste all that time and effort, the British and French decided, since they were already there, they might as well follow the Russians into the Crimean Peninsula and destroy Russia's main naval port.

It would be a great way to win more power and prestige for their empires.

Mona: So what makes the Crimean War the first modern war?

Ted: The Crimean War is the first war to rely on modern infrastructure like railroads and telegraphs. It was the first time many modern weapons were used in battle. It's the first war to be reported in global newspapers in real-time. Finally, the war will overhaul medical care and establish modern nursing. The successes and failures of the Crimean War will dictate the future of warfare.

Mona: Wow, that's a lot for a war that sounds like it could have been easily avoided! Let's talk about each of those things. How does modern infrastructure change war?

Ted: The Allies used telegraphs for communication and railroads to transport troops and supplies. Telegraphs allowed for fast, close communication between generals in different locations, supply convoys, and even politicians back in Paris and London. That ability to communicate changed how the war unfolded. The Allies were far more efficient because they were well-informed.

Mona: What about the Russians?

Ted: Not so much. The Russians were technologically behind the British and French. They built more telegraph lines during the war but couldn't keep up. That will lead to major changes for Russia after the war. The Russians saw what a huge disadvantage their outdated technology was and knew they needed to modernize. The same story happened with railroads. The Allies were supplied by train, which was faster and more reliable than the older methods.

Mona: How does weaponry change?

Ted: Naval warfare is now firmly in the modern era! Wooden ships and cannonballs are a thing of the past. Now ships are made of metal, and they're firing naval shells. A cannonball is just a big heavy ball. A naval shell explodes.

Mona: Wooden ships wouldn't stand a chance against naval shells, so now every country in the world will need to invest in building modern navies to keep up.



Ted: Precisely! Next, we need to talk about guns! Colt's 1851 Navy Revolver was all the rage among officers. The multi-shot feature was the difference between life and death in many situations. But the revolver was not widely available. Most soldiers were still fighting with single-shot muskets, but some key inventions still greatly increased the usefulness of those guns in battle. First off, rifling! Rifling is the process of adding grooves to the inside of a gun's barrel. The grooves spin the bullet! Adding a bit of spin allowed bullets to fly much farther and much more accurately!

Mona: Being able to accurately aim your gun is a big deal.

Ted: Yes! Then, French inventor Claude-Étienne Minié invented a new type of bullet that was faster, easier to load, and much more deadly! Minié bullets were so deadly a single shot could rip through two or three people. These rifles were nicknamed the "Destroying Angel." Loading guns was also sped up with the invention of paper cartridges. Guns were still slow and cumbersome, but the paper cartridges greatly sped up the reloading process. With the right strategy, guns could become the primary weapon of war. The increased usefulness of guns meant the Crimean War was the first war to experiment with trench warfare.

Mona: What's that?

Ted: In trench warfare, trenches are dug for soldiers to stand in while they fire their guns and to take shelter in to avoid enemy fire. Trenches were still an experiment in Crimea, but it was the direction modern war was heading.

Mona: Speaking of experiments, this is the first war where they proposed using chemical weapons. Chemical weapons are when dangerous chemicals are released into the air that can harm or kill people. It was just an idea in the Crimean War. The scientist the British government asked to develop them, Micheal Faraday, staunchly refused. But again, it's the direction war was headed in.

Ted: But don't think the Crimean War was entirely modern! It still had a lot of traditional elements, like cavalry charges, swords, and bayonets. The Crimean War was an awkward—and often unsuccessful—mixture of medieval and modern.

Mona: Those failures of the Crimean War were reported to the public as they happened thanks to William Howard Russell, the first-ever war correspondent. Russell was an Irish journalist who worked for *The Times*, a London-based newspaper. During the war, Russell

lived in Crimea right alongside the British soldiers. He wrote compelling articles keeping the British public up-to-date. He used telegraphs to send his stories back to London to be published in real time as the war unfolded. Never before had the public received so much information on a war as it happened. Russell's regular articles made the British public emotionally invested in the war in a whole new way.



"The Valley of the Shadow of Death" photograph showing a cannonball strewn road in Crimea taken by Roger Fenton for the art dealer Agnew and Sons. This photograph became the first iconic war photograph. It shows an area nicknamed "the valley of death" by British soldiers because the area was under heavy shelling by the Russians. Fenton expanded the nickname when he titled his photograph to create an allusion to Psalms 23.

Ted: This forever changed the nature of war. War was no longer something fought in a far-off land. No matter where in the world a war might happen, ordinary people were aware of its daily developments. That means politicians had to answer to the public's swinging opinions when making war decisions.

Mona: The British government experienced massive public outcry when Russell exposed the terrible conditions inside British military hospitals in Crimea. Many people blamed the poor conditions on the fact there were no nurses.

Ted: No nurses? Why not?

Mona: The Victorians had increasingly strict views on gender roles. Despite centuries of women providing medical support during war, no women were sent to Crimea because it "wasn't a woman's place." The public outcry pushed the British government to assemble a corps of nurses to send to Crimea. The corps was led by Florence Nightingale.

Ted: She invents modern nursing!

Mona: That's what Florence is most remembered for, but she did a lot more than that. Florence Nightingale was born to a wealthy British family and given education opportunities far beyond what other women of her day received. She was fluent in multiple languages and exceptionally gifted in math. She wanted to improve the world around her, so despite her family's objections, she chose to become a nurse. The opportunity to serve in the Crimean War was just what she'd been waiting for. When she arrived in Crimea, Florence was appalled by the hospital conditions. It was clear the hospitals needed to change, but what exactly needed to change was unclear. Florence started collecting data.

Ted: What kind of data?

Mona: The exact number and causes of death, as well as living conditions and other factors that could influence the death rate. As Florence's data piled up, she saw a pattern and crunched the numbers to prove it. Florence proved soldiers were more likely to die in the hospital than on the battlefield. She also proved that the cause of death was most likely to be disease, not injury.



Ted: So the hospitals were a disease-ridden cesspool killing injured soldiers?

Left, photograph of Florence Nightingale around 1858. Below, statistical chart included in Florence Nightingale's report Notes on Matters Affecting the Health, Efficiency, and Hospital Administration of the British Army which was sent to Queen Victoria. The blue sections represent deaths from preventable diseases, the red represents deaths from wounds, and black represents all other deaths.

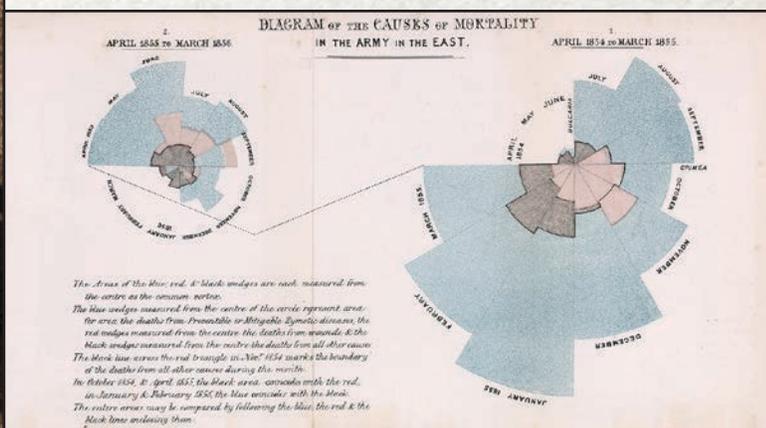




Illustration of Nightingale in the Illustrated London News on February 24, 1855 showing her visiting the bedside of ill men during the night. These type of images of the “Lady with the Lamp” won the adoration of the British public.

Mona: Exactly! Florence started advocating for reforms to change that. She believed that altering the environment of the hospital was the single most important change that could save lives. She wanted hospitals to be clean, well-ventilated, and full of natural light. She advocated for better personal hygiene, regularly changing bandages, and always providing clean clothing and bedding. She also believed

good nutrition was essential to health and recovery. She taught her nurses that they were responsible for caring for their patient’s emotional needs as well as their physical needs.

Ted: Seems like a good set of common sense reforms.

Mona: Common sense today, but not at the time. Florence Nightingale was revolutionary, but her reforms aren’t what made her famous. William Howard Russell’s sensational stories about her sweet bedside manner are what won her unprecedented fame in the British public eye. She was called the “Lady with the Lamp” because of the kind way she cared for patients at night. She was also nicknamed the “Angel of Crimea.” She became a national hero in Great Britain. Never before had a woman received this kind of praise and fame for doing a professional job. When Florence returned from the war, she continued to advocate for hospital reforms. She also helped pioneer new methods to visually represent statistical data to make it easier to understand.

Ted: Like an infographic?

Mona: Yes, she made charts and graphs that made information easy to see! Florence established a nursing school and created the profession of modern nursing. Her philosophy of nursing still guides nurses today. She also spent much of her life advocating for women’s rights, specifically a woman’s right to hold a job and be paid fairly.

Ted: Florence wasn’t the only woman making waves during the Crimean War. Mary Seacole also traveled to the Crimean War and pioneered modern nursing while running a successful business.

Mona: Mary was born in Jamaica to a Black mother and a Scottish father. Mary’s mother owned a hotel in Jamaica. While helping her mother run the hotel, Mary had many opportunities to learn traditional West African medicine to heal sick and ailing customers. Mary volunteered to be part of Florence’s corps of nurses but was rejected, likely because of her race. But Mary was undeterred. She convinced a wealthy friend to start a joint business venture with her. The two set off for Crimea, ready to start a hotel for British soldiers.

Ted: It wasn’t what we think of as a hotel today. It was more of a restaurant or club.

Mona: Mary showed up in Crimea and established the British Hotel next to the military base. The British Hotel became a home away from home for British soldiers. Mary supplied them with the comfort foods they missed from home and the luxury goods they couldn’t get from the military. It was a very successful business.

Ted: Mary also employed her medical knowledge to help the soldiers. She even followed the soldiers into battle, giving medical care after battle and compassion during a soldier’s



Photograph of Mary Seacole around around 1850.

dying moments. Like Florence, Mary understood the importance of cleanliness. She kept her hotel clean and made sure to teach the importance of cleanliness to her visitors. When the war was done and the soldiers returned home, Mary's business collapsed and she returned to London bankrupt.

Mona: When some of the men she served found out, they ran a fundraiser on her behalf in London. Tens of thousands of people showed up to a multi-day event to honor the accomplishments of Mary Seacole. A few years later, she published an autobiography detailing the many adventures of her life. Unfortunately, unlike Florence Nightingale, Mary's accomplishments were soon erased and forgotten after her death. Yet both women pioneered the profession of nursing, championed cleanliness, and provided emotional support to dying and suffering people.

Ted: Medical innovations weren't limited to the British side of the war. Nikolay Ivanovich Pirogov was a Russian doctor who significantly improved emergency medicine. He was the first doctor to perform field surgery, which means performing surgery right at the battle site. Field surgery provides much faster care and thus decreases the number of soldiers who die. He was the first to use anesthesia to make his patients lose consciousness for surgery. He developed better methods for amputation and invented a plaster cast to set broken bones. All around, medicine was becoming modern!

Mona: The Crimean War ended in 1856. That same year, Sultan Abdulmejid issued the Imperial Reform Edict, which created equality for all people in the Ottoman Empire, regardless of religion. Many saw the edict as a sign the British and French were controlling the Sultan. After the war, religious tensions, nationalism, and a lack of trust in the Ottoman Sultan continued to grow.

Ted: Those problems are ticking time bombs. When we get to World War I, every single one will come up again.

Mona: Militaries around the world will change because of this war. It showed the importance of modernization in modern warfare.

Ted: It also led to changes in the British military. After the war ended, British public opinion became anti-war because of all the very stupid mistakes that were made. The public saw the need for a professional military rather than one run by the nobility. Many people began advocating for change. It will take decades for change to happen, but this is the beginning.

Mona: Since we've seen so many medical advancements today, let's go talk to Lily about all the changes coming to modern science.

Want to know more?

Try researching the following topics:

- Crystal Palace relocation
- Albertopolis
- Death of Prince Albert, 1861
- Mary Seacole's autobiography *Wonderful adventures of Mrs. Seacole in many lands*
- Charge of the Light Brigade
- Punch Magazine

Section 2: The Sun Never Sets on the British Empire

♦ ♦ ♦ ♦ ♦

Chapter 3: Darwin Classifies Finches



Lily: Hey, guys! It's been way too long since I've been here to talk to you about science! You can't understand the modern world without science!

Mona: You're right. Scientific breakthroughs will shape how people view themselves and the world around them. Those new ideas will change how people behave.

Ted: Sounds cool. What's one big breakthrough that changes how people see the world?

Lily: Charles Darwin's theory of evolution!

Ted: What is that, and how does it change society?

Mona: It changed society because it offered a new way to understand the origin of life. That changed how people thought about the past and how society worked. It let them speculate in new ways about the future.

Lily: Hold on! To understand Darwin, we need to back up and talk about what's been going on with geologists and naturalists over the last century or two.

Mona: Naturalists are people who study living things. Today we would call them biologists.

Ted: So geologists were studying the history of rocks and the planet, and naturalists were studying the history of living things?

Lily: Yep. Geologists and naturalists were asking similar questions about where life and the planet came from. In the 1730s, Carl Linnaeus introduced the modern method of classifying animals. Linnaeus believed animals were created individually by God, but he organized them into related groups—like families. Ever since, scientists had been coming up with a host of theories to explain why animals seemed to have come from the same source.

Mona: It was almost like they had a common ancestor.

Lily: Meanwhile, geologists were discovering the earth had changed shape significantly over the years. Volcanoes, earthquakes, floods, erosion, and glaciers have all left their marks on the world. As geologists dug into the earth, they found layers and layers of fossils.

Mona: Fossils being found in layers was a big deal.

Lily: Those layers meant geologists could track the changes that have happened to an area over thousands—millions—of years.

Ted: They proved the earth is millions of years old?

Mona: Yes, they proved the earth is extremely old and constantly changing.

Lily: But the big question was how? Charles Lyell put forward a new theory in the early 1830s called uniformitarianism. He argued that the processes that shape the earth today are the same processes that shaped it millions of years ago. Natural processes do not change. They are uniform.

Ted: That's why he used the annoyingly long name 'uniformitarianism.'

Mona: Precisely. If erosion is shaping coastlines today, then erosion shaped coastlines millions of years ago, not aliens or some other bizarre, unheard-of process.

Ted: Aliens would be cool.

Mona: No, Ted.

Ted: If they were proving this with fossils, does that mean living things were changing too?

Lily: Yes! And that's where things got controversial! Scientists accepted that things change a little bit over time, but big changes? That seemed unlikely.

Mona: It also sounded blasphemous. Most Europeans were Christian and believed God created the earth perfectly, so it didn't need to change.

Lily: French scientist Georges Cuvier was unconvinced. In fact, he was quite sure life on earth had changed A LOT over the years. Cuvier uncovered the fossils of woolly mammoths in France. After examining them, he proved that woolly mammoths were distinctly different from living elephants. Since woolly mammoths obviously don't exist anymore (kind of hard to hide a woolly mammoth!), where did they go? Cuvier proposed they had all died off in a cataclysmic event.

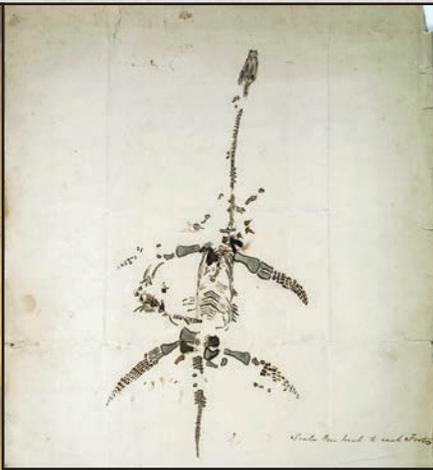
Ted: Like an asteroid crashing to the earth?!

Mona: Something like that. Cuvier introduced his theory in the 1790s. He said many species had gone extinct throughout history because of cataclysms.

Lily: Simply saying a species had gone extinct was radical. Arguing that a cataclysmic event could cause extinction was too much for most scientists! That theory was shelved for a long time.

Mona: The question of extinction was an intriguing one. Were there animals that used to live on earth that no longer exist?





Far left, Mary Anning and her dog Tray at Golden Cap outcrop in Dorset, England where Mary found many of her important fossils. Currently located in the Natural History Museum in London. Left, a drawing by Mary Anning from December 26, 1823 that was part of her announcement of discovering the plesiosaurus.

Lily: The fossil hunt was on! Mary Anning was a prolific fossil hunter in England in the early to mid-1800s. She uncovered many previously unknown species like the ichthyosaur and plesiosaurus. Unlike woolly mammoths, which are similar to living elephants, these creatures were WEIRD! These animals absolutely did not exist anymore, and they couldn't be explained away as a minor variation of a known animal. They must have gone extinct!

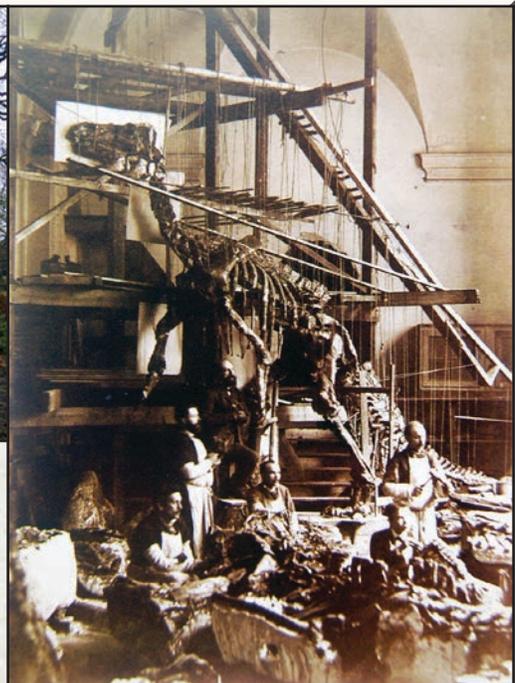
Mona: In 1822, Mary Ann Mantell discovered the Iguanodon. In 1824, William Buckland published his research on the megalosaurus. These weird discoveries just kept coming! In 1841, Richard Owen coined the term “dinosaur” to describe many of these strange reptilian fossils that were being discovered.

Ted: Dinosaurs!!!! We've finally discovered dinosaurs!

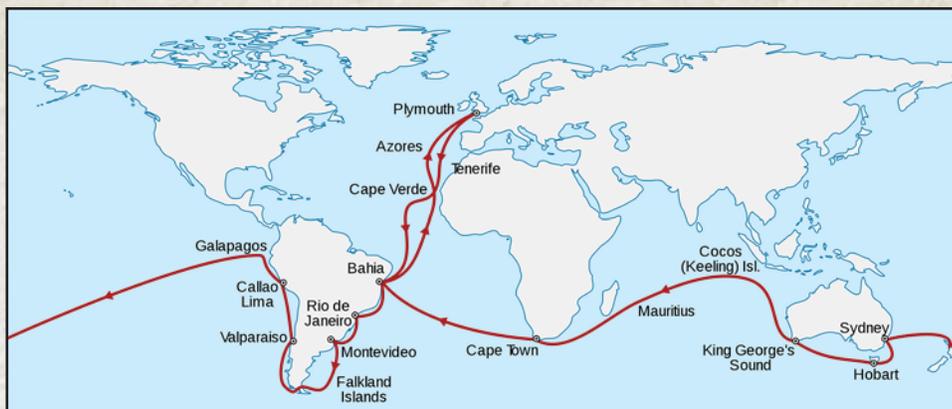
Lily: These animals completely upended the idea that life on earth has always looked the same.

Ted: So you're saying that the earth itself and the animals living on it are constantly changing, AND different animals can be arranged into “families,” so it seems like they came from the same place?

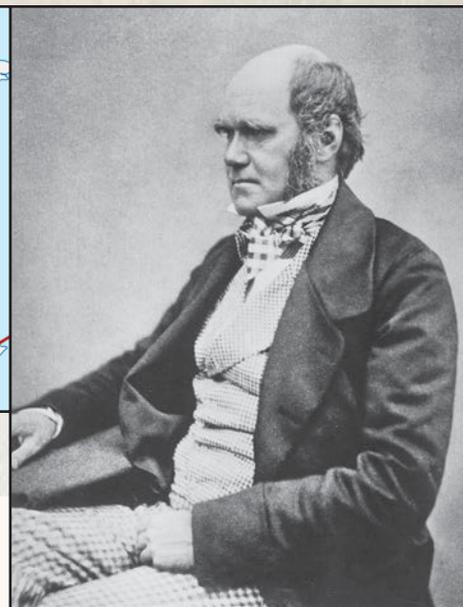
Lily: Exactly! Those were the topics on scientists' minds when Charles Darwin entered the scene. Charles Darwin's grandfather Erasmus Darwin was an early supporter of the theory that all animals shared a common ancestor. Charles Darwin was a scientist newly



Right, a photograph of museum workmen in Belgium in 1882 mounting the first *Iguanodon bernissartensis* skeleton. The kangaroo-style pose of the skeleton is no longer considered accurate. Above, an 1854 sculpture by Benjamin Waterhouse Hawkins of a *Megalosaurus* in Crystal Palace Park, London. After the Crystal Palace was moved from Hyde Park to a permanent location in Bromley, Sir Richard Owen commissioned a series of dinosaur sculptures to accompany the Crystal Palace and show off the height of scientific knowledge. All the dinosaurs are considered inaccurate by modern standards, but they illustrate the enthusiasm Victorians had for new scientific knowledge.



Above, map showing Darwin's path around the globe on board the HMS Beagle from 1831–1836. Right, photograph of Charles Darwin in 1854.



graduated from Cambridge University when he was given the opportunity to be the naturalist on board the HMS *Beagle* in 1831.

Mona: The *Beagle* was sent on a scientific expedition to chart the coast of South America. Its purpose was very similar to Captain Cook's journey to the Pacific.

Lily: Darwin's job was to collect plant, animal, and fossil specimens along the way. He also kept a journal to carefully track his various scientific observations.

Mona: Early in the journey, Darwin found plentiful seashell fossils at the top of cliffs in Cape Verde, proving either the sea level or the cliff had changed position. Darwin arrived in Chile shortly after an earthquake, so he was able to observe the very recent changes caused by the earth's movement. The evidence to support a constant, slow-changing earth was piling up.

Lily: But Darwin's most significant discoveries came from his observations of animals. In South America, he found fossils of what appeared to be giant versions of current South American animals.

Mona: For example, he discovered the megatherium, which is a type of sloth over 20 ft long and could weigh over 4 tons.



Ted: What kind of nightmare is that?!

Lily: There was clearly a relationship between the giant sloth and the modern sloth, but they were also obviously different creatures. The *Beagle* stopped in the Galapagos Islands, which is an isolated island group off the coast of South America. In the Galapagos Islands, Darwin encountered a whole host of unique animals. He found that the animals on one Galapagos Island were different, yet similar to, those on another. Some of the animals he encountered were similar to animals he'd seen in Chile, yet still notably different. Others were incredibly unique.

Mona: When the *Beagle* reached Australia, Darwin was baffled by marsupials because they were so different from other animals he'd studied!

Megatherium americanum skeleton located in the Natural History Museum in London. This giant sloth was one of the pieces of information Darwin used to formulate the theory of evolution.





Four of Darwin's finches showing their different beak shapes that have adapted to different environments. Clockwise the finches are Large Ground Finch (*Geospiza magnirostris*), Medium Ground Finch (*Geospiza fortis*), Grey warbler-finch (*Certhidea fusca*), and Small tree finch (*Camarhynchus parvulus*).

Lily: The voyage on the *Beagle* took five years. Darwin sent many letters back to England during the voyage, and news of his discoveries spread. By the time he returned home in 1836, he was a celebrity.

Mona: When Darwin returned home, he set to work with many other scientists to correctly identify and catalog all the specimens he'd collected. Darwin had made some mistakes in his early observations. What he originally thought

were several different species of birds in the Galapagos Islands all turned out to be types of finches, each with a differently shaped beak!

Lily: With a growing pile of evidence, Darwin began wrestling out the specifics of his theory of the origin and nature of life. It took years for Darwin to fit all the pieces together. When he was close to finishing his theory, he was sent a paper to review by Alfred Russell Wallace. Darwin was flabbergasted to see that Wallace had come up with basically the same theory he had. Both men's theories were introduced to the scientific community on the same day. Shortly afterward, Darwin published *On The Origin of the Species* in 1859. It was the beginning of the theory of evolution. This theory shook up the world!

Ted: What are the basics of Darwin's theory?

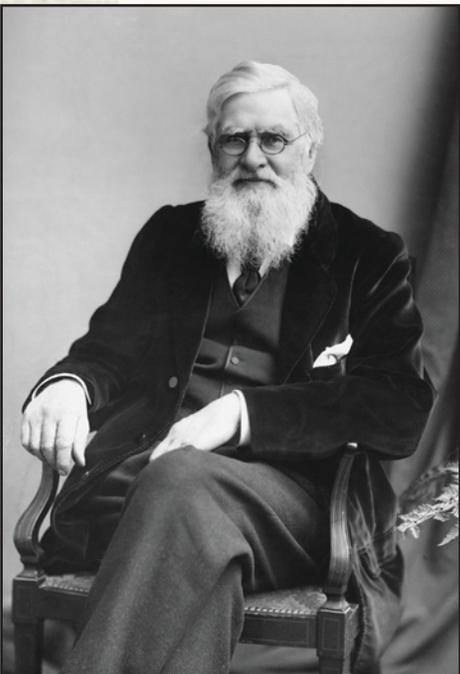
Lily: The center of Darwin's theory was natural selection. This theory built off the work of economist Thomas Malthus. Malthus argued that populations will always increase in size until there is too little food to support the population. Members of the population will then have to compete for the available food. The weak will die. Malthus was, unfortunately, talking about humans, but Darwin applied this idea to animals. Animals have to compete with each other to survive.

Ted: What makes one animal more likely to survive than another?

Lily: Animals are not identical. There are small variations in the physical capabilities and behavior of each animal. Those slight variations will make some animals better at surviving than others. The animals that are better at surviving are more likely to have children, so their survival traits will be passed on to the next generation. This is called survival of the fittest. Over a long period of time, a whole new species of animal can emerge as a series of new traits get passed on.

Mona: Over a long enough period of time, an entire planet of animals can emerge!

Lily: As the earth's environment continues to change, some species will go extinct, and new species will evolve to take their place. The wide variety of animals on this planet is explained by the many different ways animals adapt to survive in particular environments.



Photograph of Alfred Russel Wallace first published in *Borderland Magazine*, April 1896.

Mona: Darwin explained the origin of plant and animal life on earth through evolution.

Ted: How do traits get passed from parent to child? Why are some traits passed and not others?

Lily: Darwin didn't actually have an answer to those questions. He had a hypothesis, but it turned out to be incorrect.

Mona: The correct answer came in 1866 when the Austrian scientist Gregor Mendel published his research about peas.

Ted: Peas?

Mona: Yep, peas! Mendel conducted an experiment where he tracked the characteristics of pea plants over several generations. He noted how the plant height, seed shape, flower position, pea color, and so on changed with each generation. After careful study, he found he could correctly predict the characteristics of the next generation.

Ted: How?

Lily: He discovered that each parent plant contributed one factor or "gene" to the child plant. Some genes were dominant. They would always be visible in the child plant. Some genes were recessive. Recessive genes would only be seen if both parents carried a recessive gene.

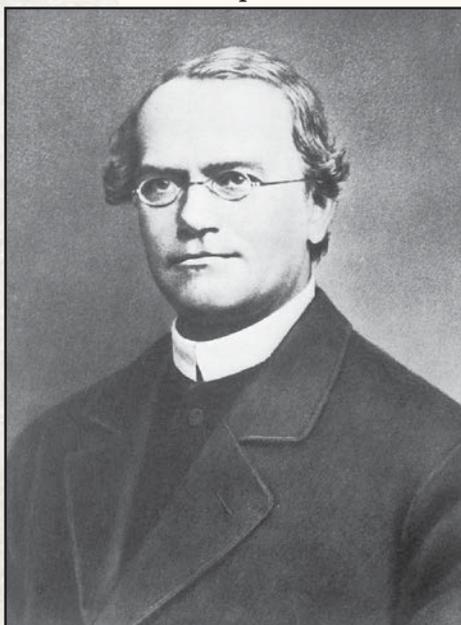
Mona: This is the birth of genetics!

Lily: Genetics was the final piece of the puzzle to make the theory of evolution work.

Ted: How do humans fit into this?

Lily: Ah, humans. Discussing the origin of humans intersects with religion. Darwin didn't directly address the origin of humans in *On the Origin of the Species*. However, he certainly hinted that humans were part of the evolutionary process and had evolved from other animals. In 1871, he published another book called *The Descent of Man*, where he built off his friend Thomas Huxley's research to show that humans were animals and descended from apes.

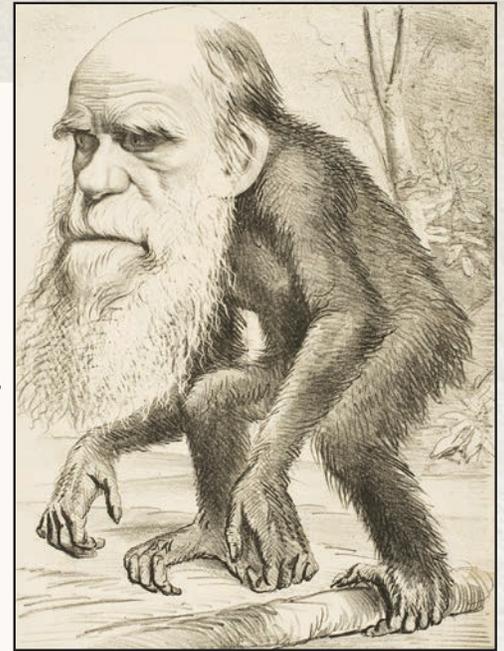
Mona: That close intersection with religion is why Darwin's theories were so controversial. Some scientists like Charles Lyell saw no conflict between evolution and religion. He simply saw evolution as a tool God could have used.



Left, photograph of Gregor Mendel. Below, three punnett squares demonstrating the color pea plants are most likely to be based on the parent plants' genetics. Green is the dominant color. If the child plant inherits just one green gene, the plant will appear green.



Caricature published in The Hornet March 22, 1871 mocking Charles Darwin following the publication of The Descent of Man. The image was titled "A Venerable Orang-outang"



Lily: On the other hand, some Christians rejected evolution because it contradicted a literal reading of the Bible. Others rejected religion in favor of evolution. Thomas Huxley was a fierce agnostic who publicly defended evolution from religious critics.

Mona: The rest of the world splintered along those lines over the coming decades. By the early 1900s, fundamentalist religious movements would begin organizing against Darwin's theories. It's a cultural divide that's still defining our society today.

Lily: Darwin's theories speculated about the very nature of life, so people started to apply these theories to daily life.

Ted: How?

Lily: One idea that became popular was social Darwinism. It took Darwin's theory of survival of the fittest and applied it to social class. Why are some people rich and at the top of the social ladder and others aren't? The people at the top are better, so they deserve to be at the top. The people at the bottom didn't have the skills to survive, so they deserved to be at the bottom.

Ted: That's. . . that's not how social class works.

Lily: We know that today, but the theory was really popular in the late 1800s, especially in the United States, where social class was more flexible. Some used social Darwinism to justify not helping the poor because they "deserved" their situation.

Ted: Ew, no, nope, don't like that.

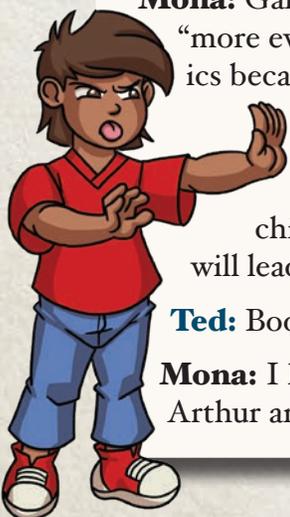
Mona: That's not the worst part. Darwin's half-cousin Sir Francis Galton came up with the theory of eugenics in the 1860s. He argued that human civilization got in the way of natural selection because societies protect people who are "weak." If "weak people" are protected, their "weakness" gets passed onto future generations, and humans will revert "toward mediocrity."

Ted: I don't like those words. No.

Mona: Galton argued that humans could use strategic marriages to intentionally create "more evolved" and "better" children over several generations. His theory of eugenics became popular in Great Britain and spread across Europe, the United States, Australia, and beyond. Some people supported "positive eugenics," where "desirable people" were encouraged to have children. Others supported "negative eugenics," where "undesirable people" were killed or prevented from having children. Throughout modern history, we'll see the impact of eugenics. Eugenics will lead to horrific events for people of color, Jews, disabled people, and more.

Ted: Boo. Now I'm depressed. Why do people have to be like that?

Mona: I know, a lot of bad things happen in this era of history! Let's turn things over to Arthur and Lily to see some of the new awesome, life-saving stuff science is doing!



Culture Corner

Louis Pasteur

Arthur: Welcome back to Arthur and Lily's Culture Corner. I just heard how your last discussion ended, and that's a terrible place to leave our exploration of modern science!

Lily: I agree. So let's talk about Louis Pasteur, whose discoveries will save billions of lives!

Arthur: Originally, Pasteur didn't want to be a scientist. He wanted to be an artist!

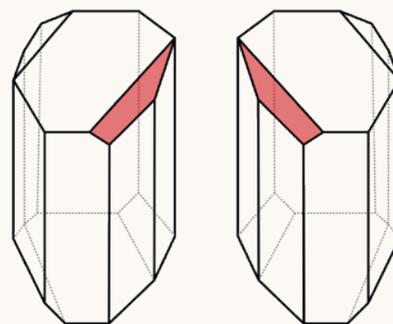
Lily: But art doesn't always pay the bills, so Pasteur became a scientist instead.

Arthur: But his artistic knowledge helped him with his first major breakthrough! In 1819, a French winemaker overheated a batch of wine and accidentally produced paratartaric acid. Tartaric acid is a normal by-product of wine production. It's where cream of tartar comes from, which you might have in your kitchen cabinet at home! But for some reason, paratartaric acid behaved very differently.

Lily: Scientists examined both and concluded they were chemically identical, so they had no idea why this new paratartaric acid didn't act like plain old tartaric acid.

Arthur: But Pasteur had an artist's eye for detail! In 1848, he realized the molecules in paratartaric acid weren't the same as the molecules in tartaric acid. In fact, they were the exact opposite. A perfect mirror image.

Lily: A mirror-image molecule is called a chiral molecule. Chiral molecules can behave in extremely different ways than their opposites. By discovering chiral molecules, Pasteur created an entirely new field in biochemistry! Chirality is one of the foundational concepts behind pharmaceutical drugs today. Some have argued that this discovery was Pasteur's most important discovery, even though Pasteur is far more famous for what he did next.



Model of left and right crystals (levorotatory and dextrorotatory), which Pasteur discovered were mirror images of each other and behave differently.

Arthur: Shortly after this ground-breaking discovery, Pasteur married his wife, Marie.

Lily: Marie was as educated as a woman could be in this era of history. She worked side-by-side with Louis as his lab assistant.

Arthur: The next problem the Pasteurs tackled was sour wine. Sometimes wine would turn sour, but as far as winemakers could tell, the good wine and the sour wine were identical.

Lily: Pasteur discovered that some vats of wine included microorganisms that produced lactic acid. The lactic acid turned the wine sour.

Arthur: By microorganism, you mean bacteria and germs, right?





Far left, photograph of Louis Pasteur. Left, painting of after a photograph of Marie Laurent Pasteur in 1899.

Lily: Yes! Louis discovered he could kill those germs—but not destroy the wine—if he heated it to the right temperature. The process of heating a liquid to kill the germs inside it was named after him: pasteurization. Pasteurization doesn't just work on wine. It works on any liquid. The process was quickly applied to beer and milk as well. Pasteur believed in germ theory. He theorized that if germs

cause disease, then preventing germs from entering our bodies would also prevent disease. Pasteurization proved this theory right. Killing the microorganisms found in wine, beer, and milk significantly reduced the spread of disease.

Arthur: That accomplishment inspired English doctor Joseph Lister to apply the same idea to surgery. Surgery in the 1800s was dangerous. The risk of getting an infection and dying after surgery was very high. Lister theorized that those infections might be caused by germs on surgical tools. He used an antiseptic on his surgical tools to kill any germs before surgery. It worked! His patients were much more likely to live!

Lily: Thanks to that discovery, doctors and nurses started washing their hands (they weren't doing that before!) and using sterilized equipment. Medicine was forever changed, and lives were being saved!

Arthur: Eugene Poubelle was another person inspired by Pasteur's work. He was the préfet, or mayor, of Paris. Seeing the connection between germ-covered things and disease, Poubelle believed germ-y things should be gathered in one place—like a trash can. Because disease spreads and impacts everyone, using a trash can shouldn't be optional. Poubelle mandated that all buildings in Paris have trash cans and that all Parisians use them.

Lily: He was met with a lot of resistance. Many people believed trash cans were too expensive and unnecessary.

Arthur: Poubelle didn't care about the criticism and enforced the law. He was right that trash cans improved the health (and appearance) of Paris. He was so insistent that people use trash cans that in French, 'la poubelle' means trash can.

Lily: Creating a system to collect and remove all that trash from Paris was complicated, but the wagons Poubelle developed paved the way for modern trash trucks. It'll be a long time before trash collection is a normal part of the modern world, but this is an important first step.

Arthur: This is all good progress on stopping the spread of disease, but Pasteur was far from done! To really get his germ theory ideas to stick, he had to take down the theory of spontaneous generation. Spontaneous generation is the theory that some organisms can just appear out of nowhere under certain circumstances. For example, if you leave a piece of raw meat out, the next day it might be covered in maggots. Ergo, the meat made the

maggots poof into existence. They spontaneously generated. So germs must also just pop up out of nowhere, you know?

Lily: Today, it's hard to believe this was ever a real scientific theory, but it actually was. Scientists actually believed that things like maggots, mice, and mold just appeared.

Arthur: To be fair, not all scientists. Italian scientist Francesco Redi conducted experiments in the 1600s to prove that maggots are baby flies. Maggots won't appear on meat if flies can't get to the meat. In the 1700s, Lazzaro Spallanzani conducted more experiments that disproved spontaneous generation. Unfortunately, the scientific community was not ready to listen.

Lily: In the late 1800s, many scientists still weren't ready to let go of the theory. Pasteur was called out by fellow scientist Félix Pouchet. The two engaged in a head-to-head competition to prove if spontaneous generation was correct. In 1862, through a brilliantly designed experiment, Pasteur proved once and for all that spontaneous generation does not exist. You cannot make something from nothing.

Arthur: That was a massive breakthrough!!

Lily: As if that wasn't enough, Pasteur went on to redefine vaccination! He created a vaccine for chickens to protect them from chicken cholera. Then he created a successful anthrax vaccine for farm animals like cows, sheep, and goats. Protecting those animals also protected the humans who had close contact with them.

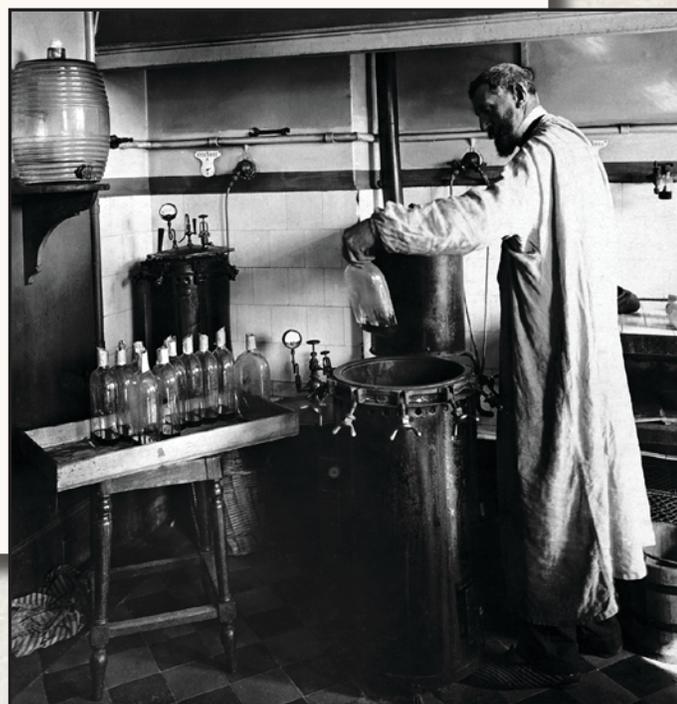
Arthur: Next up, Pasteur invented a rabies vaccine for animals! Rabies makes animals behave aggressively, and if a rabid animal bites a human, the human will die a painful and gruesome death. Protecting animals from rabies was very important for human health.

Lily: Pasteur had focused on animals and wasn't ready to try the vaccine on humans when two parents brought their child to him. The child had been bitten by a rabid dog and was going to die. The parents begged Pasteur to try to save their child. Pasteur was nervous, but he tried. The vaccine was successful, and the child lived! This was the second successful human vaccine.

Arthur: Louis and Marie Pasteur traveled around the world giving the rabies vaccine to animals and infected humans. Marie worked as a nurse caring for patients who received the vaccine, while Louis developed and administered the vaccines.

Lily: Louis Pasteur changed science forever, and he saved billions of lives in the process!

Arthur: Billions might sound like an exaggeration, but when you add up pharmaceutical drugs, pasteurization, germ theory, sterile surgery, trash collection, and vaccination, you'll realize Louis and Marie Pasteur really did save THAT many lives.



Photograph of Louis Pasteur performing an experiment in his lab.