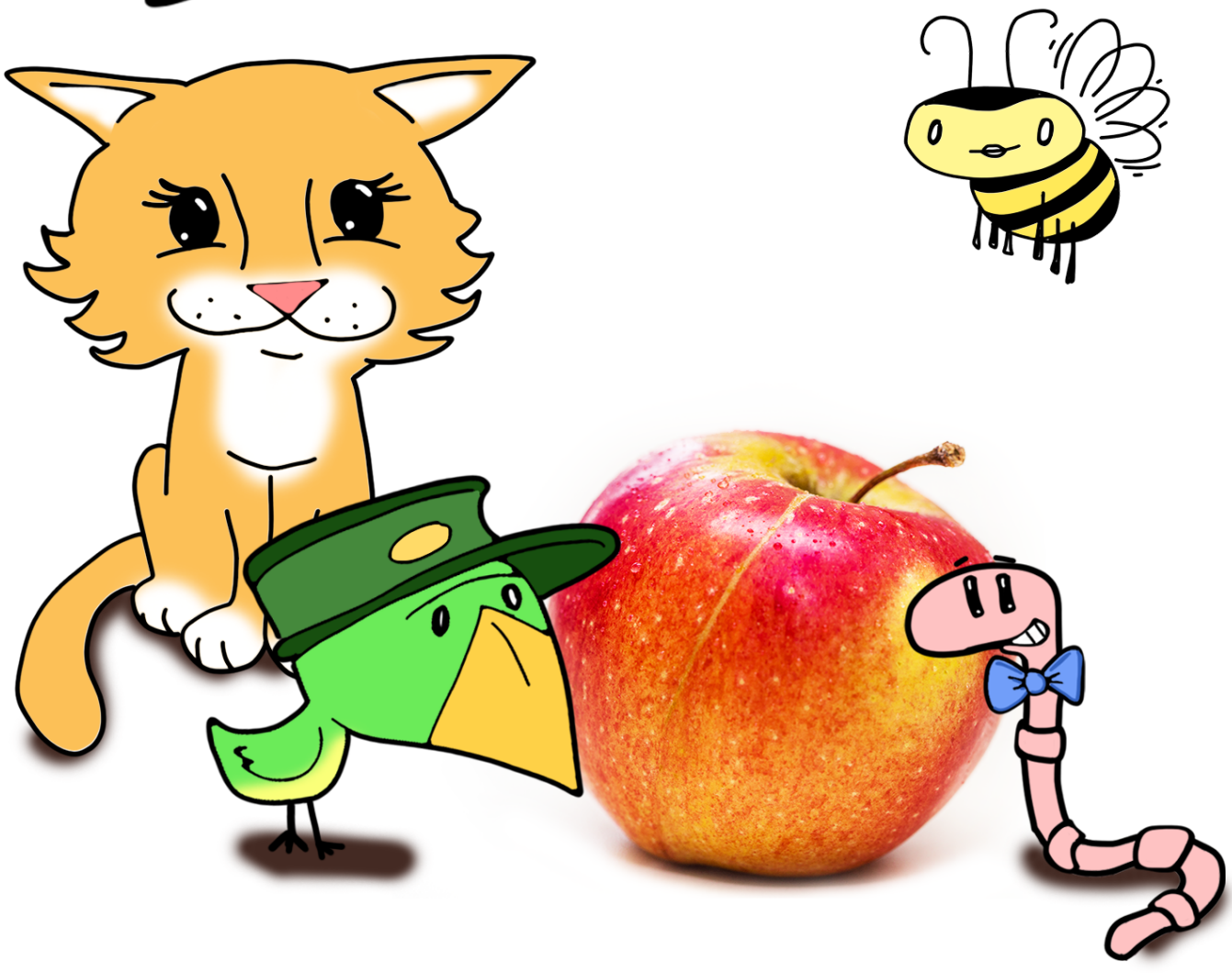
Birds, Bees and Apple Trees



A book about the Mysteries of Life, by A Bit of Orange

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Chapter 1: Why Are Red Apples RED?

Shauncey the dapper worm *(bow-tie enthusiast)* and General Byrd (*United States Air Force, Bird Division- retired*) lived in an apple tree, in the middle of an orchard on a farm in Wisconsin. One warm summer morning they were enjoying one of the red apples that grew on the apple tree they lived in as a healthy and delicious breakfast treat.

As he was munching happily, a thought suddenly occurred to Shawncy.

“**Why are our apples red**,” he asked, “when there are apple trees that make apples that are green or yellow? Why doesn't our apple tree make green and yellow apples?”

“An interesting question!” replied General Byrd. “Another interesting question is, why does this tree make apples at all? And how?”

“Yes, well that's *two* more interesting questions,” said Shawncy. “But it doesn't answer my question.”

“Actually my boy,” said General Byrd, “both of my questions are the beginning to answering your question. Are they all involved in The Mystery of Life!”

“My goodness!” exclaimed Shawncy. “I half expected it to be something to do with rainbow unicorns and pixie dust.”

“Nonsense,” said General Byrd. “The answer to your inquiry is pure science my friend. But let's begin with your question and work our way back to mine. You asked why our apples are red when other apples are yellow or green.”

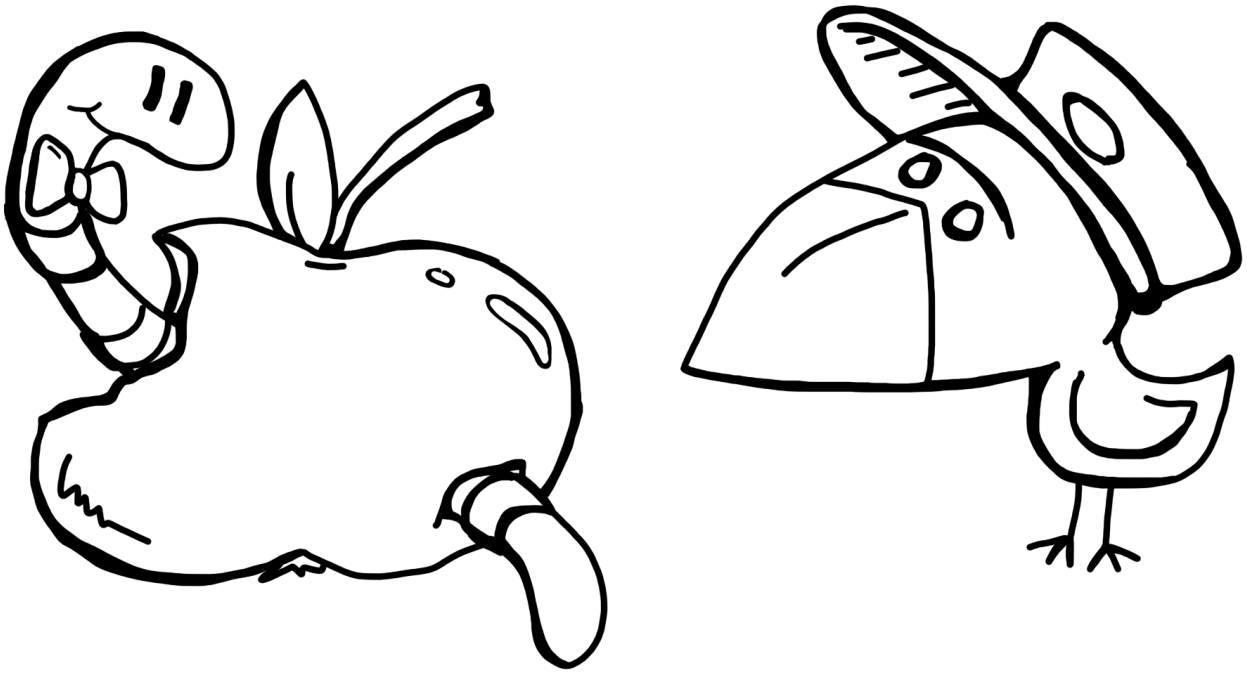
“That's right.”

“But where did *these* apples come from?”

“Well, they've grown on this tree,” replied Shawncy.

“That's correct,” General Byrd said. “But, where did *this tree* come from?”

“Does this have to do with rainbow unicorns or pixie dust?” asked Shawncy.



“Not in the slightest!” replied General Byrd. “The answer is at the bottom of your breakfast. Why don't you dig a little deeper into that apple and tell me what you find.”

Chauncey took a few bites deeper toward the core of the Apple and discovered what General Byrd was hinting at. “Seeds!” he exclaimed. “An apple is full of apple seeds. So you’re saying that this tree used to be a seed.”

“And **where did that seed come from**?” asked General Byrd.

“Well,” said Chauncey thoughtfully, “I suppose it came from an apple.”

“That is correct! Now where did *that apple* come from?”

“Apples come from apple trees,” said Shawncy, “so that apple must have come from an apple tree.”

“Logical deduction!” exclaimed General Byrd. “And most certainly correct. Our Apple grew on this tree. This tree came from a seed that came from an apple that grew on a previous tree. We have begun to answer your question!”

“I don't see how,” said Shawncy.

“You will,” said General Byrd. “Now, *what is a seed*?”

“Well, it's not pixie dust,” said Shawncy. “But I know it must be magic. It's like a bean that you bury in the ground and it turns into a plant, like a tree, or a flower, or a beanstalk.”

“I know it may appear like magic," replied General Byrd, “but it is in fact entirely explicable science. A seed is not a *magic bean* but is in fact *a baby tree*. Or to put it more scientifically, it is a tree in the embryonic stage.”

“To put it scientifically involves some big words,” said Shawncy with a puzzled look.

General Byrd explained. “Embryonic,” he said, simply means that the living thing is in a very early stage of development. It’s a baby. Our seed contains an apple tree which is an embryo, meaning a baby tree which is very very new. It might not look like an apple tree to you but it's got everything it needs to grow into the tree we're sitting in right now.”

“I still insist it's magic," said Shawncy.

“And I won't disagree with you," replied General Byrd. “But I will offer a scientific explanation for that science. I believe the bridge between your magic and my science is what we ought to call a *“miracle.”* An apple tree is, of course, completely natural, but that doesn’t mean it’s any the less miraculous.”

“So there’s no conflict between miracles and science?” asked Shawncy.

“Not at all,” replied General Byrd. “That God made the heavens and the earth from nothing is a miracle, both because it was done by God and because it could not be done with science. But science is the way we learn to understand what the heavens and the earth are doing and what they’re

made of. Science is how we learn about the results of God's creation. It doesn't prove that no miracle occurred, it teaches us what God's miracle created. All of creation is a miracle, even when we can explain it with science."

"Well, amen to that," said Shawncy. "Now you're starting to make sense."

"Thank you," said General Byrd with a nod. "Now, to explain the miracle of an apple tree with science, we need to ask where apple tree seeds come from."

"They come from apples," said Shawncy.

"And where do the apples come from?"

"They grow on apple trees."

"How?"

Shawncy sat with his mouth open for a moment, waiting for the words to come. When they did not, he said, "I'm not certain. They just sort of show up. Is this the magical part?"

"This is more science!" exclaimed General Byrd.

"So, it's a miracle?" asked Shawncy.

"Eh.. oh. Well, yes," replied General Byrd. "But there is still an explanation in science. Look at the bottom of an apple tell me what you see."

Shawncy looked at some apples growing just on the branch above him. He looked at the bottom of the apples and he noticed something he hadn't given any thought to before. "My goodness!" he exclaimed. "It appears as if there's a tiny flower wedged into the bottom of each of these apples!"

"As a matter of fact," replied General Byrd, "**the bottom of these apples used to be the top of a flower**."

Shawncy squinted at him. "You're making that up."

"No no!" General Byrd replied. "It is entirely true. Consider every year before these trees are growing apples, what do they look like?"

"Well," answered Shawncy thoughtfully, "in the winter they're just empty and brown, but in the spring they begin to grow leaves and flowers."

“But where do the flowers go?”

Shawncy looked around the tree and discovered that he couldn’t see any flowers. He only saw apples among the leaves. “The flowers seem to disappear when the apples show up,” he said. “Do Apple Fairies show up at night and replace the flowers with apples?”

“Not at all my dapper friend,” answered General Byrd. “The flowers *turn into apples*.”

“You're putting me on.”

“Not at all!”

“It’s a joke. Flowers turning into apples? You’re having a laugh.”

“It's an absolute fact!” declared General Byrd. “Let's call in an expert on the matter.”

General Byrd looked around their apple tree until he spotted the very friend that he was hoping to find- a bee named Erica. He called to her as she passed by.

“Erica!” he called. “Do you have a moment to provide an expert opinion on a matter of botany?”

Erica flew up to the Apple and said “I always have time for my friends! What do you boys need?”

“We want to know where all the flowers have gone," said Shawncy.

“What flowers?” asked Erica.

“The flowers which were all over this apple tree during the spring,” explained Shawncy.

“Well, they've turned into apples,” replied Erica.

“It's simply fantastic!” exclaimed Shawncy. “It seems too magical. I simply can't believe it!”

“I'm telling you the truth!” replied to Erica. “Helping apple trees turn flowers into apples is actually part of my job.”

“You're a magician!” exclaimed Shawncy. “Or a wizard? Or perhaps an angel?”

“All of the above,” said Erica. “I'm a Honey Bee. It's my job to collect nectar from the flowers which we turn into honey. And while we do so we carry pollen from flower to flower which pollinates the flowers causing them to turn into apples.”

*“**Pollinates*** the flowers?” Shawncy repeated. “Whatever does that mean?”

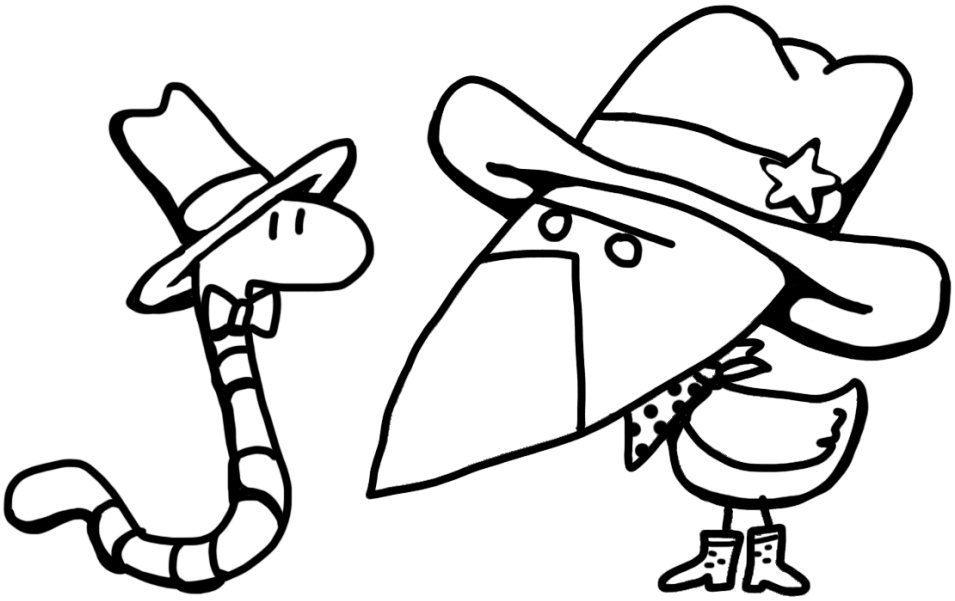
“Ah!” exclaimed General Byrd. “That is a complicated question which requires me to tell you a metaphorical story about a fictional old west.”

Questions!

1. Shawncy asks, “Why are our apples red?” What do you think the answer is? Why are red apples RED?

2. If Generally Byrd handed you an apple seed and asked, “Where did that seed come from?” what would you reply?

3. General Byrd tells Shawncy, “The bottom of these apples used to be the top of a flower.” What does he mean?



Chapter 2: A Western Tale (About Libraries)

A metaphor to explain why our apples are red, as told by General Byrd.

In 1812, the state of LIFE was founded, and Mrs Gren was elected its governor.

“There’s no state named *“Life!”* interrupted Shawncy.

“Yes, I know,” replied General Byrd. “It’s a metaphor. That’s why I said it was a *fictional* old west.”

“Ah, so you did,” recalled Shawncy. “So sorry. Carry on.”

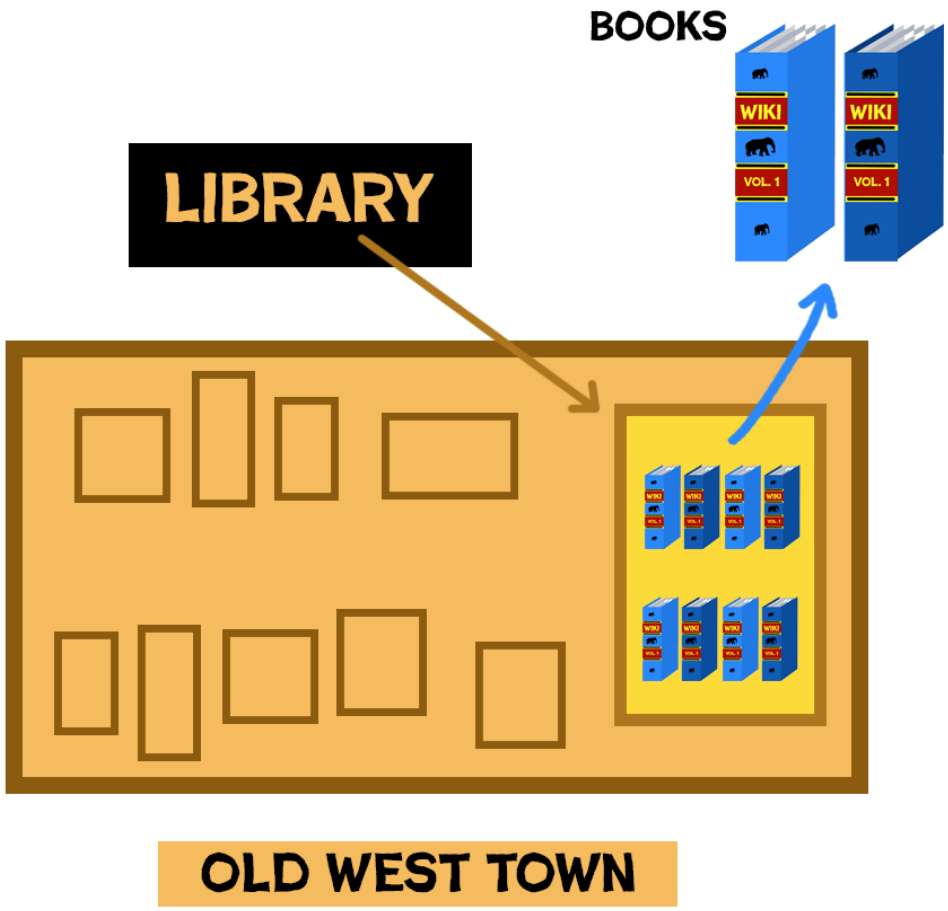
“Thank you,” said General Byrd. “Where was I? Never mind. I’ll start over.”

In 1812, the state of LIFE was founded, and Mrs Gren was elected its governor.
The state was brand new, so her first act as Governor was to establish the rules for how new towns would be founded.

Aside from the normal utilities, such as plumbing, police, garbage and groceries, **every town was required to have a library.** And the library would hold books on how to build and run every part of a town. There would be books on how to build a firehouse, and how to build a police station. There

would be books on where to put the roads and how to dig wells and when to plant corn. The library would carry instructions for everything anyone in the state needed to do. And because the library was so important to building and running every other part of town, it would go in first.

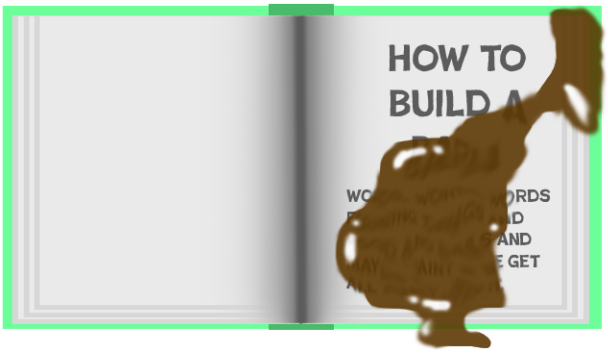
Each town was different. Some were mining towns, and others were farming towns, but they each had a complete library. Not every town used every book, but they all had them. Just in case they needed them.

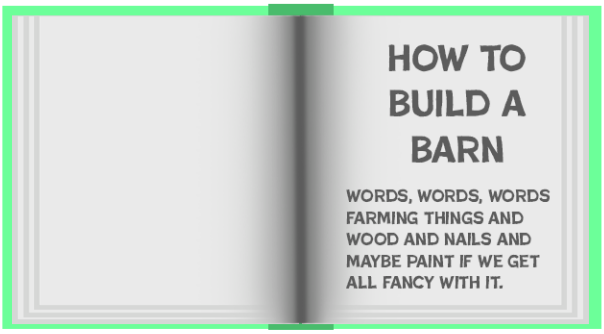


The library system was designed by Mrs Gren to ensure everyone had everything they needed. First of all, **every library would have TWO copies of every book**. For example, the encyclopedia set had 23 books, so each library had space for 46 books on the encyclopedia shelves because it had to have two copies of the entire encyclopedia.

There were TWO copies of EVERY book. There were many advantages to this. For instance, if someone spilled their coffee on a copy of “How to Build a Barn,” there would still be a perfectly good

copy of “How to Build a Barn” in the library so people could continue to build barns. If the library didn’t have two copies of every book, they were not allowed to open to the public. It was the law, for the good of the people.





At the beginning, the State of Life had only two counties.

A county is an area made of towns all working together. A county had mining towns and ranching towns and farming towns. One of the counties was run according to the red book in the library, and so it was called a red county. The other county was run according to the blue book in the library, and so it was called a blue county.

BOOKS IN THE RED COUNTY

BOOKS IN THE BLUE COUNTY

Red and blue counties had a lot in common, but they had a few differences too. Just to name a few- the Blue county had a copy of the Blue book and a copy of the red book, whereas the red county only had two copies of the red book. Also, while both counties made horse drawn wagons, the red county, using the chapter on building wagons in the red book, made much larger wagons which could take eight horses to pull. These wagons could hold a thousand eggs in egg cartons, and so they were called egg wagons. The blue county, using the chapter on building wagons from the blue book, made wagons which were much smaller and only needed one horse to pull them. They could each hold one large bag of seed, and so they were called seed wagons.

But the counties were an awful lot alike, despite these differences.

Eventually, the red and blue counties were getting big and full of people, and the Sheriff decided that something needed to be done. Sherif Olive was thinking about the future of the state of Life, and she realized it was time for a new county. She paid a visit to the governor.

“Governor Mrs Gren,” Sheriff Olive said, “the time has come to establish a new county. But we ain’t never made a new county before, so we need to decide how to best get it done.”

“This is an important step in the growth of our state,” said Mrs Gren. “We must consider carefully how to create new counties so that the State of Life can thrive!”

“I was thinking the same thing,” said the Sheriff.

“Perhaps we can simply establish a new county the way we establish a new town,” suggested the Governor.

“Remind me again how we do that?” said Sheriff Olive.

“We begin with the library,” said Mrs Gren. “An existing town in the same county makes copies of all of the books it contains, and then it sends those copies to the new library building so it can serve to build the new town.”

“I don’t feel like that is going to work,” suggested the Sheriff. “We can’t just duplicate a whole county to make the new one. It needs to start with a single town and grow from there.”

“But it still needs to begin with a library,” insisted the Governor.

“But which library?” asked the Sheriff. “If you simply duplicate the blue library, you’ll end up with a blue county. Then the red county will feel like the blue county has just gotten bigger and maybe feel threatened. But if we just duplicate the red one, it will be the same problem in reverse.”

“I see what you mean,” replied the Governor. “Either way it seems like we’re just expanding one county instead of starting a new one. There must be a way for both counties to be able to participate in the founding of a new county so they both feel a sense of kinship.”

“You mean, have both the red county and the blue county donate some books to start that new library in the new county?” said the Sheriff.

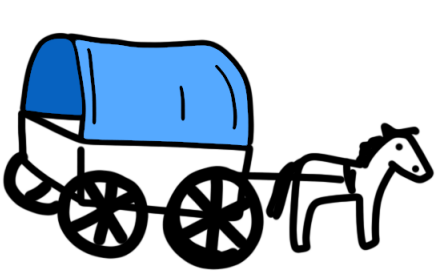
“Yes!” exclaimed the Governor. “That is a wonderful idea! The new county can be made from both of the existing counties!”

“I like it in principle,” said the Sheriff, “but how do we make it happen?”

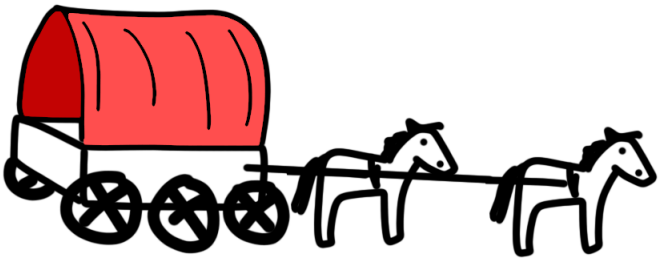
“A new library needs a building,” said the Governor. “Nothing big, but just enough to hold all of the books it needs. And two copies of every book just like all of the other libraries.”

“Ok,” said Sheriff Olive, nodding. “I understand so far. We need a building and some shelves and what not, and then two copies of each book. But how do we get all of that to the new county?”

“Well, consider the wagons,” said the Governor. “The red county makes really big egg wagons, capable of carrying a lot of things. But the blue seed wagons, while fast, are much smaller. So what if we had the red county use one of their big egg wagons to bring the material to build the library buildings in the first town of that new county?”



BLUE COUNTY SEED WAGON



RED COUNTY EGG WAGON

“That’s a great idea,” agreed the Sheriff. “But does that mean the new county will always be a red county?”

“No, a new county will be either red or blue,” said Mrs Gren.

“But how do we decide whether it will be red or if it will be blue?” asked the Sheriff.

“We won’t decide,” said the Governor with a smile. “Listen- here’s my idea for how the counties will be made. The red county will take a library- all of it, books, tables, desks, walls, and doors, and divide everything up into two collections, each put onto its own big red egg wagon. When the time is right, one of those red egg wagons will be sent into the new county to prepare to build the first library in the new county.”

“That will be enough for each wagon to make a small library,” said Sheriff Olive. “But it will only have one copy of each book.”

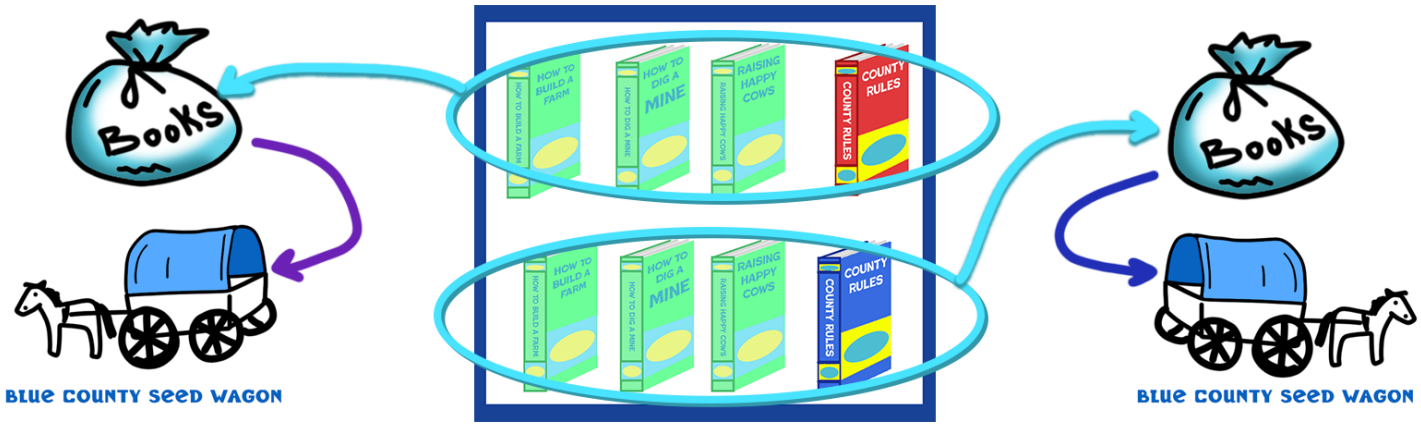
“Yes,” said the Governor, “and the other books will come from the blue county! A library from the blue county will put one book from each pair of books it has into a bag, and the other book from each pair into another bag, making two almost identical collections of books.”

“Almost identical?” replied the Sheriff, a puzzled look on her face.

“That’s right,” said Mrs Gren. “If you remember, one of the things that makes the libraries in the Blue county different is that they have a copy of the red book in addition to the copy of the blue book. The red county only has two copies of the red book.”

“Oh, that’s right!” said the Sheriff.

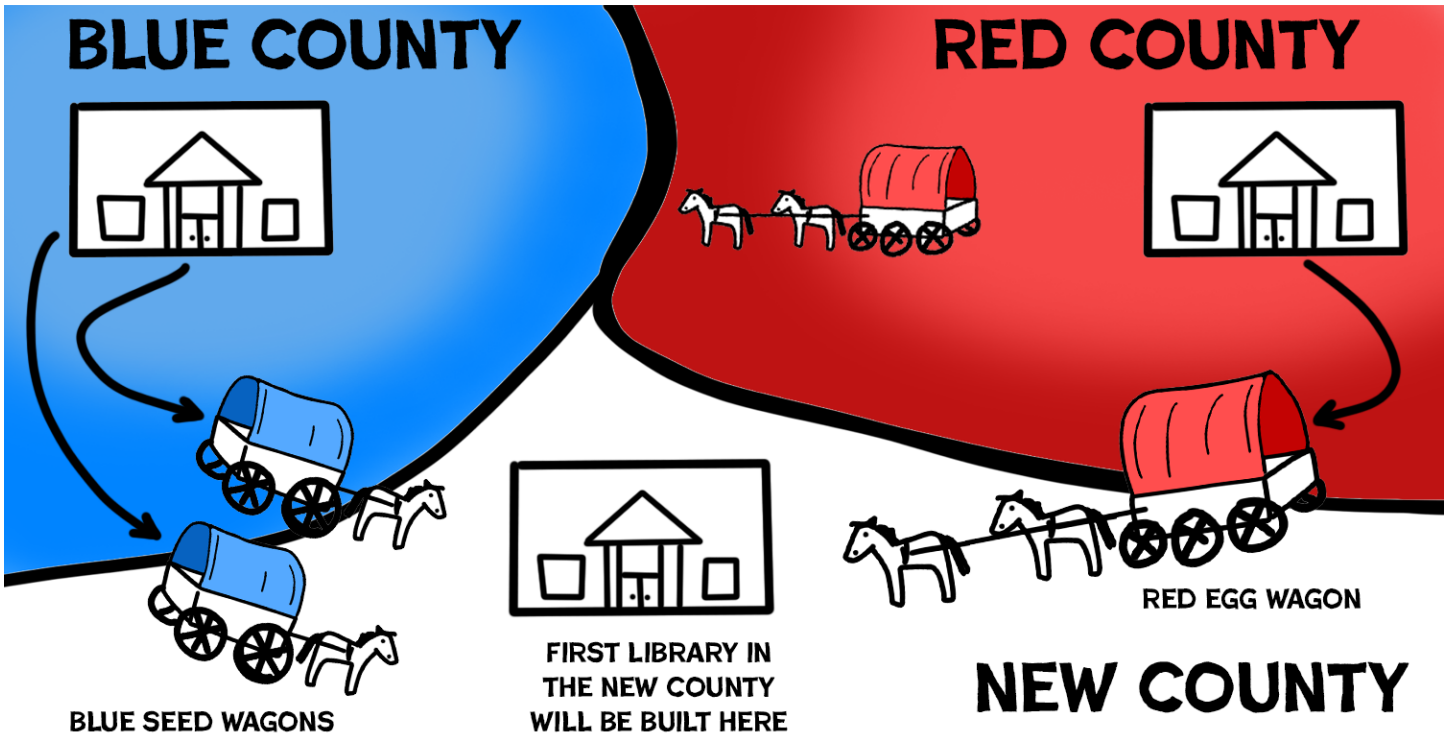
“And so those two bags full of books will be different in one important way,” explained Mrs Gren. “One of them will have the red book and the other will have the blue book.”



“So which one do we send to the new county?” asked the Sheriff.

“Both of them!” exclaimed Governor Mrs Gren with delight. “They will have a race to determine the future of the new county! One red egg wagon will head into the new county, to the place where the new library in the first town is to be built. Each collection of books from the blue county will be put on its own wagon, and the blue seed wagons will race to the new library in the new county! The first one to deliver its books will determine which kind of county the new county will be!”

“You mean,” said the Sheriff, “if the wagon carrying the red book gets to the new library in the new county first, the county will be a red county, but if the wagon with the blue book gets there first, the new county will be a blue county!”



“Exactly!” replied the Governor. “Each county will have donated half of the books it takes to make that library, but we don’t have to assign the new counties to be red or blue. They will randomly be assigned red or blue depending on which wagon gets there first!”

“But even though a new county might be red,” said the Sheriff, “half of its books will have come from the blue county, and so both counties will feel a kind of kinship because that new county is made of both of them, no matter which one it takes after more.”

“That’s right,” said the Governor. “Every county in the State will be built using books from red counties and blue counties. When two existing counties make a new county together, they won’t think of the new county as MINE or YOURS, but as OURS- a new county WE made together! So instead of causing conflict because of how many red or how many blue counties there are, it will bring unity because whatever color the new county is, it will be made from both red and blue!”

“That’s beautiful,” said the Sheriff, and she brushed away a tear from her eye.

“And once that first town in the new county is up and running,” explained the Governor, “it will make new towns in that new county the same way new towns are made in the other counties- by making copies of its books and sending them to the new town in its own county. Our red and blue counties

will work together to start the new county, but once it is established, the new county will be responsible for its own growth, making it an independent county that can someday grow until it can help start new counties!”

And so the State of Life had been given a way for new counties to be born using different wagons to deliver the information needed to build towns.

The Red county Library Egg wagon had everything it took to make a small, starter library, including one of every book. However, it had to wait until a Library seed wagon arrived and both collections of books could be put on the shelves. The two blue seed wagons raced to the new county, and whichever one got there first, delivered its books to complete the new library in the new county. Once the new, first library of the county had a complete collection, the books could be put to use for building and running the town, and making other new towns in the new county.

“Life is going to be a pretty dull fictional old west,” said Shawncy.

“Why do you say that?” asked General Byrd.

“Every library had the exact same books, and so every town in the state would look exactly the same!”

“You might think so,” replied General Byrd. “But you would be wrong. First of all, because not every town is the same kind of town. A mining town would use the books about mining, but not the ones about farming. A farming town would use the books about farming, but not the books about mining. The ranching towns wouldn’t use the books about farming OR mining, but they would use the books about ranching.”

“Oh, that does make sense,” admitted Shawncy.

“I love this story,” said Erica.

“But,” said Shawncy, “every farming town would look exactly like every other farming town.”

“I can see that,” added Erica.

“That’s not necessarily so either,” replied General Byrd. “For example, while a lot of the older churches were painted white and blue, the newer churches in the east are only white, and the churches in the west are only blue.”

“Doesn’t the library have books about what color to paint the churches?” asked Shawncy.

“They do,” said General Byrd.

“Then how did we get churches that look different?” asked Shawncy.

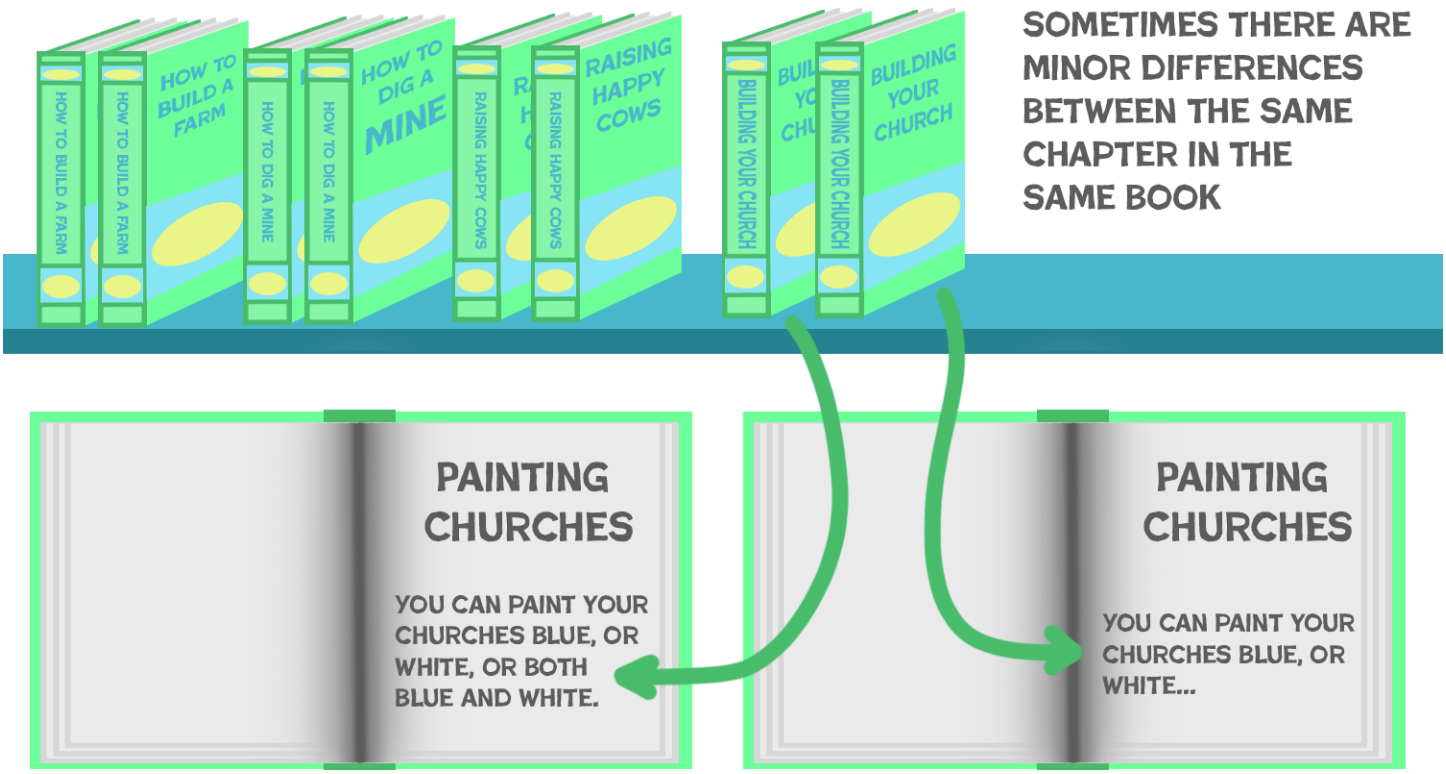
“It’s a mystery!” exclaimed Erica. “I love a good mystery!”

“Here’s how that happened,” continued General Byrd.

When Mrs Gren put the first copies of the book about building churches in the library, that book had a chapter which said ***“churches can be painted white, or blue, or blue and white.”***

So the information in the original book had options already written in for different looking churches. But there is another reason some counties look different from other counties.

On occasion, one of the librarians would make a mistake when typing out a new copy of a book. On one such occasion, when making copies for a new library in a new southern county, a librarian who made a copy of the book that said what color churches could be painted forgot the line that said *“or blue and white.”* That copy which went to the southern counties said ***“churches can be painted white or blue.”***



So a lot of the churches in the north were *blue and white*, but the churches south of those were only *blue OR white*, and never both blue and white at the same time.

Later on, another librarian made a copy of *that* book and she forgot to include the words *"or blue,"* so her copy said ***"churches can be painted white,"*** and this is the copy that got sent to the east on a Library Seed Wagon, and so all of the counties that got a copy of that book only know that they can paint their churches white, and so they do.

Over time, a lot of little changes like that, as well as a lot of options in the original books, allowed all of the towns to be very similar, and yet still unique.

"I can see that," admitted Shawncy. "I suppose each town in the State of Life has the chance to be special after all! How exciting. That was an excellent story, General Byrd."

"Thank you, my boy," said General Byrd.

QUESTIONS!

1. What is EVERY town required to have before it can do anything else?

2. How many copies of each book are required to be in the library? Why might that be helpful?

3. There are two kinds of counties- red and blue. How are they different? How are they the same?

4. Mrs Gren created a way for two existing counties to work together to make a new county. What does the red county provide to make the new county? What does the blue county provide?

5. What difference does it make which blue seed wagon gets to the new library first?

6. What problems might arise if the new county was started by simply having a library in the blue county send all of its books? Why is it better to have the red county and blue county combine their books instead?

Chapter 3: Part 1- Honey Horses and Tiny Libraries

“How fascinating!” said Shawncy.

“I love that story,” said Erica.

“But what does it have to do with Erica carrying pollen around?” asked Shawncy.

“Yeah,” said Erica. “What does it have to do with me?”

“In my fictional, old western tale,” explained general Byrd, “you’re the horse pulling the blue seed wagon.”

“Oh, I get it!” exclaimed Erica.

“Well I don’t,” admitted Shawncy. “How can a honey bee… be a horse?”

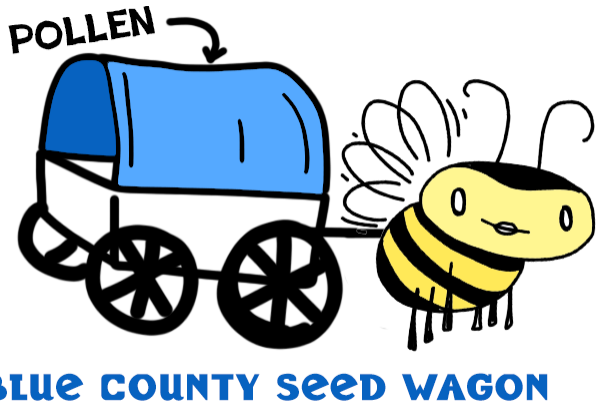
“Shawncy, what was the horse pulling?” asked Erica.

“A wagon full of books,” Shawncy replied.

“And where was that wagon being taken?” she asked.

“It was going to be combined with another wagon full of books so they could make a library,” he answered.

“***The pollen is like a tiny wagon full of books***, and it needs to be combined with another tiny wagon full of books to make a full library!” Erica exclaimed with delight.



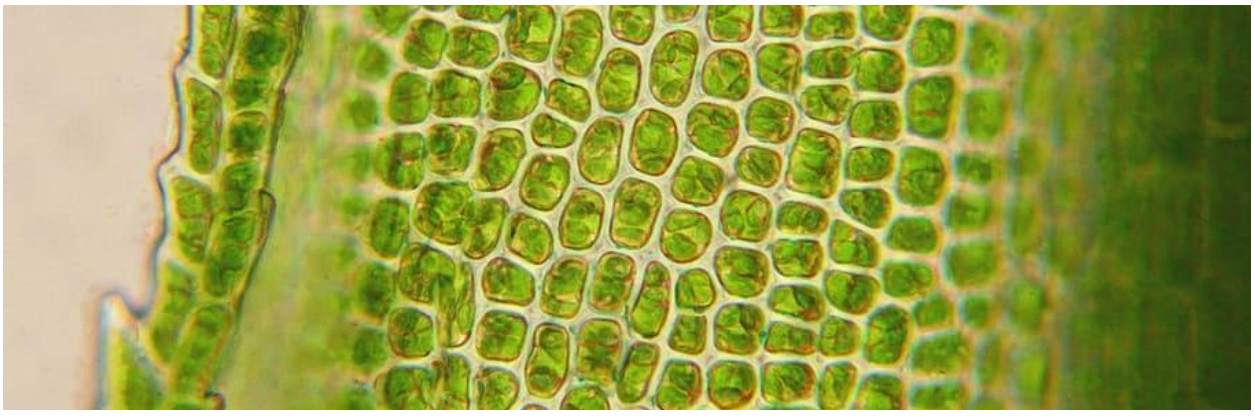
“Precisely,” said General Byrd.

“You’re both mental,” said Shawncy. “There is no way that a tiny bit of pollen has a bunch of books in it.”

“It’s a metaphor,” explained General Byrd. “There aren’t real, paper and ink books inside a pollen.”

“Then what are we talking about?” asked Shawncy.

“**Every living thing is made of tiny parts called CELLS**,” said General Byrd. “Plants, like this tree and its apples are made of cells, and even you and I and Erica are made of cells.”

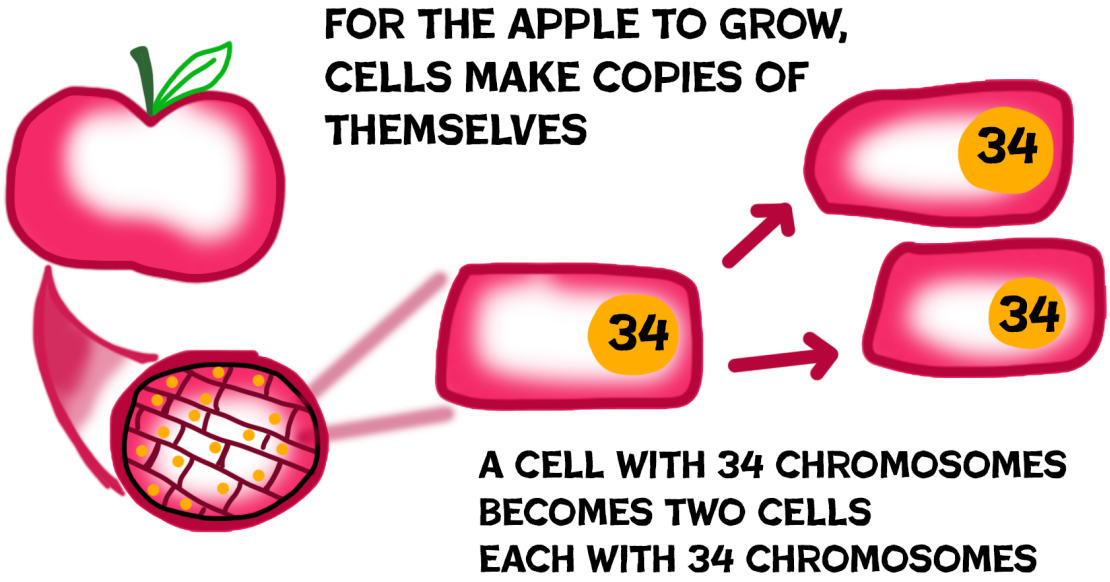


“How many?” asked Shawncy. He squinted at his tail and added, “I don’t see any. Are you sure I have some?”

“Cells are too small to see with just your eyes,” explained general Byrd. “You are probably made up of millions of cells.”

“You don’t say!” Shawncy exclaimed. “How remarkable! Is an apple made of cells?”

“It is,” said General Byrd. “If you could look at the skin of the apple under a microscope, it would look like tiny boxes all stacked together. And each of those boxes would have a dark little circle in the middle of it. That little circle is the nucleus.”



“And what does a nucleus do?” asked Shawncy.

“**A nucleus is a library!**” replied Erica. “It holds all of the instructions for making the apples and the apple tree!”

“But you don’t mean tiny little books of ink and paper, right?” asked Shawncy.

“No,” said General Byrd. “**The information in the nucleus is carried in a molecule called DNA**. It’s not made of ink and paper.”

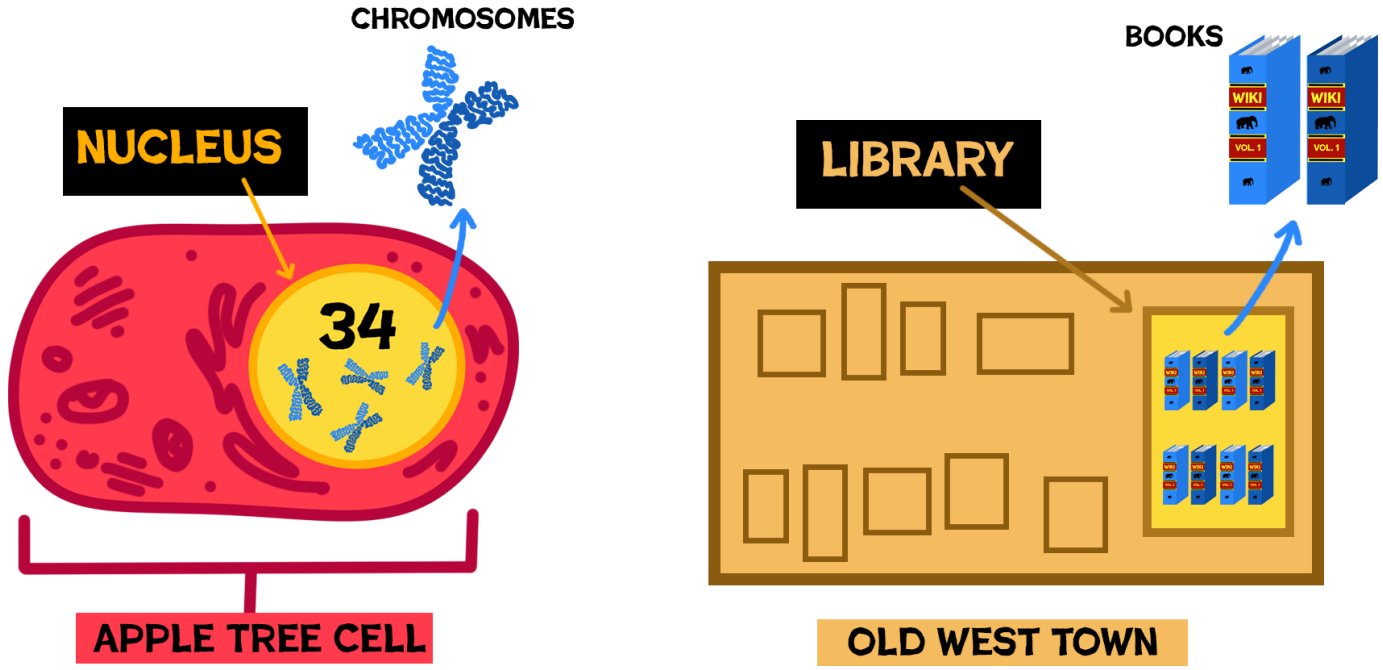
“But it still carries information?” asked Shawncy.

“Yes,” replied General Byrd. “**The DNA in any living thing carries all of the information it takes to make that living thing**. Your cells’ DNA carries the information for making a worm. Erica’s DNA

carries the information for making a bee, and the apple's DNA carries all of the information for making the apple and the tree it came from."

"That's a lot of information," said Shawncy, his eyes wide with wonder. "So apples are made of boxes with dots in them, and the dots have instructions inside them?"

"Oh, cells are much more complex than a box," said General Byrd. "That's why in my fictional old west tale, the cell is a whole town. It's got all kinds of parts that do different things. And the county is a collection of different cities. And just like a county is made of cities and towns, a living thing is made of cells. A living thing, like a worm, is a collection of different kinds of cells, but in each cell, there's the instructions for making the whole worm."



"I suddenly feel much more important," said Shawncy. "I never knew I was carrying around millions of tiny libraries!"

"You are an artwork and a miracle, my boy," said General Byrd.

"But the pollen," said Shawncy, "it doesn't have all of the books it needs to be a library. It only has half. Like the Library Seed Wagons from your tale. But, if cells don't have books, how does your story relate to the DNA in our cells?"

“You know how libraries have books in them?” asked General Byrd.

“Yes, of course,” answered Shawncy.

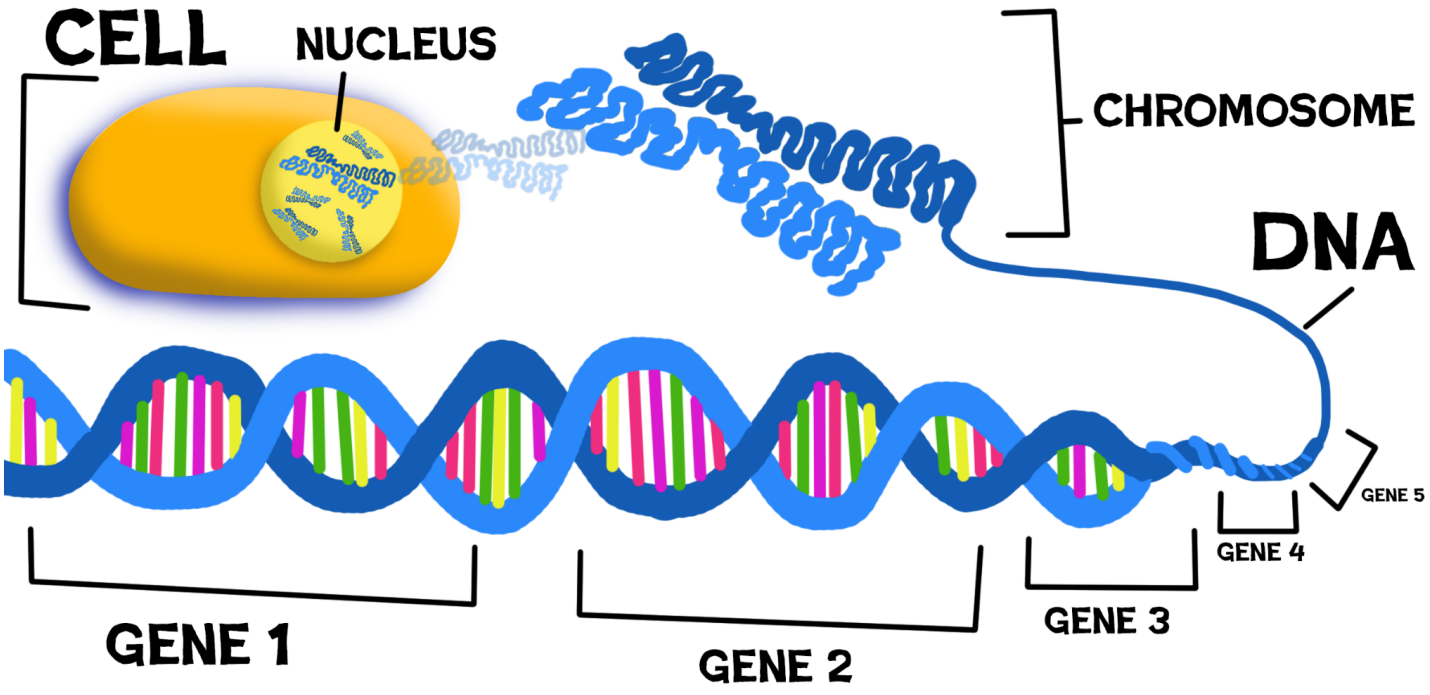
“And a book is made of a collection of chapters which are physically bound together in a single volume.”

“Right,” said Shawncy. “Like, the encyclopedia has information from A to Z, but the topics all starting with the letter A are all bound together in a single book.”

“Yes, exactly,” said General Byrd. “DNA is something like that. Like a library has a collection of books, a nucleus has a collection of Chromosomes. **A Chromosome is like a book of DNA**.”

“So, a particular chromosome would be like the Encyclopedia volume A?” asked Shawncy.

“In a manner of speaking,” said General Byrd. “Just like **a book has a bunch of chapters** bound together in a single unit, **a chromosome has a bunch of genes** bound together in a single unit.”



“Wait, what’s a gene?” asked Shawncy. “You don’t mean that guy who comes out of a lamp and grants wishes?”

“That’s a genie,” explained Erica. “It’s a very different thing.”

“**A gene is an instruction for a particular feature,**” said General Byrd. “Remember how the libraries in my old west tale had the instructions for everything? And one of those instructions came from a book about how to make the church, and the book about how to make the church had a chapter on what color to paint the churches?”

“Sure,” said Shawncy.

“A gene is a chapter that has information about a particular feature,” explained General Byrd. “You asked why our apples are red. Well, our apples are red, because the instructions in the book on making apples has a chapter which says to paint the apples red.”

“That’s remarkable!” exclaimed Shawncy. “So, if I put all of the big words together, the science way of saying all of this is; these apples are red because the apple skin is made of cells which have a nucleus that carries chromosomes, one of which carries a gene telling it to make the apple skin red.”

“Now you’re getting it!” said General Byrd.

“Am I?” asked Shawncy. “I have no idea what I just said.”

“Let me translate for you,” said General Byrd. “The apple skin is made of cells- little towns in our old west tale. The cells each have a library which we call a nucleus. **The books in the library are called Chromosomes, and one of those Chromosomes has a chapter- which we call a gene- that says to make the apple skin red.”**

“So, the apple has a chapter, in the books in its library, that says to make red apples, and that’s why the apples are red?”

“Exactly,” said General Byrd proudly.

“By golly. I think I’m beginning to catch on.” Shawncy thought for a moment and then asked, “But where does Erica come into all of this? Didn’t you say she was a horse?”

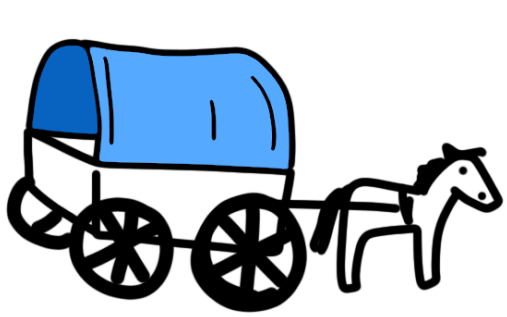
“I’m the horse that pulls the Blue Library Seed Wagon,” Erica said.

“Yes, I remember,” said Shawncy. “So, according to your old West tale, Cells have a nucleus, which is a library, and a nucleus has chromosomes, which are books, and the chromosomes have genes, which are chapters with instructions for certain things… but where do the tiny horses come in?”

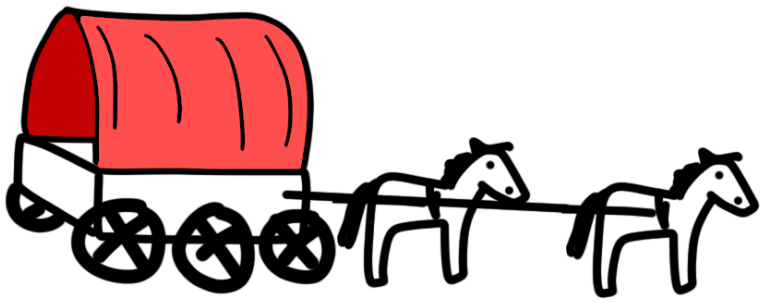
“This brings us back to pollen!” said Erica. “Pollen isn’t a seed, and it can’t make a baby tree by itself. It’s only HALF of the instructions for making a tree. Just like the libraries in general Byrd’s tale needed two copies of every book to open, a cell needs two copies of every chromosome to be a living cell that can grow and make more cells.”

“So you need to put two pollen together?” asked Shawncy.

“This is where the real world gets a little more complicated,” admitted General Byrd. “Two blue seed wagons can’t make a library, because they don’t have a building and a desk for people to check out books and all of the other things a library needs to BE a library. This is why there was another kind of wagon made by the red counties- the Red Library Egg Wagon. That was the one which had walls and doors and windows and chairs and desks and shelves to put the books on.”



BLUE COUNTY SEED WAGON



RED COUNTY EGG WAGON

“Pollen is like the Blue Library Seed Wagons,” said Erica. “Two pollen can’t make a seed because they don’t have all of the things it takes to make a seed. They only carry the half of the books that the main library building is waiting for. The pollen is just a wagon of books.”

“Then where is the library?” asked Shawncy. “Or, I suppose I’m asking what the Red Library Egg Wagon is if it is not another pollen.”

“This is where the flowers come in!” said Erica. You could tell that she loved her work, and enjoyed talking about it. “Look, there’s a flower still left on that branch near the top of your tree. Let’s go up there and take a look at it.”

General Byrd grabbed Shawncy and they flew to the top of the tree where there was still a flower on a high branch. Erica landed on the flower to be able to point out the different parts of the flower.

QUESTIONS!

1. In General Byrds fictional old west tale, what represents pollen?

2. Every living thing is made of tiny parts called *WHAT*?

3. If you look at cells under a microscope, cells all have a circle in them, called the nucleus. What is the nucleus? What does it contain?

4. The information in the nucleus isn’t stored on paper and ink books. What is it stored in?

5. In the nucleus is DNA, which stores information. What information is stored on DNA?

6. In our library metaphor, the nucleus is the library. What are the Chromosomes? What are the Genes?

7. What is a gene? What information does a gene hold?

8. Why is a red apple’s skin RED?

Chapter 3, Part 2- Moose, Guns, and other things not found on Flowers

“These are the petals,” Erica said, indicating the pink and white petals around the outside of the flower. “I think most people know what petals are. But do you know what the rest of these parts are called?” she asked.

Shawncy looked at the flower and thought for a moment. “I don’t think I do,” he admitted.

Erica crawled to the bottom of the flower and pointed out some little green leaves where the stem met the big pink petals. “These little green leaves are called sepals, and they are the little flower parts you see looking like a little flower in the bottom of the apples.”

Shawncy looked at the sepals, and then looked at the bottom of a nearby apple. Just like she said, there were little sepals at the bottom of the apple, like a little flower. “Well, look at that,” he said. “Sepals. Who knew?”

“And up here are two important parts to our discussion,” Erica said. “These long, tall skinny things around the flower are called **stamen**, and they are made of the tall bit, called a filament. The word

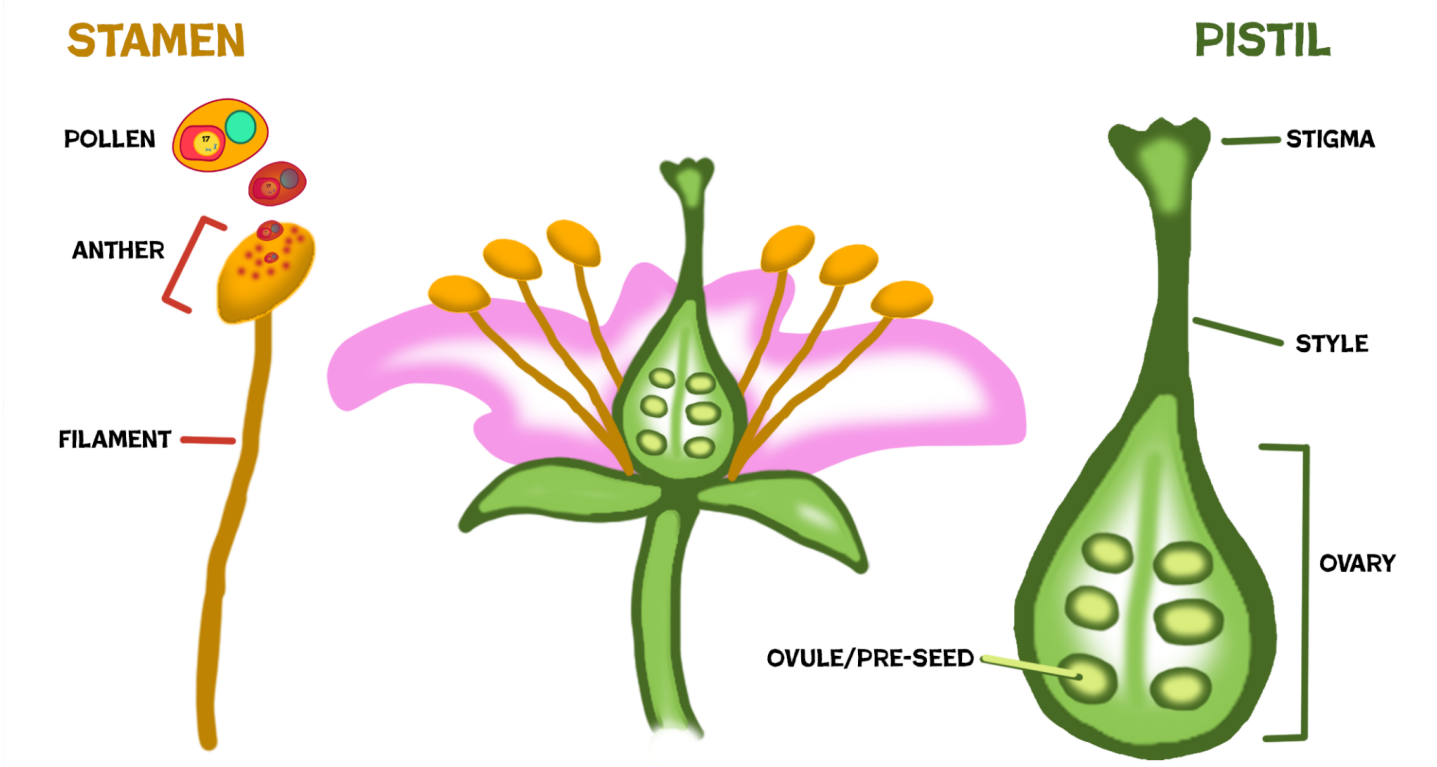
filament basically means thread, and these look like threads that stand here between the flower and this little part at the top of the stamen called an anther."

"Like on the top of a moose?" asked Shawncy.

"No, those things on the top of a moose are antlers," said Erica. "This part at the top of a stamen is an anther."

"Anther," Shawncy repeated. "And what does an anther do?"

"**The anther is the part of the flower that makes the pollen**," Erica explained.



"So in my tale," added General Byrd, "there were towns in the Blue County which made blue Library Seed Wagons to help start new libraries in new counties. The anther has the cells which make the pollen, which is our tiny little blue wagons carrying half of the books."

"OK, I think I understand," said Shawncy. "But where are the little pollen wagons going?"

“The pollen are trying to reach the female parts of a flower, here in the middle of the flower,” answered Erica. “It’s what we call the flower’s Pistil.”

“It’s got a gun?!?” said Shawncy with alarm.

Erica looked at the dapper little worm with a puzzled expression. Suddenly General Byrd spoke up. “Ah,” he said with an understanding nod. “Erica said the flower has a Pistil, not a pistol.”

“What’s the difference?” asked Shawncy.

“A pistol, with an “o”, is a handgun,” explained General Byrd. “**A pistil, with an “i”, is the female parts of a flower.**”

“Ah, I see,” said Shawncy. Then his eyes got wide and he said, “Hold on. Did you say the FEMALE parts of a flower?”

“That’s right,” said General Byrd.

“That’s very funny!” said Shawncy. “Imagine flowers being boys or girls. I guess this flower would be a girl then!” and he chuckled.

“General Byrd is right, Shawncy,” explained Erica. “**The Pistil is the female parts of the flower**.”

“So you’re telling me that this flower is a girl,” said Shawncy with a look of disbelief.

“No,” answered Erica. “It’s not a girl. We call the stamen the male part of the flower, and we call the pistil the female part of the flower.”

“I’m confused again,” admitted Shawncy.

“It’s because of the kinds of cells they make,” said Erica. “The stamen makes the pollen, which is like the Library Seed Wagons made by the BLUE Counties. For animals, the males make this kind of cell, so we call the part of the flower that makes it the *male part of the flower*. But the pistil makes a cell

which is like the Library Egg Wagon made by the RED counties. It has almost everything it needs, but it's still waiting for the second half of the books it needs to be complete. This is what female animals make, so we call this part of the flower *the female part*."

"I'm still confused, but it's starting to get clearer," said Shawncy. "The stamen is a blue county and the pistil is a red county. Please, continue."

"Here's how the magic happens," said Erica. "The male part of the flower- the stamen- makes pollen. The pollen is intended to get to the female part of a flower- the pistil- where it delivers its half of the books."

"Books, which we call chromosomes, because they're not actually made of ink and paper," said Shawncy.

"That's right!" exclaimed general Byrd. "They're made of DNA."

"So the pollen lands on the top of the pistil," said Erica, "and it delivers those books."

"The pollen goes into the pistil?" asked Shawncy.

"No," Erica replied. "Remember, the pollen is just the wagon. It's not the books. It carries the books for the journey. The books are wrapped up in a little cell called a germ cell, which gets sent into the pistil."

"What?" exclaimed Shawncy with alarm. "Are you telling me that flowers make each other sick?"

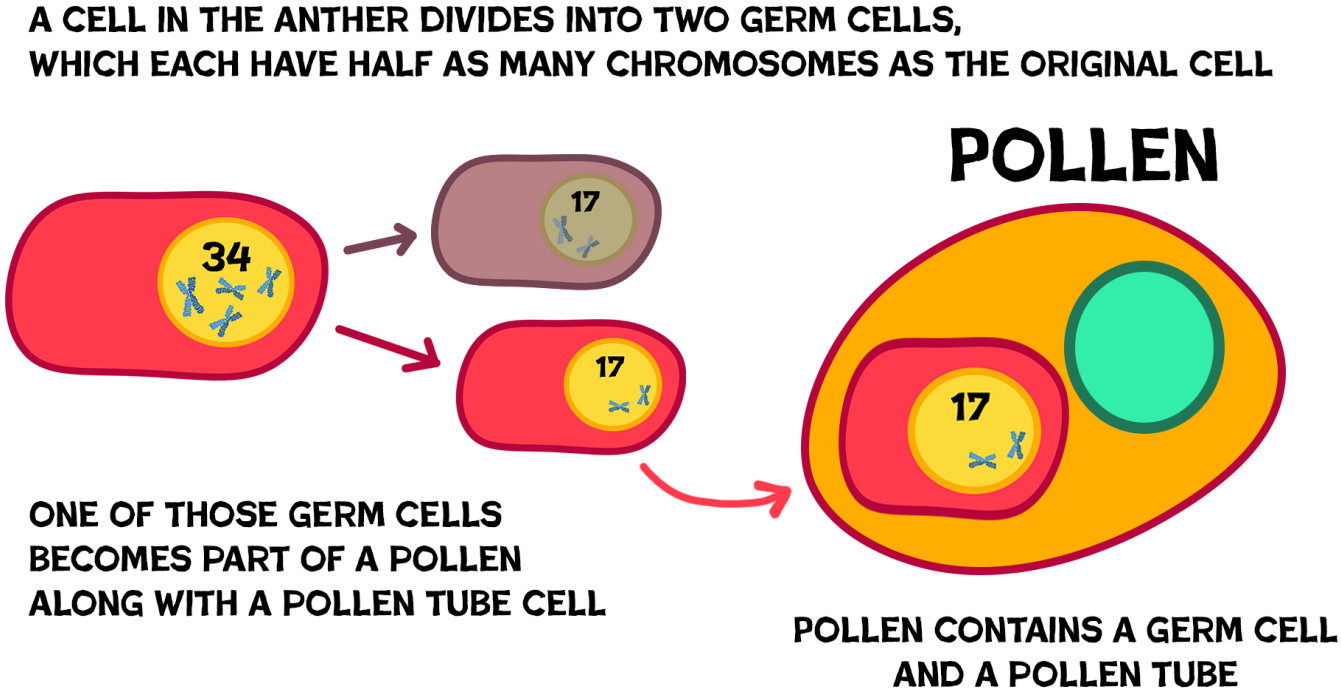
"Sick?" asked Erica. "No, of course not. What are you talking about?"

"You just said pollen puts germs into the pistil!" said Shawncy.

"Oh," said Erica, suddenly understanding where the little worm had gotten confused. "A germ cell isn't the kind of germ that makes you sick," she said. "The word germ in this case basically means 'seed,' because, when it gets planted in the pistil, it makes a baby tree grow."

“So a germ cell is like a seed that makes… a seed?” asked Shawncy.

“The terms can be confusing because we use the same words in different ways sometimes,” said General Byrd. “A germ cell isn’t a seed, but it carries half of the DNA information which makes a seed possible.”



“A germ cell is like a bag full of the books that were being carried by the wagon?” asked Shawncy thoughtfully.

“Yes!” exclaimed General Byrd. “Imagine that the books are all put in a big bag, and then the bag is put on the wagon. The wagon arrives at the new library, and the bag full of books is carried inside. That bag full of books is the germ cell.”

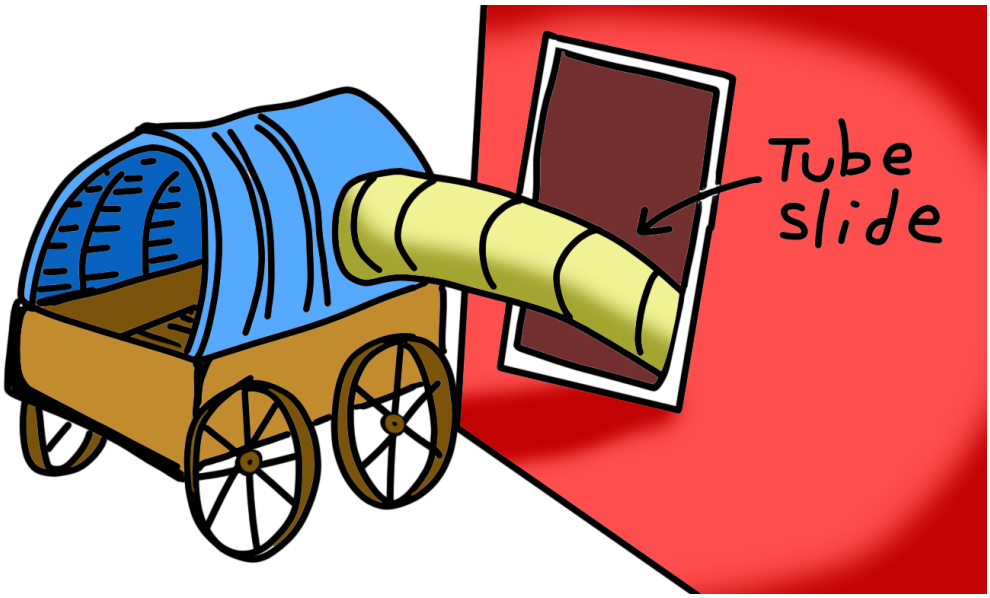
“The pollen wagon parks outside the library,” said Shawncy, talking it over with himself to make sure he understood, “and the bag full of books is carried into the new library so it can have two copies of every book. Have I got that right?”

“I believe you do, my boy,” replied General Byrd.

“The wagon has one more thing in it,” said Erica. “It’s got a tube slide.”

“Is this for real life,” asked Shawncy, “or just in General Byrd’s old west tale?”

“Both!” replied Erica. “Pollen makes what is called a pollen tube, which acts like a tube slide for the germ cell to slide down into the pistil.
“If you can imagine the wagon making a tube slide that extends from the wagon into the library so the bag of books can be delivered, you can imagine what it’s like when **the pollen makes a pollen tube to deliver the germ cell to the egg in the ovary**.”

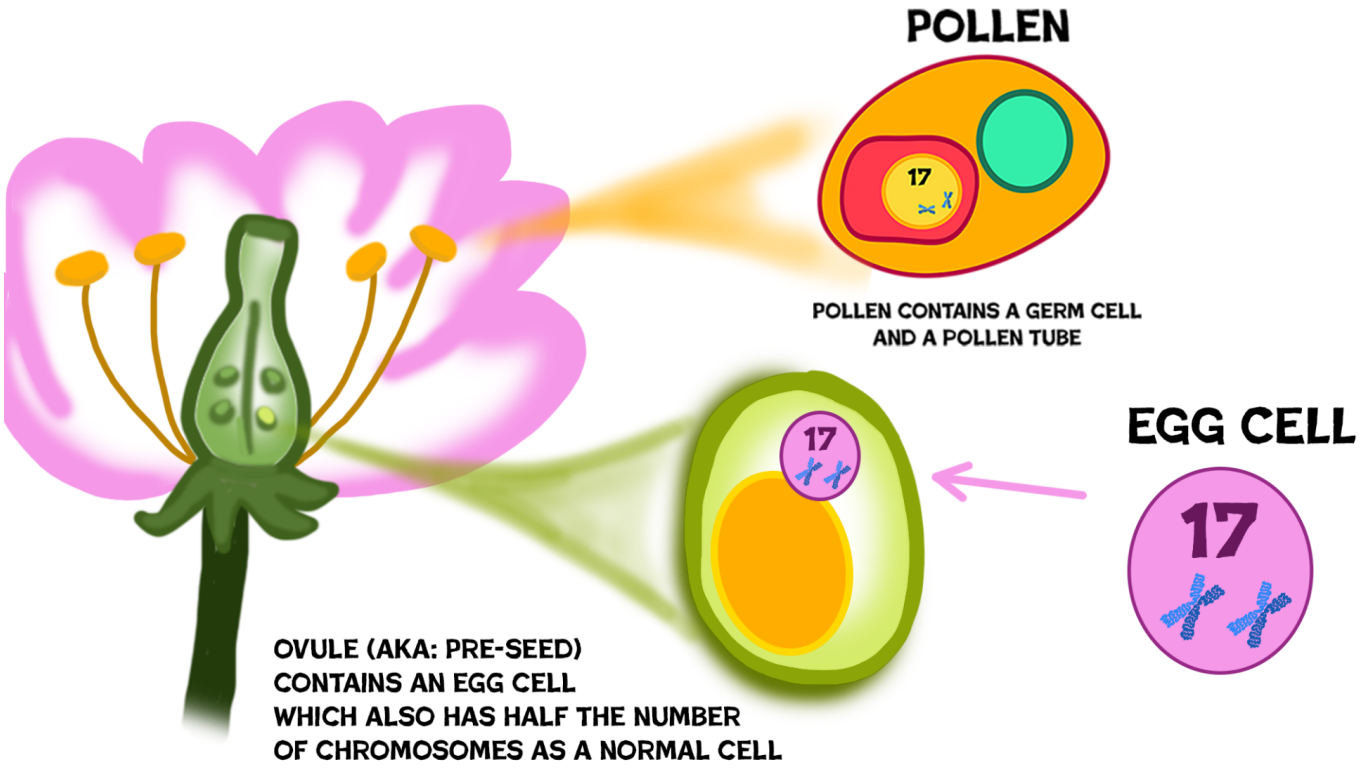


“You had me,” said Shawncy, “but then you lost me again. Are we still talking about flowers?”

“Yes, of course,” said Erica.

“But… flowers don’t lay eggs,” said Shawncy. “Do they?”

“Here’s another example of what I was talking about,” said General Byrd. “When we use the word ‘egg,’ we often mean the round little thing that chickens or turtles hatch out of. What Erica was referring to was a cell we call an ***‘egg cell,’*** which is a little different.”



“That’s right,” said Erica. “**The egg cell is that library that has one of every book, but it still needs the second copy of each book**. Don’t think about an egg cell like a chicken egg, but like that Library Egg Wagon from the Red County. ”

“So the pollen is the blue seed wagon,” said Shawncy, “with a bag full of books. The bag full of books is the germ cell. The library with one copy of each book is the egg cell, and when the wagon makes a tube slide, it sends the bag of books into the library, completing its collection of books, and it can now open for business.”

“You’ve got it!” exclaimed General Byrd.

“I’m getting there,” said Shawncy. “But tell me again what part of the pistil makes the egg cell.”

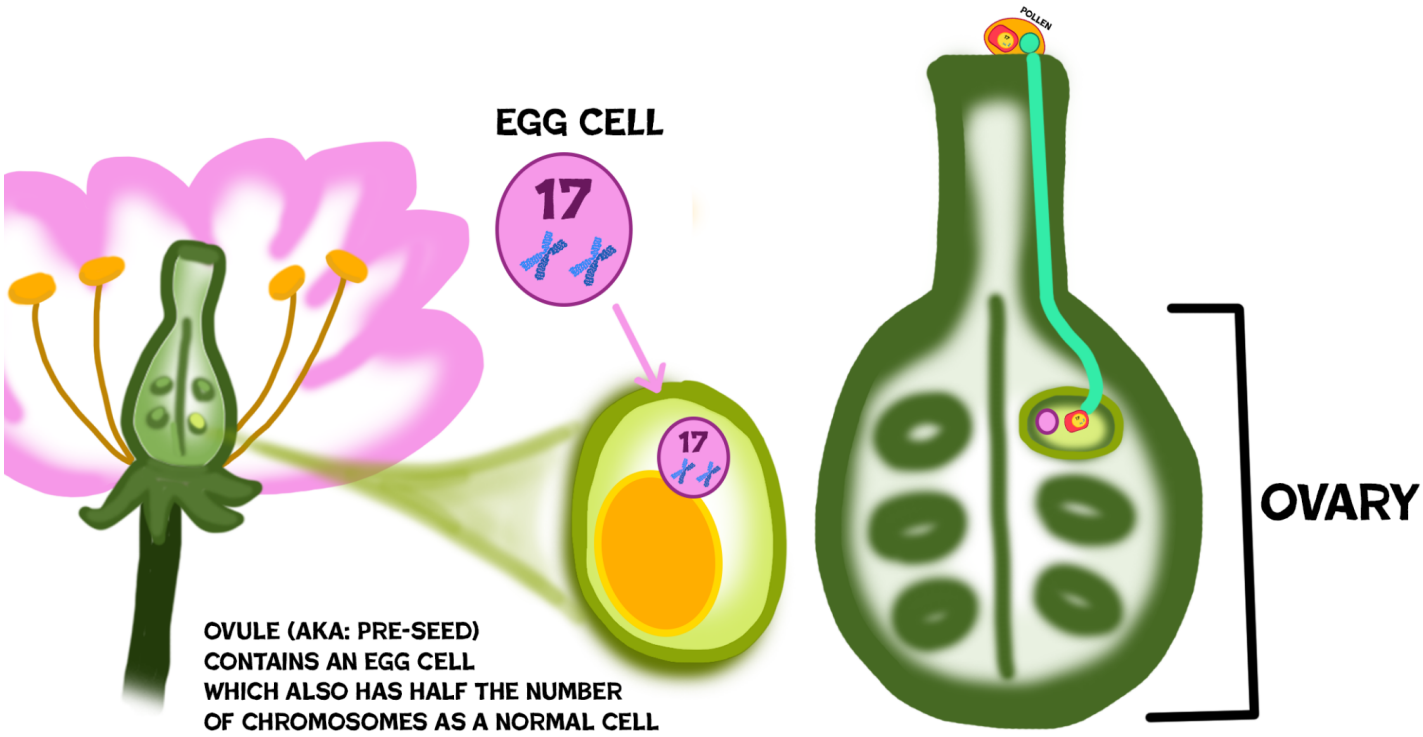
“At the bottom of the pistil,” answered Erica, “is a little round part called the Ovary. The ovary makes ovules.”

“Ovules?” said Shawncy.

“Yes. These words are all connected,” said Erica. “The word ovum means ‘egg.’ That’s where these names come from. The ovary makes the ovum- the egg cells. Ovule means ‘little egg’ and it’s the part of the flower which will become the seed. The egg cells are inside the ovules, and the ovules are inside the ovary.”

Shawncy let it roll around in his head for a moment. “So, the ovum is in the ovule in the ovary?” Shawncy blinked a few times. “I’m going to be honest," he said. “I don’t think I’m going to remember any of that in thirty seconds.”

“How about this,” said Erica. “Let’s say, **the egg cell is in the pre-seed, which is made in the part of the flower called the ovary**.”



“Why are you calling it a pre-seed?” Shawncy asked.

“Because until it is fertilized,” explained Erica, “it’s not a seed yet.”

“Fertilized?” repeated Shawncy.

“Yes,” said Erica. “**When the pollen delivers its germ cell to the egg cell and they merge into one cell, that is called fertilization**. Or, along the lines of our metaphor tale, when the seed wagon from a blue county sends its bag of books, by way of the tube slide, into the library made of an egg wagon from a red county, and the books are all put on the shelves so that there is two copies of every book in the library- the pre-library becomes a full library, which allows the pre-town to become a functioning town which can do all of the things that a town needs to do.”

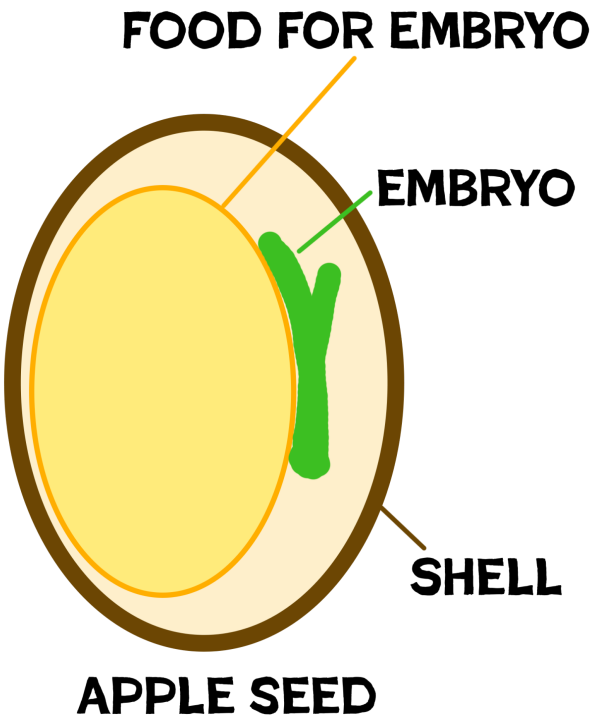
“Is fertilization the point where an egg cell becomes a seed?” asked Shawncy.

“No,” replied Erica. “Fertilization is the point where an egg cell and a germ cell become a baby apple tree.”

“I thought the seed was the baby tree!” said Shawncy with surprise. “Doesn’t a seed become a tree when you plant it?”

“Not really,” said Erica. “It’s more accurate to say a seed has a tree inside it.”

“Perhaps I can help explain,” said General Byrd. “But to do so, we’re going to need to go get some brunch.”



QUESTIONS!

1. What does the anther do?

2. What is the female parts of a flower?

3. What part of the flower do we call the male part of the flower?

4. What is a “germ cell”? Does it make the flowers sick?

5. How does the DNA in the pollen get into the flower’s pistil?

6. Where is the pollen trying to deliver its DNA to?

7. In General Byrd’s fictional Old West tale, what would be the equivalent of the ‘egg cell’ in the ovary of the flower?

8. Erica calls the ovules the “pre- seeds.” What are they and where are they found?

9. What is **fertilization?**

Chapter 4: Apple Seeds Have Baby Trees

General Byrd, Shawncy the dapper worm, and Erica the Honey Bee traveled to the farmer's house on the edge of the apple orchard. They landed on the kitchen window sill and General Byrd called, "I say! Good day! Are you in, Butters?"

"Greetings General," said a soft voice. General Byrd, Shawncy and Erica looked up to see a caramel colored cat sitting on top of the refrigerator. "What brings you to the kitchen?"

"Our dear Shawncy needs to see an egg," he explained.

"I think I can do that," she said.

"Ah, and this is our friend Erica. She's helping me explain the mysteries of life to Shawncy."

"No one better to explain the mysteries of life than the birds and the bees," said Butters.

"Erica, this is Miss Butterscotch Francine Dutchess Twinkles Stormbringer."

"You may call me Butters," she said, softly leaping down from the fridge to the counter top.

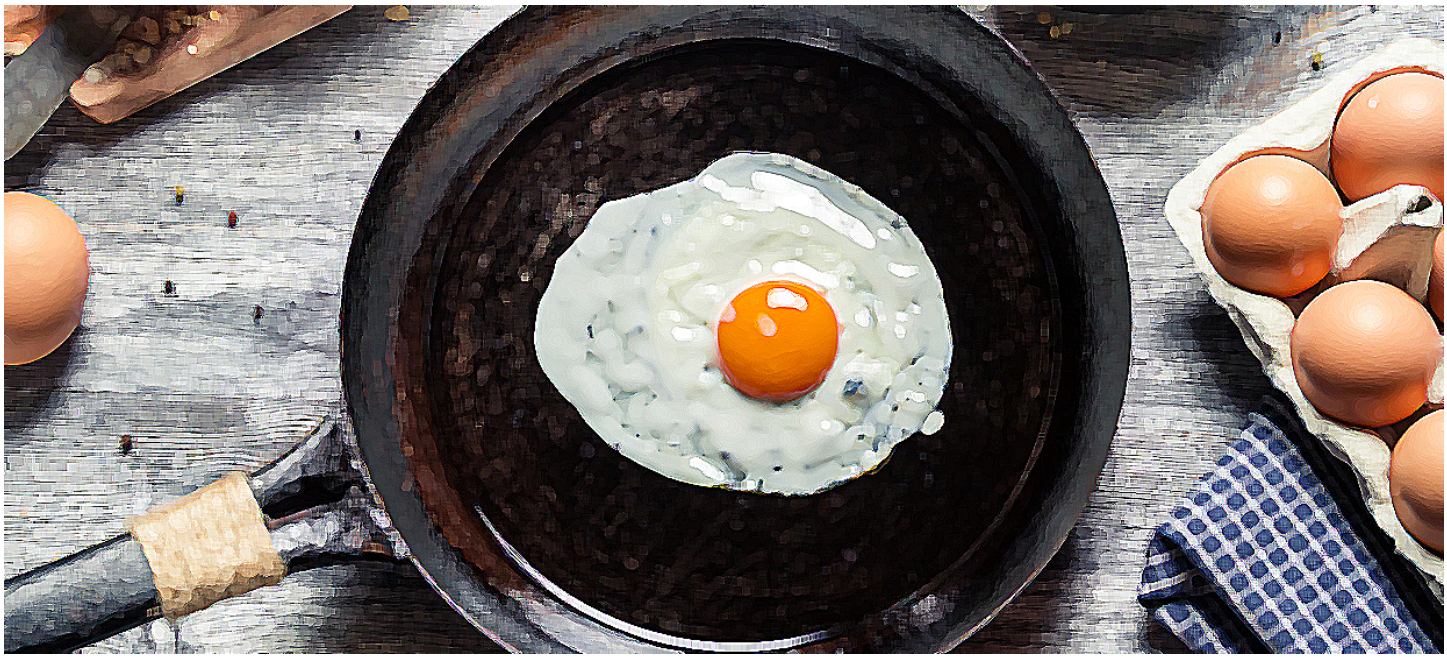
"It's nice to meet you!" said Erica.

Butters pushed open the refrigerator door. "How would you like your eggs, General?" she asked.

"Over easy, if you please."

"Coming right up."

Butters cracked an egg into a warm frying pan and the others watched as she cooked. The bright yellow yolk sat in the middle of the pan while the egg white slowly turned from clear to white.



“Now, my dear Shawncy,” said General Byrd, “when we eat an egg for breakfast, are we eating a baby chicken?”

“My heavens!” exclaimed Shawncy. “I certainly hope not. But…” he hesitated, staring into the pan. “Isn’t the yellow bit the chicken part? I mean… isn’t that what the yolk is? The baby chicken?”

“It’s not,” said Butters.

“Oh thank heavens,” replied Shawncy. “But then, what is the yolk?”

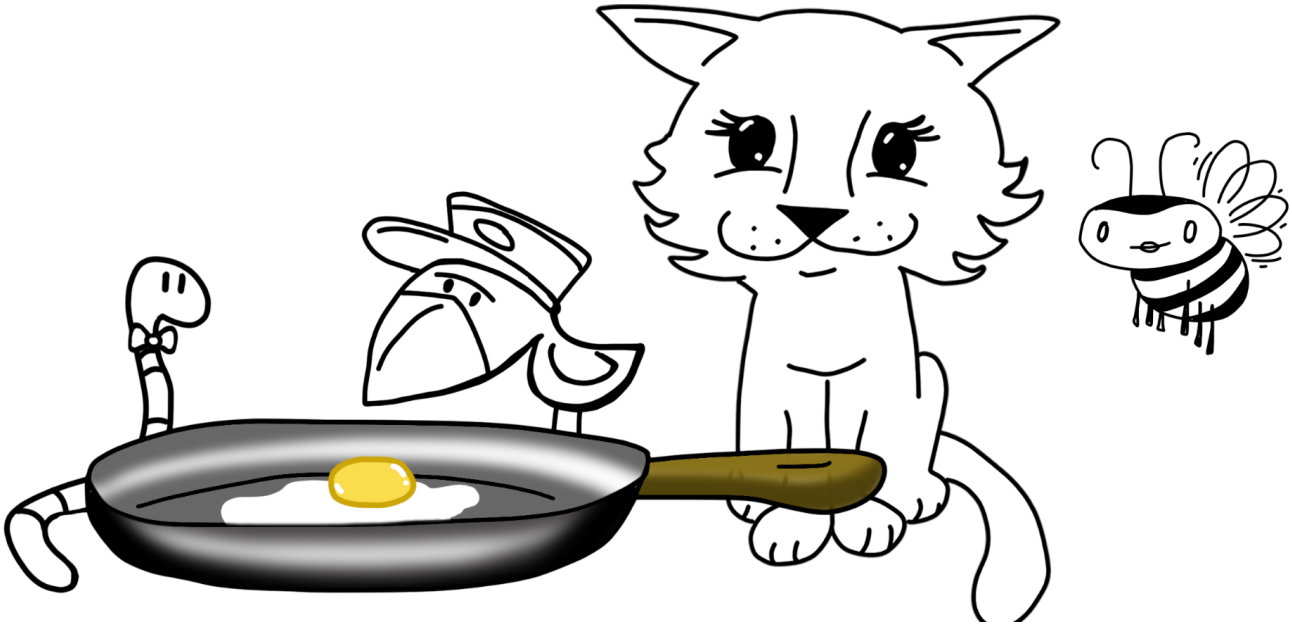
“It’s the part of the egg that *would* feed the baby chicken if there was one in there,” Butters explained.

“Huh,” said Shawncy, taking it all in. “But, why isn’t there a baby chicken in there?”

“The egg hasn’t been fertilized,” replied General Byrd.

“Do you remember how I told you that the pre-seed in the ovary of the apple flower has an ‘egg cell’ in it?” asked Erica.

“Yes,” said Shawncy. “And when the pollen sends its DNA down the pollen tube slide, the egg cell and the germ cell combine into one, and we call that fertilization. OH!” exclaimed Shawncy. “But if some pollen gets on the egg, it makes a baby chicken!”



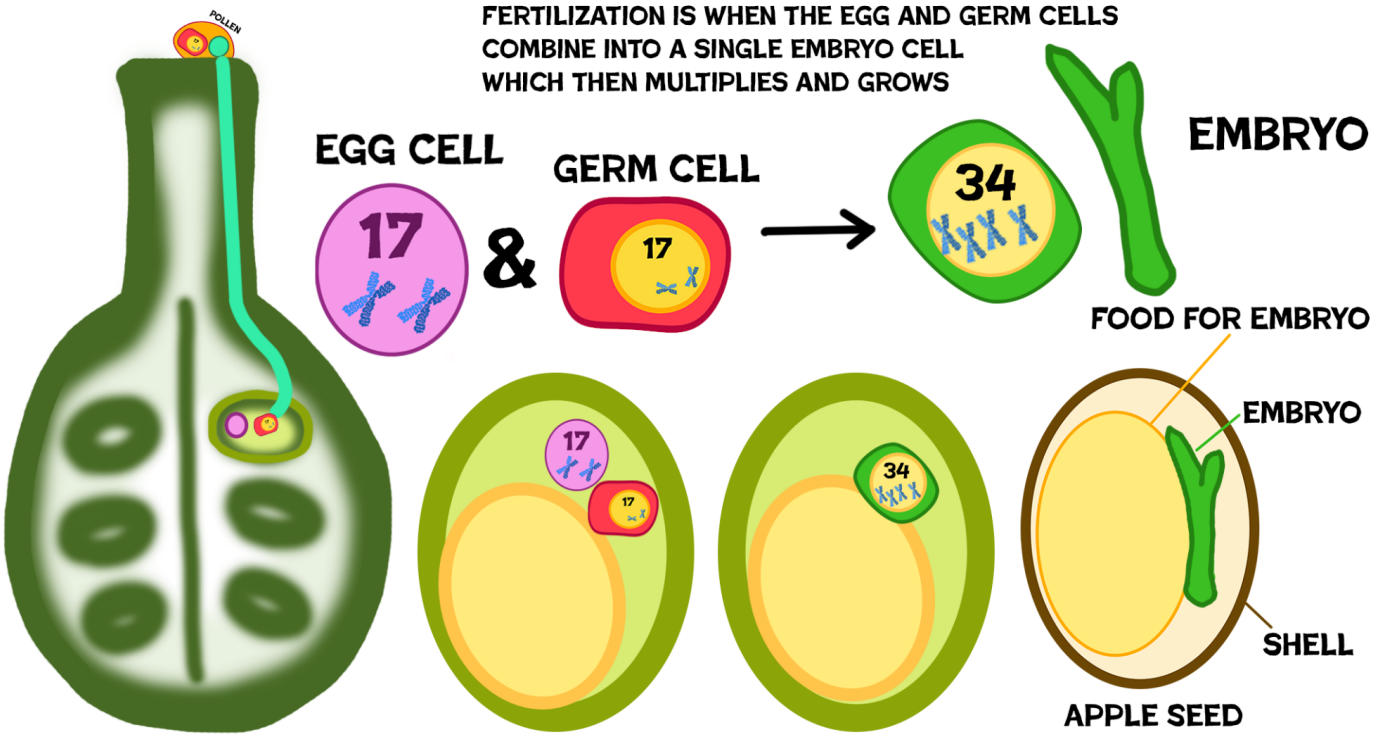
“Not exactly,” said Erica. “You see, **the pollen is VERY specific**. **Apple tree pollen can ONLY fertilize an apple tree egg cell to make an apple tree seed**. Apple tree pollen can never fertilize a chicken egg, or even another kind of tree, like a cherry tree or a lemon tree.”

“Oh, that’s too bad,” said Shawncy. “I would like to try a strawberry apple.”

“But I don’t think anyone wants a chicken berry,” said General Byrd.

Shawncy’s eyes got big and he shook his head in disgust. “Ew,” he said. “I suppose not.”

Butters plated the egg and the four of them looked at it for a moment.



“So, this egg doesn’t have a baby chicken,” said Shawncy.

“Correct,” said General Byrd. “An unfertilized chicken egg does not have a baby chicken inside of it. Rather, it is a chicken pre-seed.”

“Chickens don’t come from seeds, they come from eggs,” said Shawncy. “Unless what I am going to learn today is that everything I know is wrong.”

“No, not everything,” said General Byrd. “But we do need to clarify what a few things mean. Again, the way we use certain words can get confusing. This breakfast dish is what we call an egg, but the cell that needs DNA from a pollen’s germ seed is also called an egg. So let me explain. This thing we call a chicken egg, contains an unfertilized chicken egg cell.”

“I don’t see one,” said Shawncy, squinting at the plate.

“You aren’t likely to,” said General Byrd. “It’s a single cell, and far too small to see without a microscope. But the egg cell is somewhere in an unfertilized egg. If the egg cell was fertilized, that

egg cell would become a baby chicken, and the **yolk is the food that the baby chicken would live on** until he hatched out of the egg shell."

"The yolk is chicken food?" exclaimed Shawncy.

"Essentially, yes," replied General Byrd. "You've seen a chicken hatch out of an egg shell haven't you?"

"Once or twice," said Shawncy.

"Did you ever wonder what they ate while they were in the egg, growing and developing?"

"No," admitted Shawncy, "but apparently I should have. And it's the yellow egg yolk?"

"That's right," said General Byrd. "But since there is no baby chicken in an unfertilized egg to eat the yolk, we can eat it for breakfast."

And so they did.

"That was delicious. Thank you, Butters," said Shawncy.

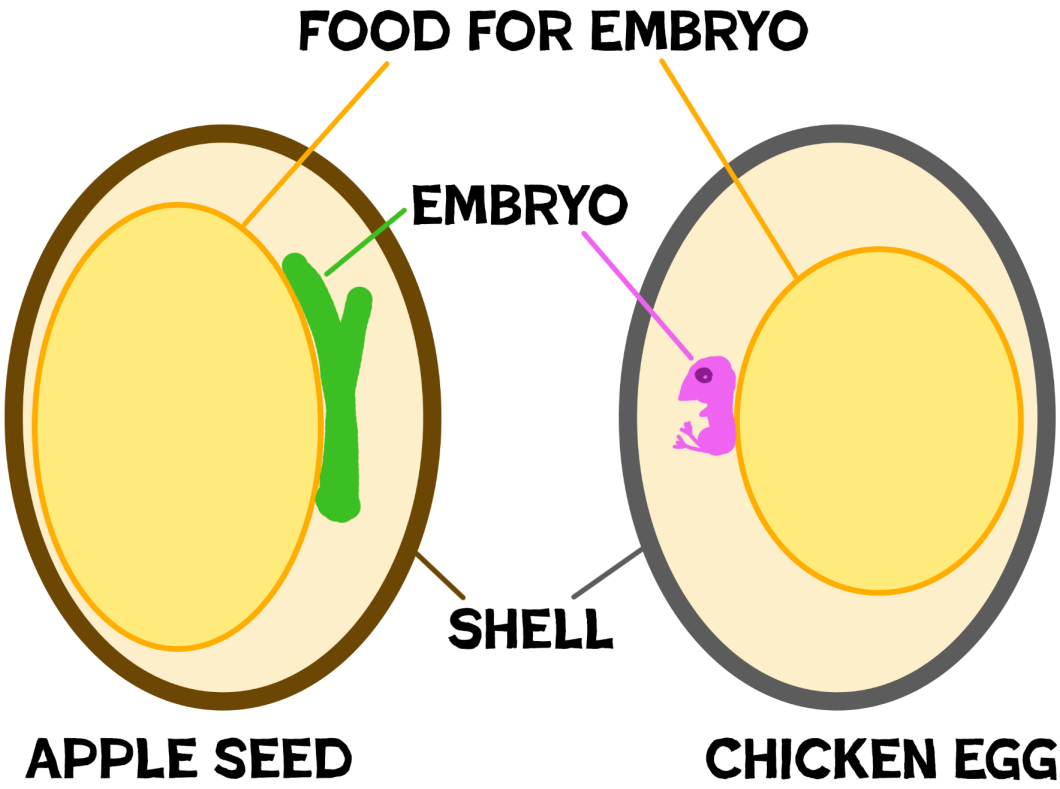
"My pleasure," she purred.

"But what does this have to do with the apple tree?" Shawncy asked.

"Ah yes," said General Byrd. "I had almost forgot. Remember what I said about the baby chicken in the egg? That he has the yolk to feed him until he can hatch and eat something outside of the egg?"

"Yes, of course," Shawncy replied.

"Well, that is essentially what a seed is like," explained General Byrd. "**Like the chicken egg, there is a hard outer shell- what's called a seed coat. Also, there is a food source for the baby, and of course, there is the baby."**



“There is a baby chicken in an apple seed?” asked Shawncy.

“No, no,” said General Byrd. “There is a baby apple tree in the apple seed. The pre-seed in the apple blossom ovary has an egg cell and some food that the baby tree can live on, just like the yolk in the chicken egg. Once the apple tree egg cell is fertilized, it becomes a baby apple tree, and it lives on the food in the seed as it grows, until it can be planted and break out of its shell to live on sunlight like other plants.”

“So an apple seed,” said Shawncy thoughtfully, “is like a chicken egg. Or, perhaps an egg is a chicken seed.”

“Except you don’t plant chicken eggs,” added Butters. “They hatch above ground.”

“So a seed isn’t a baby tree any more than an egg is a baby chicken,” said Shawncy. “They both contain a baby in a shell, with some food for the baby to live on until it’s big enough to get out of the shell.”

“That’s right!” exclaimed General Byrd. “By golly, I think he’s got it!”

“I think I do!” said Shawncy. “How very miraculous! Chicken seeds. I never.”

“Nobody calls them Chicken seeds,” added Butters.

“I think I shall,” said Shawncy.

“I’m not one to argue with a worm,” said Butters.

“Well, Shawncy,” said General Byrd, “we’ve almost answered your question.”

“What question was that?” asked Shawncy.

“You wanted to know why our apples are red,” General Byrd replied.

“Oh Yes!” exclaimed Shawncy. “I’d almost forgotten. Yes, when there are apple trees that make apples that are green or yellow, why doesn't our apple tree make green and yellow apples?”

“To finish answering your question, we need to head back out into the trees,” said General Byrd. “Would you care to join us, Butters?”

“No thank you, General,” she purred. “There is a sun puddle in the living room which I simply must lay in. And then I need to remind my humans to feed me.”

“You don’t need them to feed you,” said Shawncy. “You can cook! You could just make something for yourself.”

“Of course I could,” Butters replied. “But what fun is that?” And she quietly slipped away to the living room.

QUESTIONS!

1. Can pollen from an apple tree fertilize a chicken egg?

2. What is the purpose of the Yolk of an egg?

3. What three parts do seeds and eggs have in common before they are fertilized?

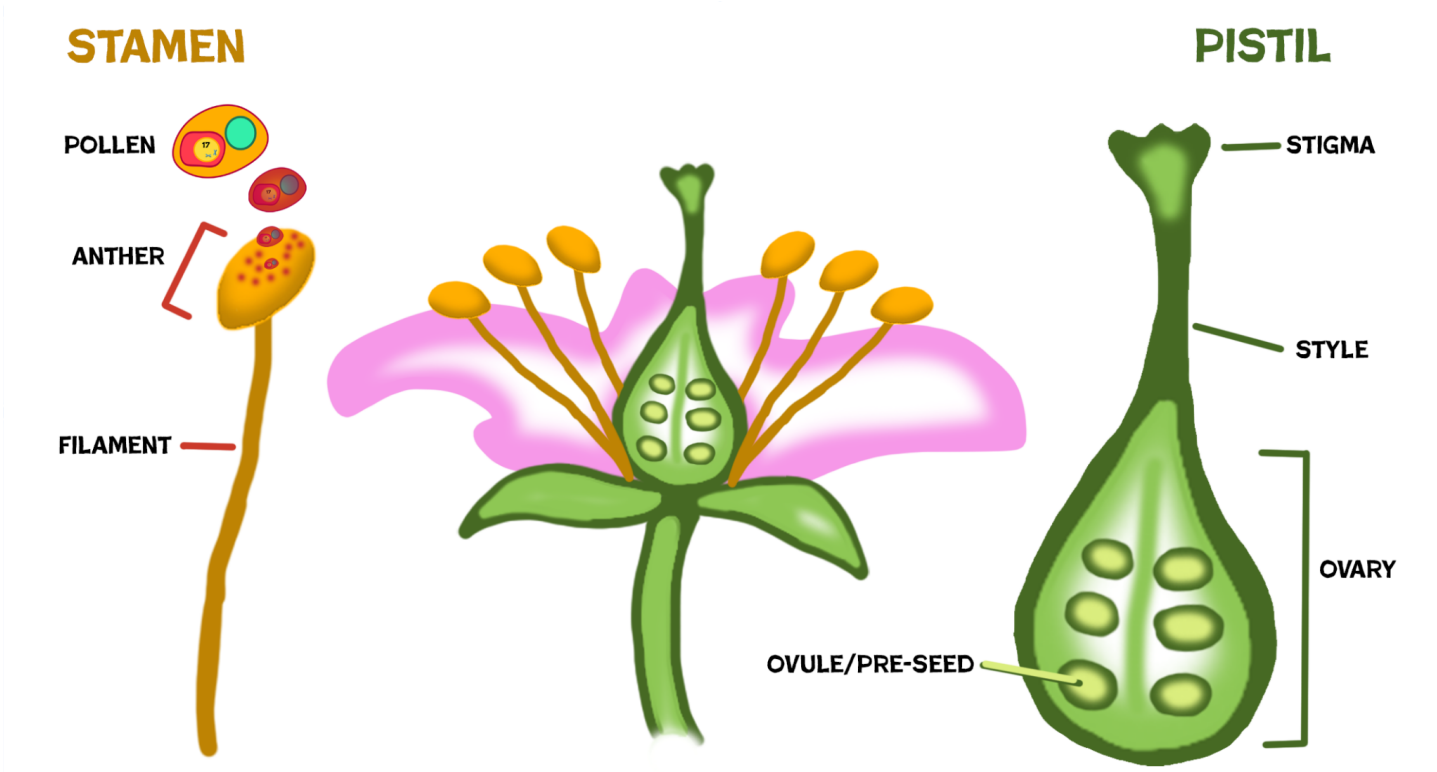
4. What change happens in seeds and eggs after fertilization?

Chapter 5: Apple Seeds and Little Green Apples

General Byrd, Shawncy and Erica returned to their apple tree out in the orchard. They flew back to the top of the tree to revisit the flower that was still growing there.

“Now let me see if I have all of this straight," said Shawncy. “These parts around the middle of the flower are called the **stamen**, which we call **the male part of the flower** because they make germ cells, and the part on the top called the anther makes the pollen which carries the germ cells. The part in the middle of the flower is called the **pistil** and it's what we call **the female part of the flower** because it makes the egg cells.”

“So far so good,” said Erica encouragingly.



“If pollen from an apple tree blossom,” Shawncy continued, “gets to the pistil of an apple tree blossom, it can fertilize the egg cell inside a part of the pistol called the ovary. The ovary has a collection of pre-seeds, each with its own egg cell waiting to be fertilized.”

“That sounds about right,” said General Byrd. “Good show!”

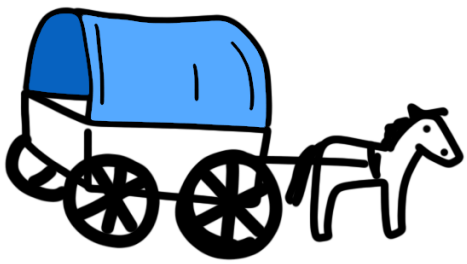
“And once an egg cell gets fertilized,” Shawncy continued again, “it becomes a baby apple tree plant, and the pre-seed becomes a seed. Which is a lot like a chicken egg except that you plant them in the ground. The apple seeds, not the chicken eggs.”

“It sounds like you've learned a lot today," said General Byrd. “But before we finish answering your question, I believe we need to address the way in which Erica is like a horse.”

“Oh yes!” said Erica. “It's rather simple really. The job of the horse is to simply make it faster and easier for the wagon full of books to get to the library that is waiting for it. You could imagine one of those wagons simply rolling downhill and accidentally winding up where it needed to go. But if you had a horse you knew would go from your town to another town, then attaching your wagon to that horse would be a very efficient way of making sure your wagon actually reached its intended destination. That's what honey bees do for pollen.”

“How do you do that?” asked Shawncy.

“You see, while we are going from flower to flower gathering nectar so we can make honey, we also gather up a lot of pollen and we carry it with us to the other flowers that we visit. I’ll be honest- we don’t even mean to. It just gets everywhere. So as I'm going from apple blossom to apple blossom, I'm carrying pollen from one flower to the next and making the speed at which the apple tree egg cells get fertilized much faster. Just like you could let your wagon roll downhill, pollen can get dispersed just by being blown away in the wind. And if the wind carries it to another flower and it lands on the pistol, then that apple tree’s egg cells can get fertilized and produce seeds. But when bees are working it's a bit more certain that the pollen will get where it needs to go.”

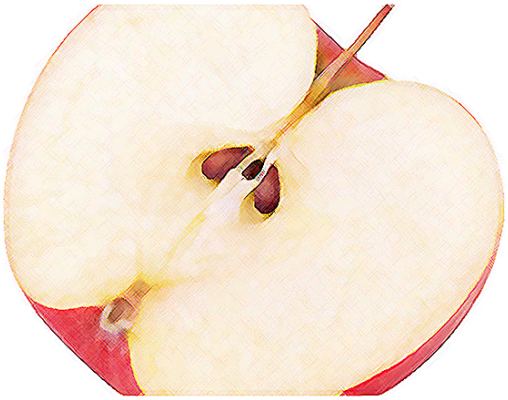


“I've always liked the honey you produce,” said Shawncey, “but I've never realized how important you are to this orchard.”

“I'm like a tiny horse pulling a wagon full of books,” said Erica.

“Yes," said Shawncy, “but only in General Byrd’s fictional old-timey Western tale. But I still haven't figured out how these apple blossoms can magically turn into apples. How does a flower become a fruit?”

“That's because the thing that you are calling an apple fruit,” said General Byrd, “is already a part of the flower. If you open up an apple, what do you find inside?”



“There are apple seeds inside an apple,” answered Shawncy.

“And where did those seeds come from?” asked General Byrd.

“They were in the ovary of an apple blossom,” said Shawncy.

“So here's the miracle that answers your question,” said General bird. “Once the apple blossom’s egg cells are fertilized and the pre-seeds become seeds, **the ovary of the apple blossom becomes the apple fruit.** It grows and grows until it becomes the apple. The other parts of the flower shrink or fall off except for the couple remaining leaves on the bottom of the apple, which are on the bottom of the apple because it becomes so heavy that instead of growing up like the flower did, it hangs down because it's too heavy to stand up anymore.”

“So you are telling me that an apple fruit is an upside down apple blossom?” asked Shawncy.

“That is exactly correct," said General Byrd.

“My goodness!” exclaimed Shawncy. “That truly is a miracle.”

“Now let's finish answering your first question,” said General Byrd. “There are apple trees that make apples that are green or yellow or red and yellow but this tree only produces apples that are red. Why does this tree produce red apples?”

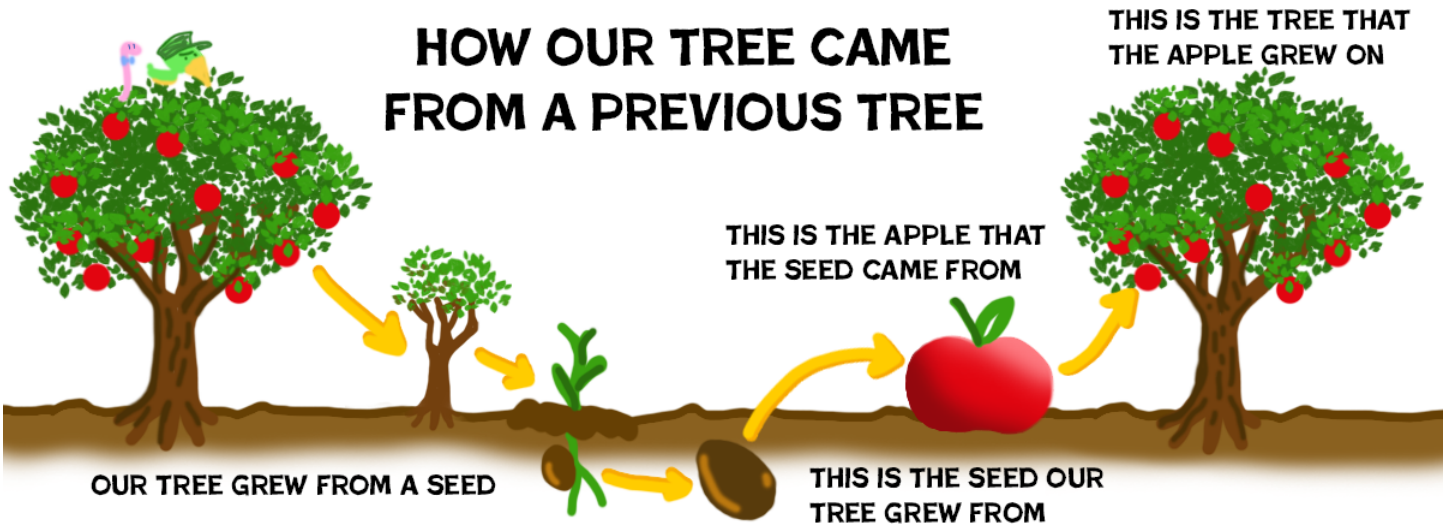
Shawncy thought for a moment and then said, “If the apples are red, it’s because it carries the instructions for making red apples. It has a chapter- a gene- that tells the apple skin to be red.”

“But how many copies of each book does the library have?” asked General Byrd.

“Oh, that’s right!” said Shawncy. “It has two. So, that means that there are two chromosomes with the gene for apple color, which means two genes with the instructions to make the apple red.”

“A reasonable deduction,” said General Byrd. “But now, where did those chromosomes come from?”

Shawncy thought again, thinking very hard about the tree he called home. “Well, this tree was once a seed. And a seed is made when a pollen’s germ cell combines with a pre-seed’s egg cell. So, this tree’s chromosomes must have come from a previous tree’s pollen and egg cells.”



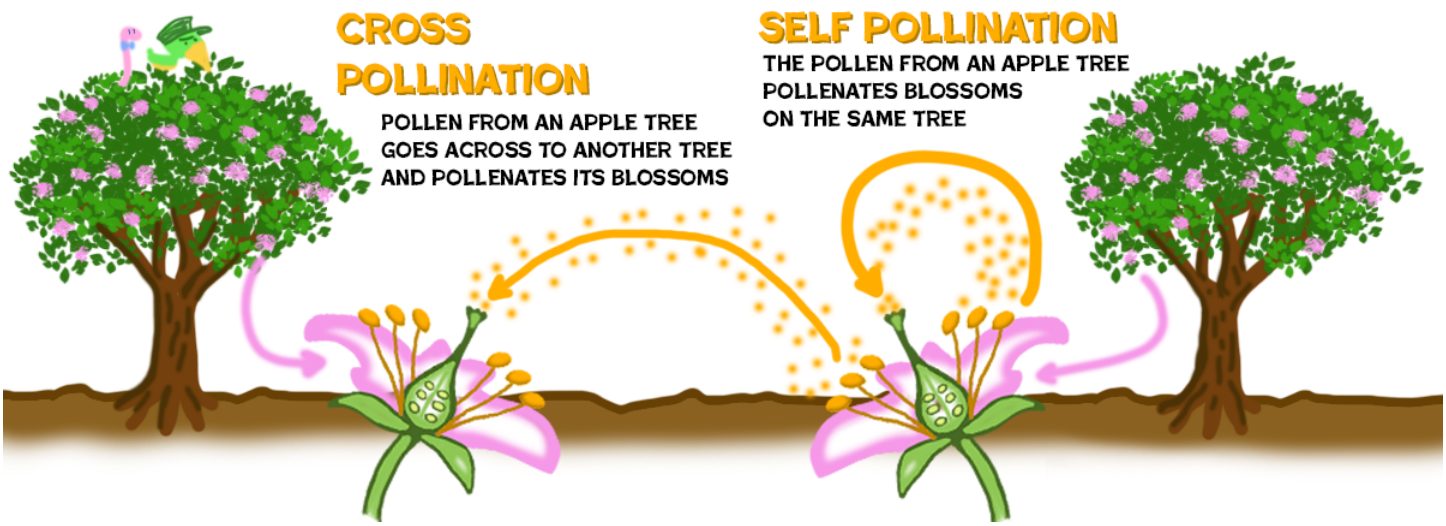
“Very good!” said General Byrd. “One of the first things to keep in mind is that **every living thing comes from a previous living thing of the same kind.** Apple trees come from seeds which come from previous apple trees. Chickens hatch out of eggs which were laid by previous chickens.”

“Everything has a mom and dad,” said Shawncy.

“Essentially, yes,” said General Byrd. “And that mom and dad- or in this case, male part of the flower and female part of the flower- are the same KIND of plant or animal as the babies they produce.”

“Apple blossoms can only be fertilized by apple blossom pollen?” said Shawncy.

“Yes, that is correct,” said General Byrd. “Now, if this tree we live in has two genes for making apples red, and **its genes came from two previous trees** (one providing the pollen and the other which provided the egg cell) those trees must have had apples that were…?”



“Oh!” exclaimed Shawncy. “They must have also had red apples because they had the gene for making red apples! And our tree has those red genes because it got them from those previous trees!”

“And if a tree makes green apples,” asked General Byrd, “what can we deduce?”

“If an apple tree has green apples,” said Shawncy thoughtfully, “then it must have genes that tell it to make green apple skin, which means it got those genes from previous apple trees that also had green apples.”

“What if,” said Erica, “a tree has yellow apples?”

“Then it came from two apple trees with yellow apples,” said Shawncy proudly. “Because the tree with yellow apples has two genes for yellow apples, which means it got those from trees that also had two genes for yellow apples.”

“Almost,” said Erica with a smile.

“Almost?” repeated Shawncy. “I thought I was starting to understand all of this.”

“I too would like to know where Shawncy has gone wrong,” added General Byrd.

“In that case,” said Erica, “grab Shawncy and follow me.”

General Byrd picked up Shawncy with his little bird feet and followed Erica to a different row of apple trees. They landed on a branch and Erica said, “Take a look around.”

Shawncy and General Byrd looked around at the apples growing on the tree they now stood on. “Say!” exclaimed Shawncy. “These apples are both red AND yellow!”

“How extraordinary,” observed General Byrd.

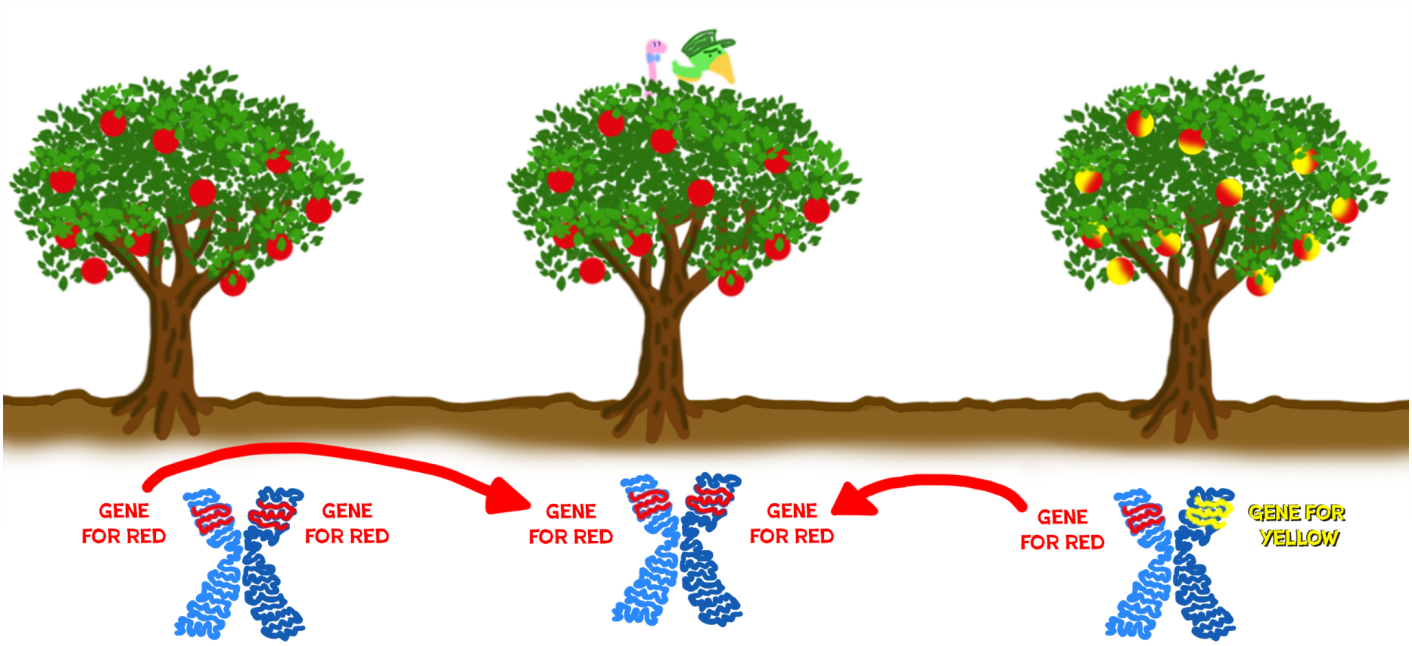
Each apple on this tree had apples that were not red or yellow. Instead, each apple had red areas and yellow areas. An apple might look yellow on one side, but once you walked around to the other side, it might look like a red apple!

“So if these apples are both red and yellow,” said Erica, “what do we know about them?”

“They must have one gene for red,” replied Shawncy, “and another gene for yellow!”

“Aha!” said General Byrd. “This is like the churches in my old western tale when the book in the library said to paint the churches blue and white.”

“Sort of,” answered Erica, “but it’s actually a little different. Instead, imagine that one book said to paint the church blue, and the other copy of the book said to paint it white, and the church painting team checked out both books.”



“So, one gene is telling the trees to make red apples,” said Shawncy, “and the other gene is telling it to make yellow apples…”

“And the tree is using both sets of instructions on each apple!” added General Byrd.

“Now you’re getting it!” exclaimed Erica cheerfully. “But now let’s imagine that this tree makes pollen. What instructions will its pollen carry to the flower it fertilizes?”

“Since it carries one gene for red and one gene for yellow,” said Shawncy, “the pollen will have either one or the other. Say, that means one of the pollen that gave our tree the gene for red apples might not have had red apples. It might have been like this tree!”

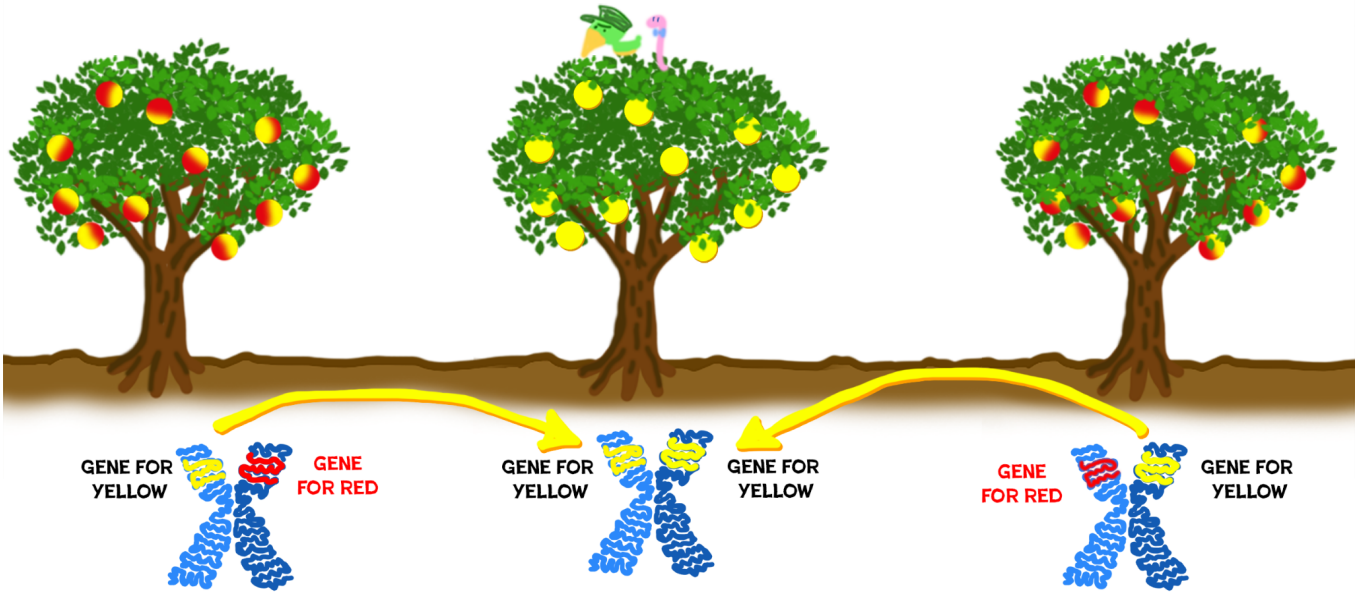
“And if a pollen from this tree sent a pollen to a tree with the gene for yellow,” added General Byrd, “then the new apple tree which results might have two genes for yellow and produce only yellow apples.”

“My goodness,” said Shawncy. “This keeps getting more complicated.”

“There are all kinds of ways that genes can interact,” said Erica. “What is certain is, if a plant like one of these apple trees has a gene, it’s because it got that one gene from a previous tree that had that

one gene. Your tree might have two genes for red apples, but it might have gotten one of those genes each from a tree like this one, that had red and yellow apples."

"That makes sense," said Shawncy. "Everyone always said I look like my father, but I have my mother's eyes. I think I'm starting to see why that makes sense."



QUESTIONS!

1. Do flowers **NEED** bees in order to be pollinated? Why or why not?

2. What part of the apple blossom flower becomes the apple fruit?

3. General Byrd says "**every living thing comes from a previous living thing of the same kind."** What does this mean?

4. If their apple tree has two genes for making the apples red, where did those genes come from?

5. Erica takes General Byrd and Shawncy to a tree with apples that are both red and yellow. Why does this tree make apples that are two different colors?

6. Their tree has only red apples. It grew from a seed that came from a previous tree when a pollen's germ cell combined with an ovary's egg cell. Is it certain that the trees that provided the pollen and egg cell also had ONLY red apples? Why or why not?

Chapter 6: How Frogs, Fish and Chickens Pollinate

Shawncy, General Byrd and Erica the Honey Bee were enjoying a red and yellow apple, and noting how it was subtly different in flavor than the entirely red apples they normally enjoy on their own tree. Shawncy was enjoying the things he had learned to help him answer his question, which was *"Why are our apples red, when there are apple trees that make apples that are green or yellow? Why doesn't our apple tree make green and yellow apples?"* He now knew a good deal about why the apples on his tree were red, and why the apples on this tree they were snacking on were both red and yellow.

Shawncy had discovered the answer to his question by entertaining General Byrd's questions- *"Why does this tree make apples at all? And how?"* Now Shawncy understood how the different parts of a flower made different kinds of cells that combined into a complete collection of the information it takes to make an apple tree, and how in the process, the apple blossoms became the fruit of the apple tree. It was magical and very interesting and he enjoyed thinking about it.

"There is something I do wonder," said Shawncy as he pondered his new discoveries.

"What's that, Shawncy?" asked General Byrd.

"When Butters the cat made us breakfast, we talked about the fact that a breakfast egg is like a chicken seed that contains an unfertilized egg cell."

"That would be a chicken pre-seed then," said Erica.

"Oh, yes," said Shawncy. "I suppose that is true, since there is no baby chicken in the breakfast eggs. But the thing I was wondering is, do chickens make pollen? Do chickens have anthers? Or ovaries?"

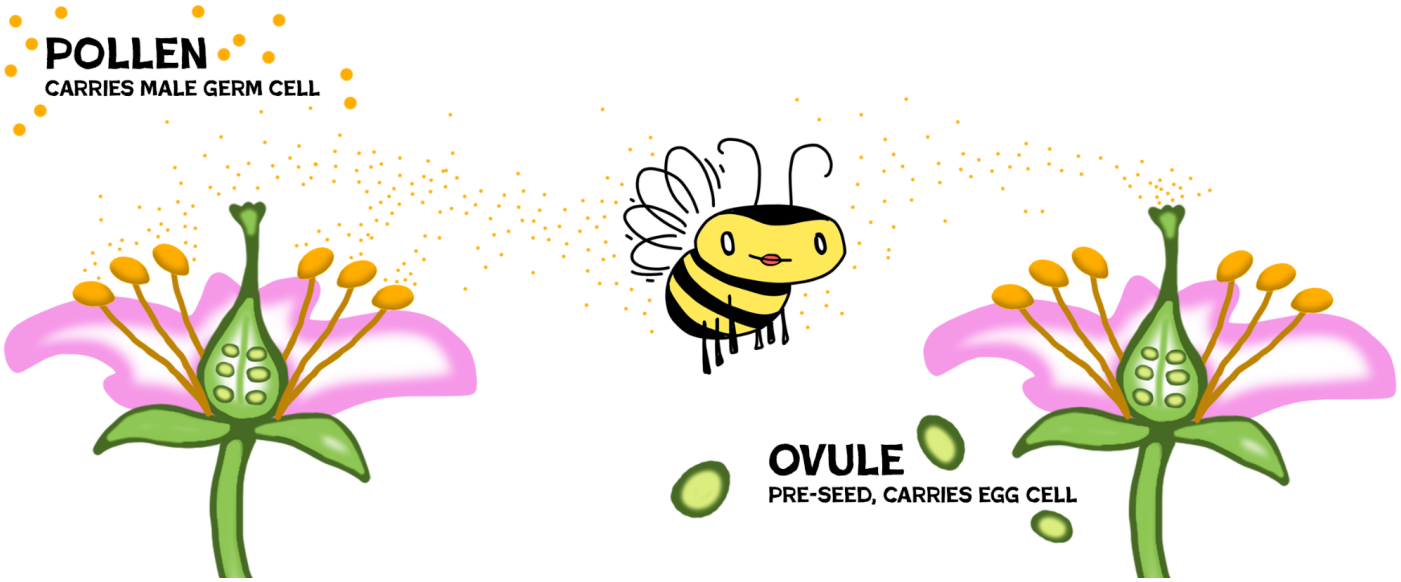
"Ah. A very interesting question," said General Byrd. "And a necessary next step in learning the Mysteries of LIFE!"

"I have an idea," said Erica. "Let's head to the pond."

“Are the chickens going for a swim?” asked Shawncy.

“No,” she replied. “But I think the chickens will make more sense after we visit the fish and frogs.”

The plucky little trio headed over to the pond and found a place on a nearby rock to observe the quiet bustle of life under the surface of the water. Nearby, dragon flies buzzed and crickets chirped. In the water, fish swam and frogs floated.

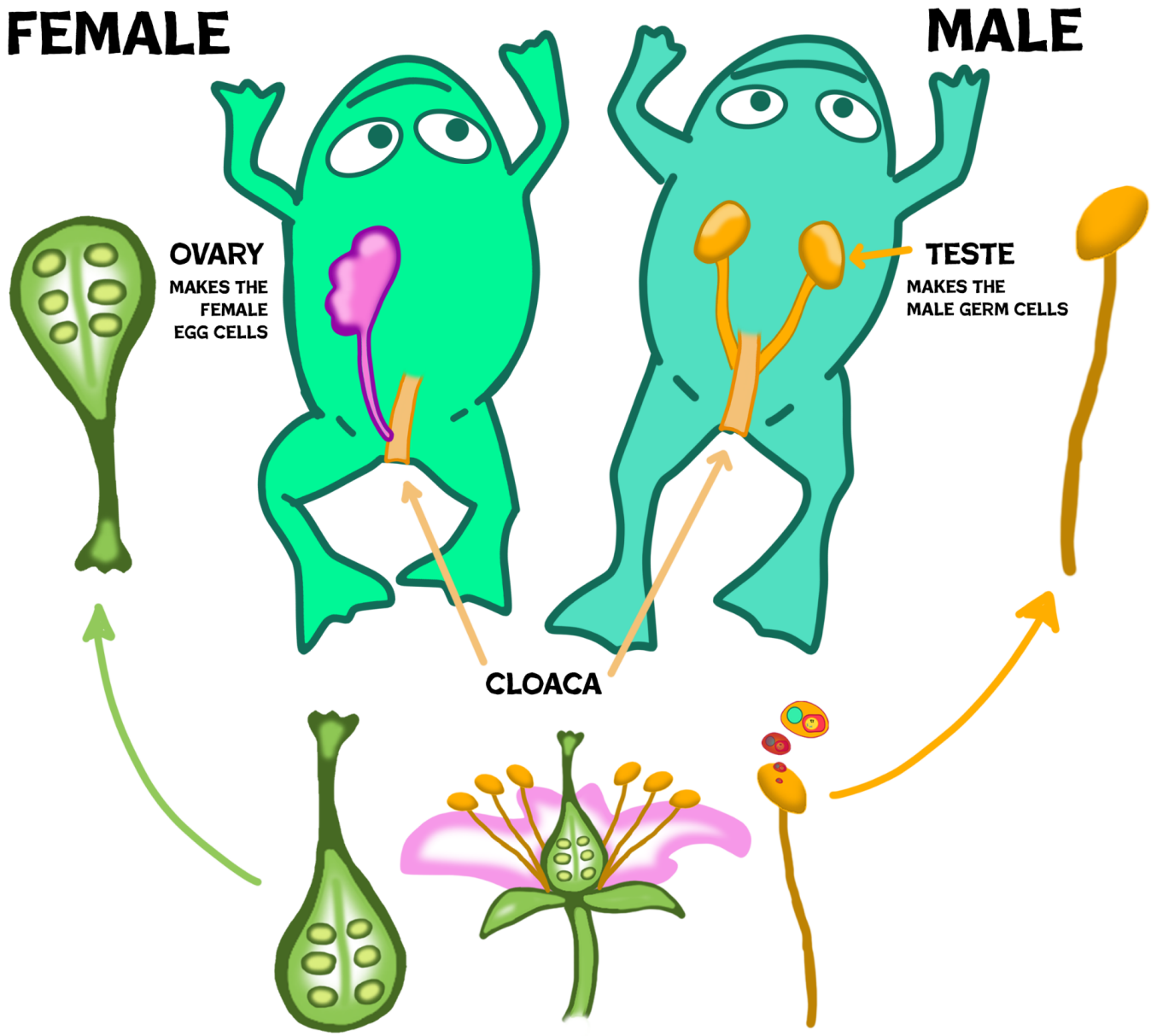


“Think about the way that apple blossoms are fertilized when pollen is carried by the wind or some helpful bees to an awaiting egg cell,” said Erica. “A little cloud of pollen is released by the male part of the flower with the purpose of finding an egg cell and making a baby tree.”

“The anther makes the pollen,” said Shawncy, “and sends it into the breeze, or onto some bees. The pollen sends a germ cell down into the ovary where it fertilizes an egg cell and makes a baby apple tree.”

“Well, frogs and fish don’t have anthers,” said Erica. “But they do have ovaries and what they do is actually very similar. Just like the apple blossom, **the female frog has something called an ovary which makes eggs.** The fact that it has an ovary and makes eggs is, like the pistil of the flower, the reason that those are the female frogs.”

Shawncy looked down at a frog drifting by on the water, whose eyes were keeping a lookout for flies to eat. “I don’t see a pistil on that frog,” said Shawncy. “Does that mean it’s a boy frog?”



“Frogs don’t have pistils,” said Erica. “Instead, the ovary is *inside* the frog with its other organs, like its heart and intestines. The **ovary** makes egg cells and the equivalent of frog pre-seeds. Then the female frog releases them into the water.”

“And that’s when they get pollinated?” asked Shawncy.

“Sort of,” said Erica. “But when we’re talking about animals instead of plants, we change the names a little. For example, we don’t call it pollination, and the male frog doesn’t have an anther. He has a

similar organ inside of him- two of them actually- that make the male germ cells. These two organs are called **testes**, and t**hey basically do the same job as the anther. They make germ cells**."

"And they make frog pollen?" asked Shawncy.

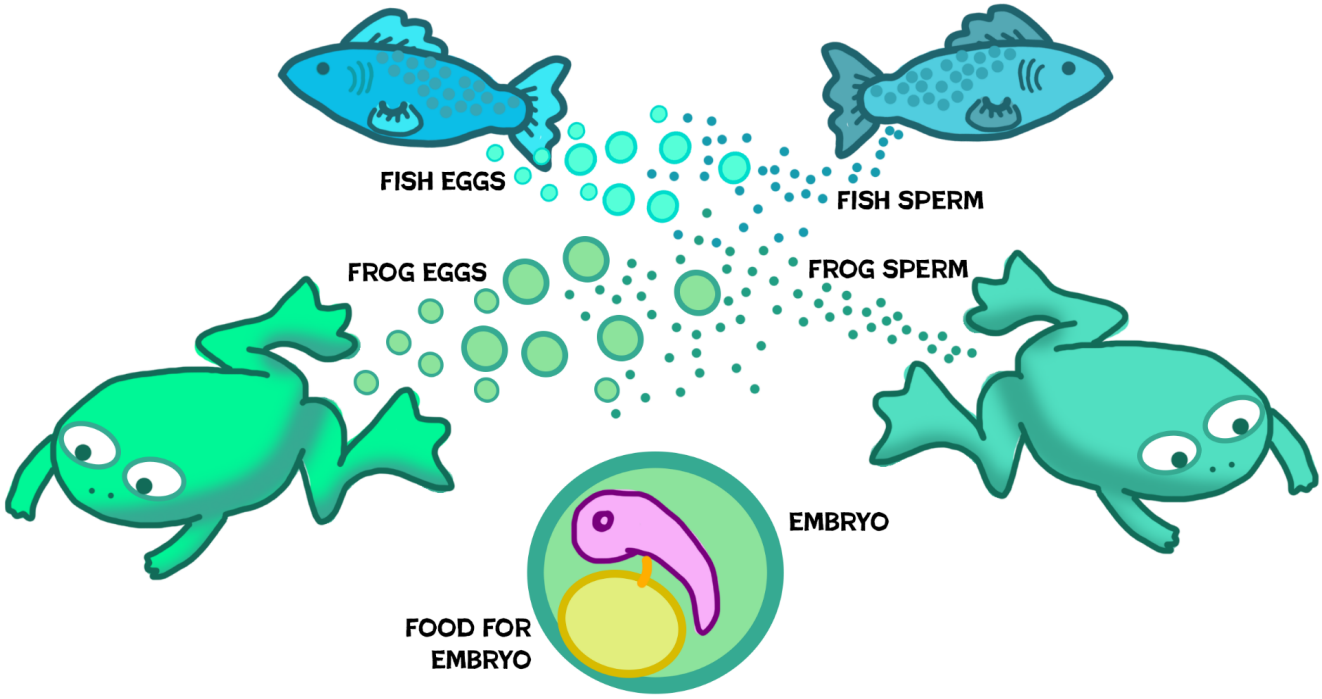
"No, there's no pollen," said Erica. "The frogs do things a little differently. Remember the pollen tube?"

"Sure," said Shawncy. "That was the little tube slide that carried the bag of books from the wagon into the library."

"Well, in the frog, the testes have a tube that carries those germ cells from the place they are made inside the frog, to the outside of the frog where, if all goes right, he and the female frog will release their eggs and sperm at the same place at the same time."

"You mispronounced *germ*," said Shawncy with a smirk. "You said *sperm*."

"I didn't mispronounce it," said Erica. "Like I said, we use different terms when talking about animals than we do when we talk about plants. *Germ* in the case of plants means seed, and ***sperm*** in the case of animals also means seed. In both cases, it's the male cell which carries half of the instructions for making the apple tree, or in this case, a frog."



“So the male frogs don’t have an anther,” said Shawncy, “but they still have a part that makes the male cells used to make frog seeds.”

Erica laughed. “You’re not wrong, but like with chickens, we don’t call the fertilized eggs frog seeds. We just call them fertilized eggs. The part of the plant that makes the male cells that we call germ cells is the **anther**. The part of the frog which makes the male cells that we call sperm cells is the **teste**. When the male cells reach the female cells- the eggs- they combine into one cell which is the very beginning of the embryo.”

“The who now?” said Shawncy.

“**Embryo just means baby**,” said Erica. “In the apple seed, the embryo is a baby apple tree. In the fertilized frog egg, the embryo is a baby frog.”

“Why do we use words that mean seed to refer to the male cells?” asked Shawncy. “It’s not a seed! A seed is that shell with the baby plant in it.”

“That’s true,” answered Erica. “It’s because, before microscopes, we didn’t really know how all of this worked because the cells are so small. So, people took their best guess and supposed the sperm

was, as they called it, the seed of the male. Just as you can toss grass seeds on a bunch of dirt and grow a lawn full of grass, the male frog can toss his male frog seed all over the female eggs and it will grow a bunch of little baby frogs."

"It's not accurate," said General Byrd, "but it's an honest mistake based on what nobody could see because no one had a microscope yet. But this is also why we generally don't call the male cells *the seed of the male* anymore. It got too confusing, so we use the words germ cell or sperm cell."

"That makes sense," said Shawncy. "So, is the fertilized frog egg basically a frog seed?"

"If you want to think about it that way," Erica replied. "Just like a seed has a shell, a baby tree and some food for the baby tree to live on while in the seed, and the chicken egg has a shell, a baby chicken and some food for the baby chicken to live on in the shell, **the frog egg has a soft shell, a baby frog, and some food for the baby to live on**. Frog yolk and egg shells are different from chicken yolk and egg shells, but the idea is the same. It's an embryo with some food in a protective environment."

"How do fish pollinate…" Shawncy paused for a moment. "I mean, how do fish fertilize their eggs? Is it the same way frogs do?"

"It is!" said Erica. "The female releases her eggs into the water, and the male releases his sperm into the water, and the sperm combines with the egg to make what you would call a fish seed."

"But probably no one else would call it that," added General Byrd. "We just call them fertilized fish eggs."

"Wait a minute," said Shawncy. "If they're all releasing these cells into the same pond water, then why don't we end up with frog fish or fish frogs?"

"Because, just like with trees and flowers," answered Erica, "**one kind of plant or animal can only fertilize the same kind**. Fish sperm cannot fertilize frog eggs, and frog sperm cannot fertilize fish eggs. Every germ cell is designed to only work with the opposite germ cell from its own kind."

“That’s very smart,” said Shawncy. “Otherwise things would get confusing very quickly.”

The plucky little trio headed from the pond over toward the barn where the chickens live. They picked a spot in a nearby tree where they could watch the chickens going about their chicken business. There were a bunch of chickens behind some chicken wire, with a little ramp leading into part of the barn. Outside the wire fence was a rooster, strutting around like he owned the place.

“That fellow right there,” said General Byrd, “is the rooster. He is the male chicken. Inside the barn enclosure are all the hens. They are the female chickens.”

“I know a few things about chickens,” said Shawncy. “First of all, I know to keep my distance because they might eat worms.”

“That seems wise,” agreed General Byrd.

“I also know that only the girl chickens lay eggs.” Shawncy looked at the rooster strutting by. “I suppose,” he said, “that means the rooster makes pollen. I mean germ cells. Wait, no, I mean sperm cells.”

“That’s right,” said Erica. “And that’s why the rooster is kept away from the hens. The farmer wants those eggs for breakfast, and if the rooster fertilizes them, they won’t be breakfast eggs. They will have baby chickens in them.”

“I don’t see why they have to lock him out of the hen house,” said Shawncy. “Can’t they just keep the chickens out of the pond?”

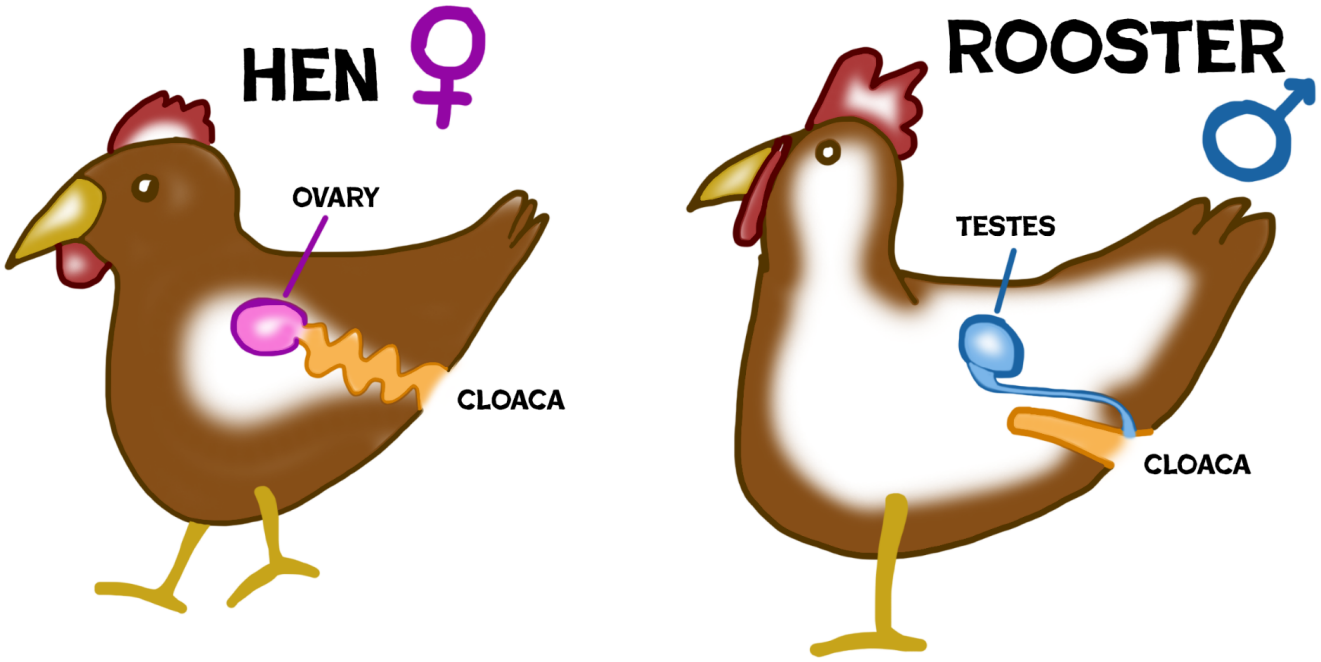
“Ah, I see what you are thinking,” said Erica. “But chickens do things a little differently than the fish and the frogs. They don’t use the pond.”

“Then how does it work with chickens?” asked Shawncy.

“Just like the fish and frogs,” Erica explained, “the female chicken has an ovary inside her. And just like the apple blossom and the fish and the frogs, the chicken’s ovary makes the egg cells. But when

the eggs leave the chicken's body, they already have the hard shell on them. So if there is going to be a baby chicken in that egg, then the egg cell needs to be fertilized before the hen lays the egg."

"So the egg cell has to be fertilized, INSIDE the hen?" asked Shawncy, not entirely sure that he was following.



"That's right!" said Erica. "Just like the germ cells went onto the pistil, down into the ovary to fertilize the egg cells in the pre-seed, **the chicken sperm needs to get into the hen's body and fertilize her egg cells before the egg shell is formed and she lays the egg**."

"Astounding!" said Shawncy. "How ever does that happen?"

"It is time for Shawncy to be introduced to the cloaca," said General Byrd.

"I was just thinking that," said Erica.

"Who is that?" asked Shawncy.

"It's not a who," answered General Byrd. "It's a what. Remember how Erica said that the frogs and fish released their eggs and sperm into the water?"

“Yes, of course.”

“Well,” General Byrd continued, “the opening at the back of the fish or frogs that the eggs or sperm come out of is called the **cloaca**. It’s a sort of all purpose exit door out the back of the animal. If something is coming out the back of a fish or a frog, it’s coming out of the cloaca.”

“That’s handy,” said Shawncy.

“Indeed,” replied General Byrd. “Very efficient. But all of that to say, the chicken also has a cloaca.”

“I see,” said Shawncy.

“Remember that pollen tube?” asked Erica.

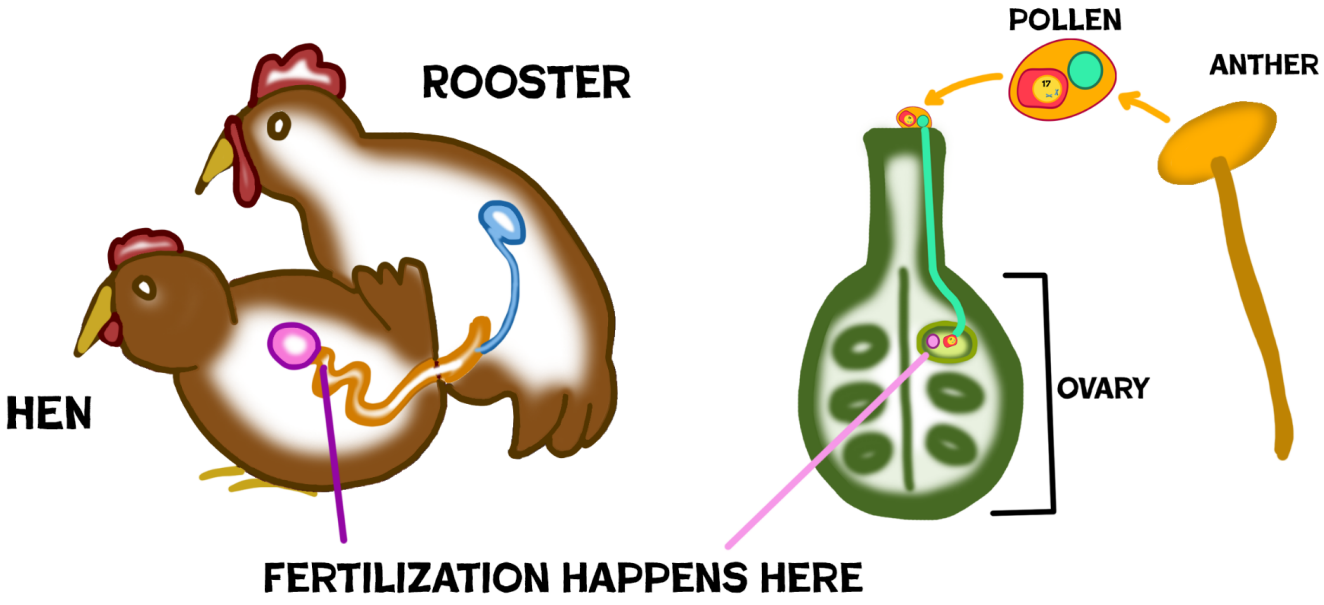
“Yes,” said Shawncy. “It was the tube that let the pollen’s germ cell reach the ovary’s egg cell. And you said the frog has a tube that goes from his testes to the outside of the frog’s body- through his cloaca I suppose.”

“That’s exactly right!” said Erica. “But whereas the frog only needed his sperm to reach the eggs in the water, the rooster needs his sperm to reach the eggs inside the hen.”

“My goodness!” said Shawncy. “How ever do they manage that?”

“The chickens have to work together!” said General Byrd. “The hen lifts her tail, and the rooster drops his, and they put their cloacas together, making one long pollen tube from his testes to her ovaries.”

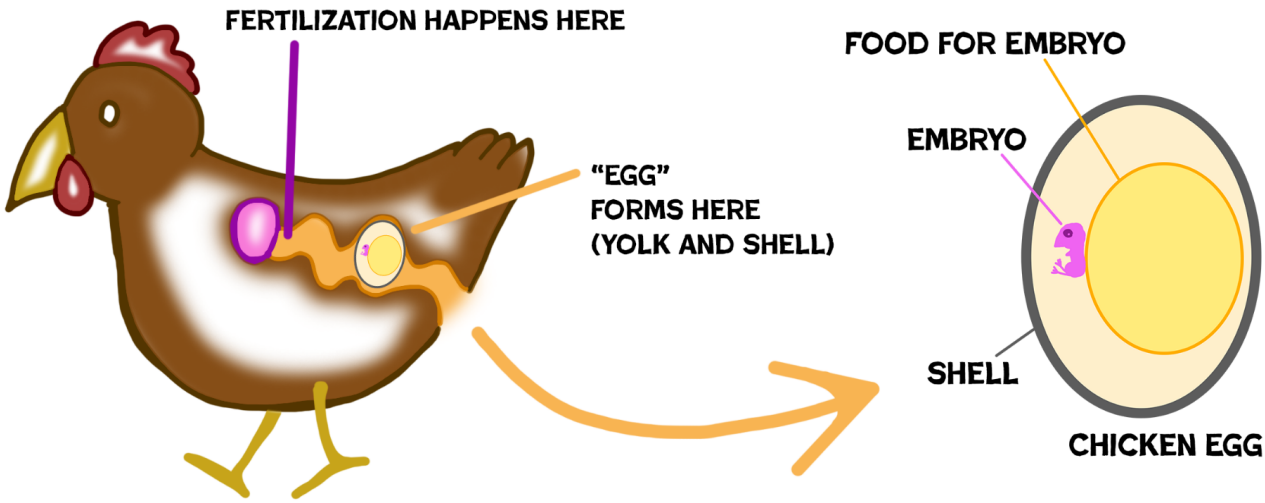
“Aw…” said Shawncy with big eyes. “It’s like a cloaca kiss!”



“Very good, Shawncy!” said General Byrd. “That’s actually exactly what it’s called!”

“Really?” said Shawncy, surprised. “Well, what do you know about that?”

“It is during this cloaca kiss,” continued General Byrd, “that the sperm travels from the Rooster, into the hen, and then up to the egg cells in the ovary. Once an egg cell is fertilized, it travels the same path that every egg cell does, gaining a yolk and then the egg shell. But unlike our breakfast egg, this one has a little baby chicken in it.”



“And that makes it a chicken seed,” said Shawncy with confidence.

“But again,” said General Byrd, “no one else calls them that.”

“Well,” said Shawncy. “I’m still going to. I just like the sound of it.”

QUESTIONS!

1. The female frog has an ovary inside her. What does this organ do?

2. The male frog has two organs inside him called testes, which do the same job as what part of the flower? And what is that job?

3. The cell in pollen that carries its half of the DNA information for fertilizing an apple blossom egg cell is called a germ cell. What do we call this same kind of cell which is made by animals, such as frogs, fish and chickens?

4. When a germ cell or sperm cell combines with the egg cell from the same kind of plant or animal, it produces an embryo. What is an embryo?

5. What parts does a fertilized frog egg have in common with a fertilized chicken egg or fertilized apple seed?

6. If frogs and fish are releasing their eggs and sperm into the same pond, why don't they produce fish frogs and frog fish?

7. Where does the chicken egg cell get fertilized?

8. Frogs, fish and chickens have a sort of all purpose exit door out the back of the animal. What is this opening called?

9. What is the purpose of the cloacal kiss?

Chapter 7: Cows Don’t Lay Eggs

General Byrd, Shawncy and Erica the honey bee watched the chickens for a few more minutes from their perch in the tree. Shawncy was thinking through all he had discovered about the mysteries of life.

He thought about the apples. They made apple seeds, which were a lot like eggs.

He thought about the fish and frogs. They made eggs that were a lot like seeds.

He thought about the chickens. They made eggs that Shawncy was going to call chicken seeds, because that made sense to him.

“So, fish lay eggs in the water,” Shawncy said aloud. “And frogs also lay eggs in the water. And chickens lay eggs on land.”

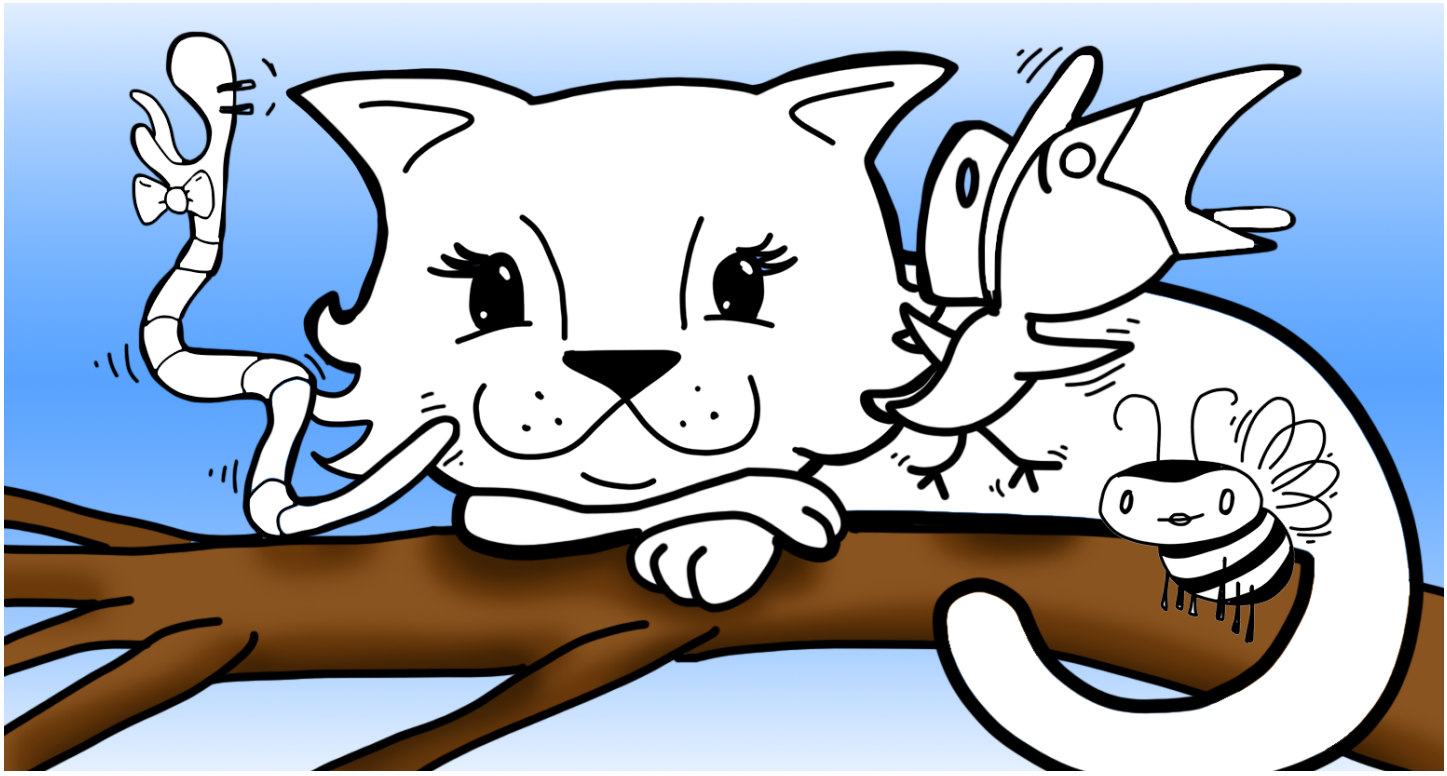
“Astute observation, Shawncy,” said General Byrd.

“So it seems that all animals lay eggs!” Shawncy exclaimed.

“Less astute,” said General Byrd.

“Cows don’t lay eggs,” said Butters.

“AAAAAHHHHHH!!!!” said General Byrd and Shawncy, because they had not heard Butters silently climb the tree, and did not know she was with them until she spoke.



“Hey Butters!” said Erica.

“Hello, Erica,” replied Butters.

“Yes, yes, good day,” said General Byrd. “A pleasure to see you again.”

“I almost fell out of the tree!” exclaimed Shawncy.

“What were you saying, Butters?” General Byrd asked his cat companion.

“I said, cows don’t lay eggs.”

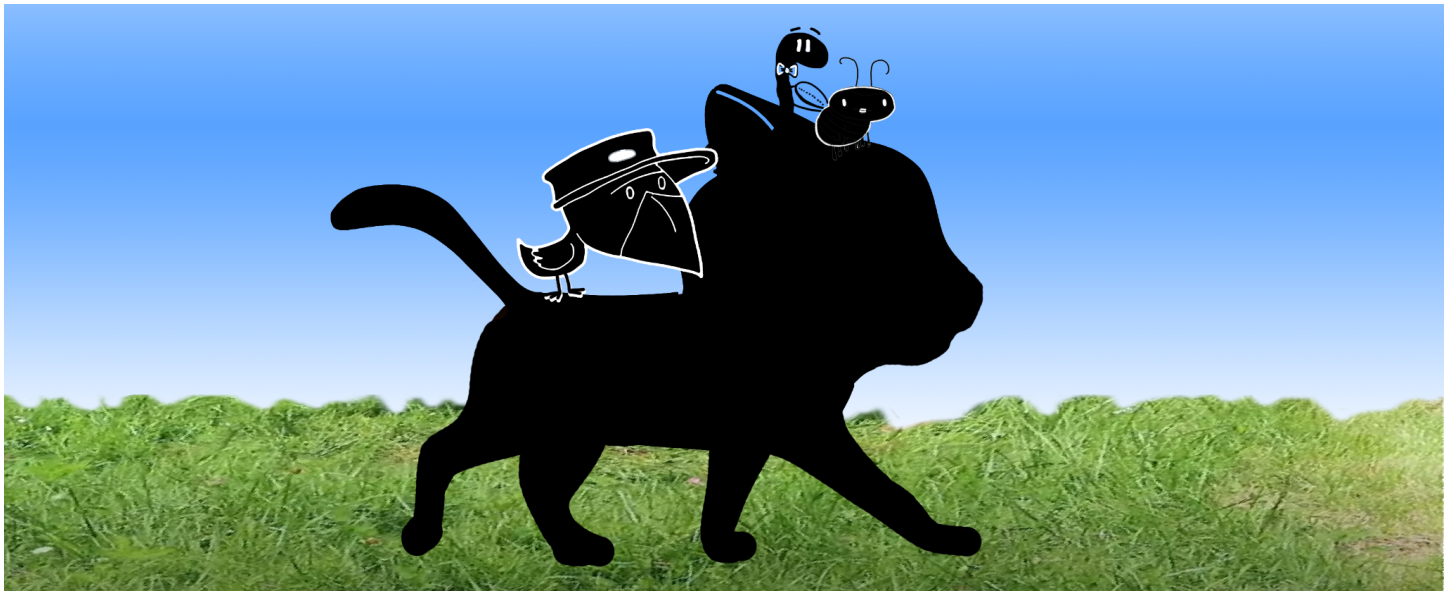
“Don’t they?” said Shawncy. He thought about it for a moment, and it occurred to him that cows didn’t even build nests. And he hadn’t seen them spending any time in the pond. “Do they make pollen?” he asked.

“They do not,” said Butters. “Why don’t you all climb on and we can take a little trip to the pasture behind the barn.”

“Hooray!” shouted Erica.

The three little friends climbed aboard their cat companion and she headed to the pasture like a furry little bus. Butters walked quietly past the barn, and hopped up onto a fence post where they could all

see the cows. The cows were great big, red and white beasts of the field, gently munching on grasses and occasionally mooing.



They each found a comfortable spot around Butters on the fence to watch the cows.

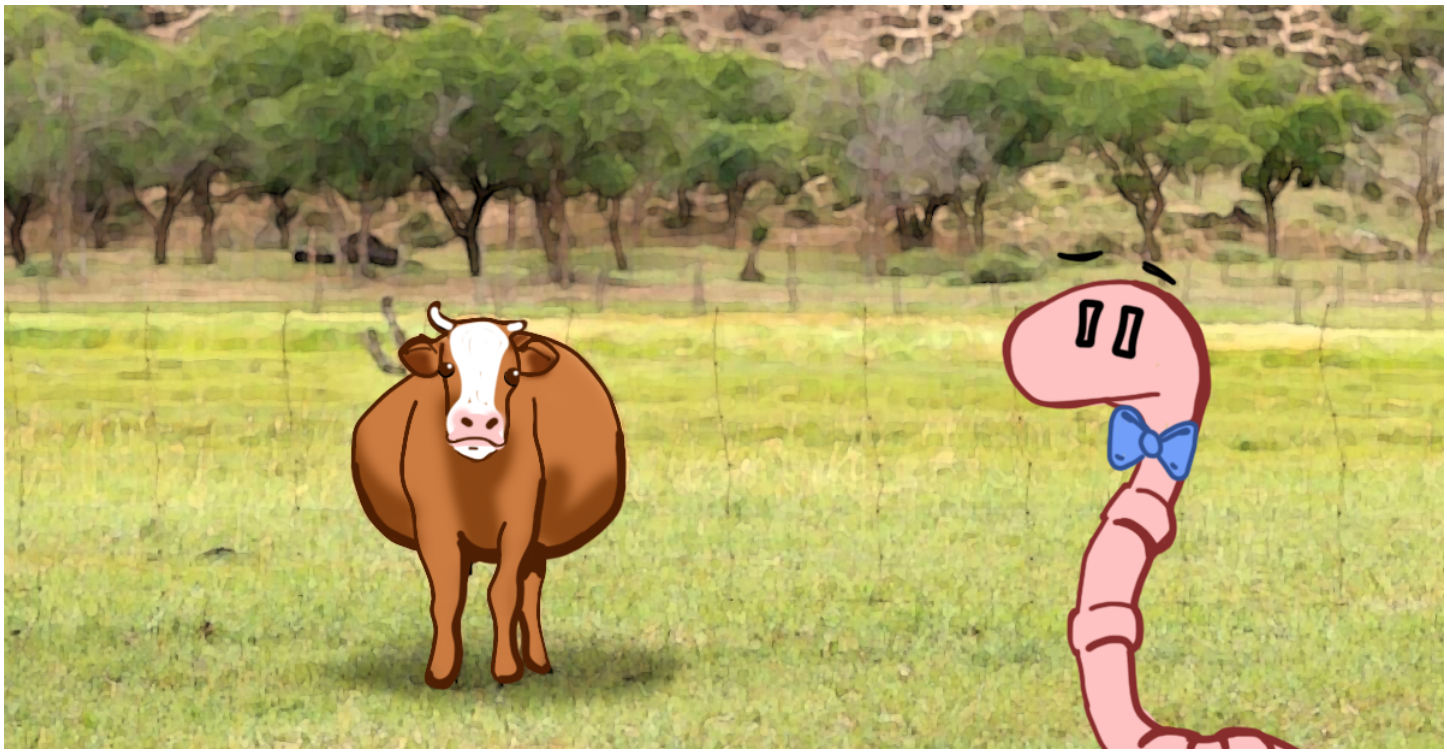
“You see that cow?” said Butters. “The big one in the middle of the field.”

The three friends looked at the small herd of cows standing around the field, and the cow Butters was indicating was easy to spot. She was very wide in the middle, much more so than any of the other cows.

“That is a very wide cow,” said Shawncy. “She must eat a LOT of grass. And possibly too many cupcakes.”

“That cow is wide,” said Butters, “because **she is pregnant**.”

“Oh, I see,” said Shawncy. But then he realized that he did not see. “What does that mean?” he said.



“It means,” answered Butters, “that she has a baby cow inside of her.”

“She ate a baby cow?” shouted Shawncy. “That’s terrible! And I thought they were vegetarians!”

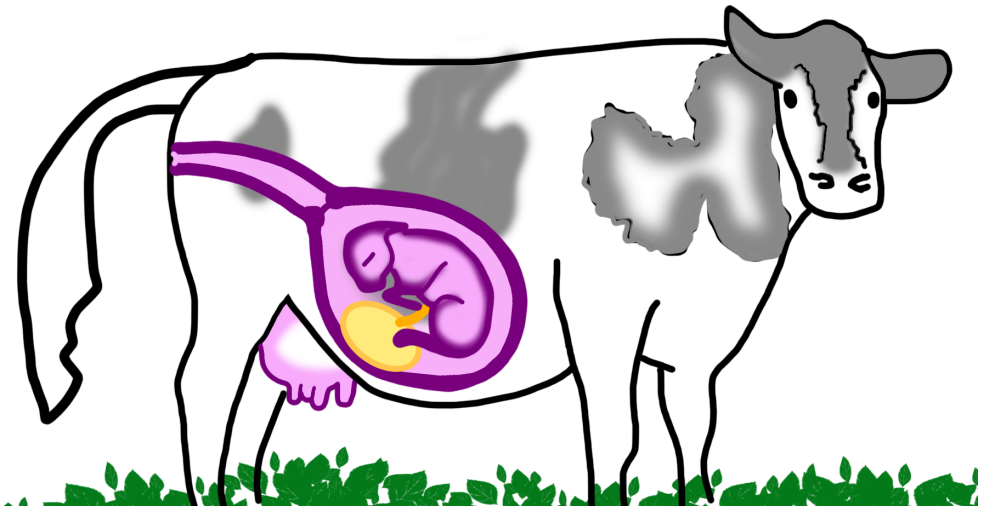
“No, little worm,” said Butters. “It’s nothing so vile. She is the baby cow’s mother.”

Shawncy looked disgusted. “I fail to see how that makes it any better,” he said. “If anything, that only makes it worse!”

“Shawncy!” said General Byrd. Shawncy looked at him. “Listen, my dapper friend. That cow did not eat a baby cow,” General Byrd explained slowly. “**The cow is pregnant, which means she has an embryo inside of her because she contains a cow seed**.”

Shawncy’s eyes got wide with wonder, while Butters’ eyes got narrow with suspicion. She looked at the little bird and said, “A cow seed?”

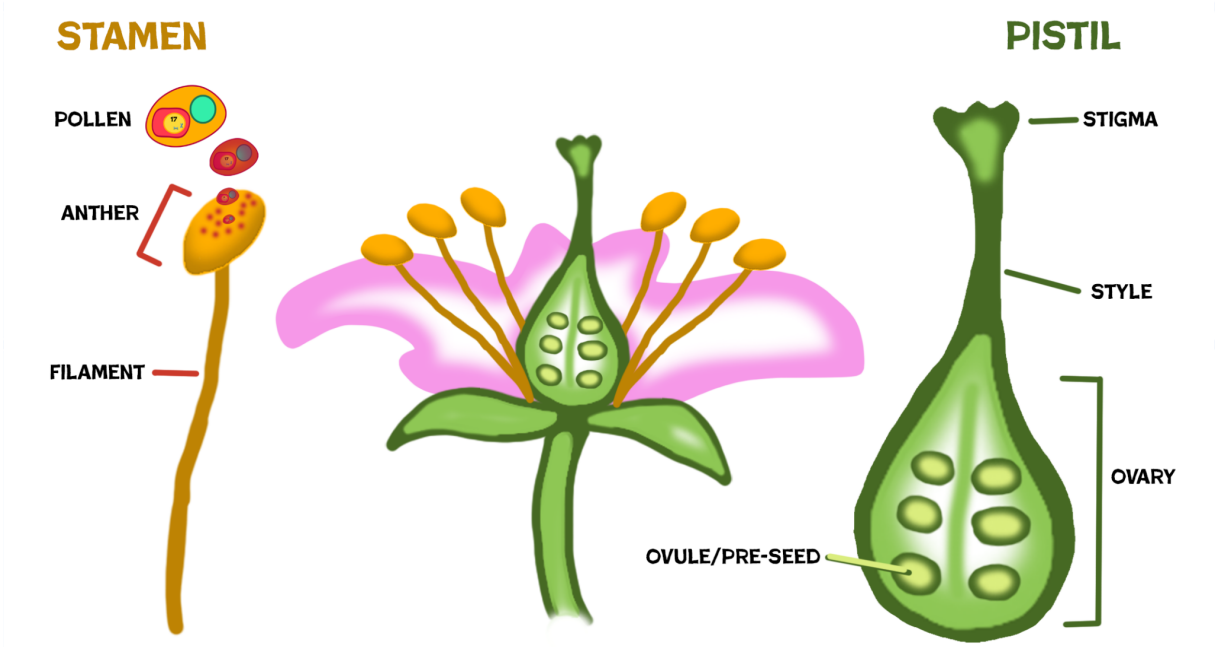
“Yes,” he replied. “I uh… I’ll explain it later.”



“So there is a cow embryo inside that cow mother,” said Shawncy, “but… she isn’t going to lay a cow egg? I had no idea that cows could be so mysterious.”

“I think I can clear up some of the mystery,” said Erica. “Do you remember what the pistil looked like, Shawncy?”

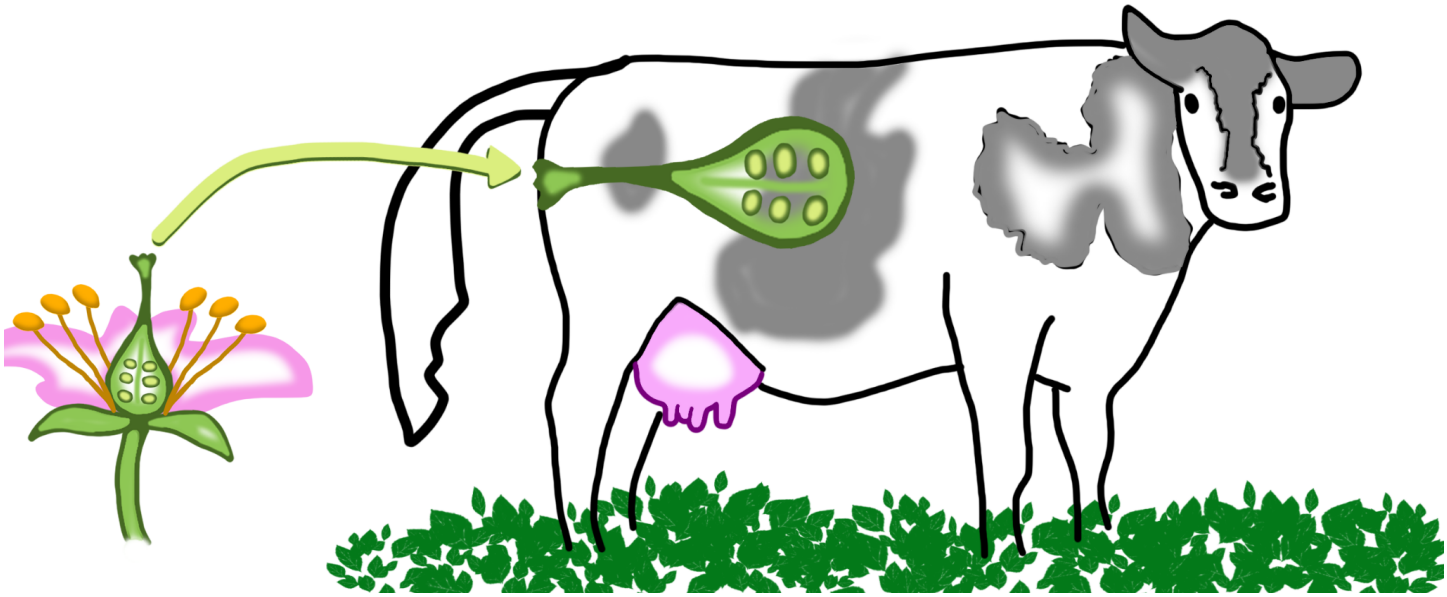
Shawncy thought deeply. “It was sort of tall,” he said. “There was a wide part on the bottom which was the ovary, and there was a long, skinny part on the top where the pollen would land and make its pollen tube.”



“Now imagine that the pistil is laying sideways,” said Erica, “and is inside of that cow.”

“Which way is it facing?” asked Shawncy.

“It lays from the tail end toward the head,” Erica explained, “and the top of the pistil where the pollen lands to make their pollen tubes is just under the tail.”



“Not RIGHT under the tail,” said Butters. “One notch down from that.”

“That is correct,” said General Byrd. “The cow does not have a cloaca like the frogs and chickens. It has multiple different openings for distinct purposes. The opening immediately under the tail is the termination of the digestive tract.”

“The what?” asked Shawncy.

General Byrd closed his eyes and sighed. “It’s where the poop comes out,” he said.

“Oh!” said Shawncy. “I thought you were just making up words.”

“Anyway,” General Byrd continued, “the opening just below *that* is where the reproductive system is located.”

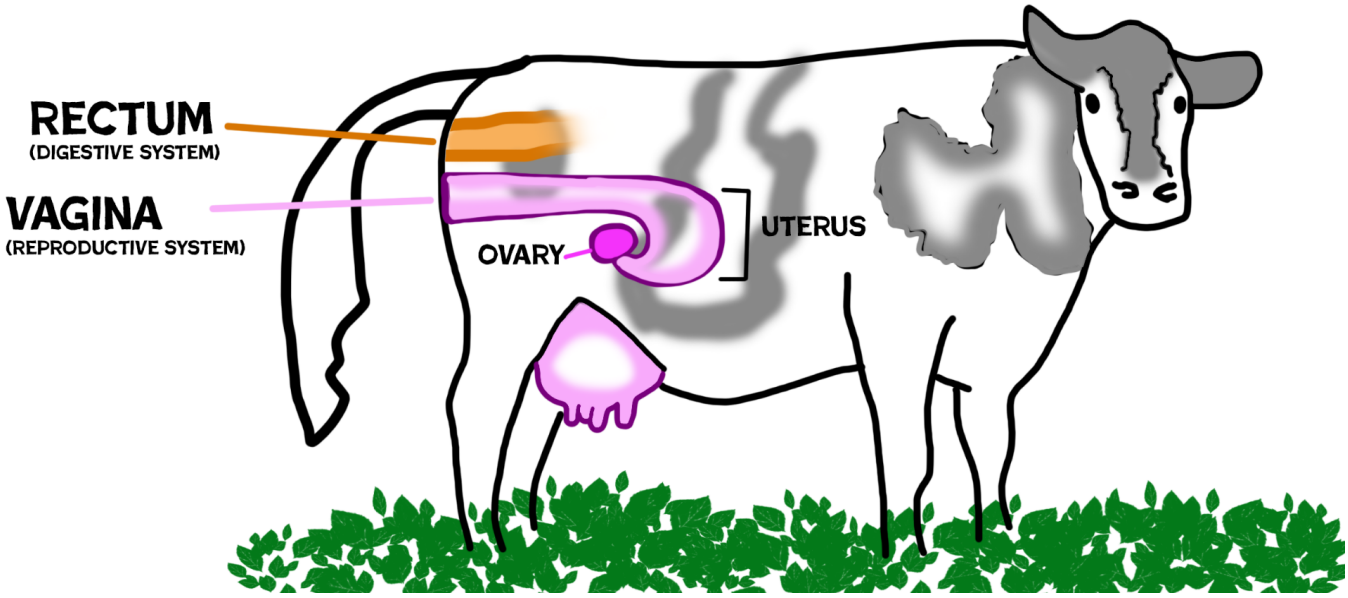
“Reproductive?” said Shawncy.

“Ah, yes,” said General Byrd. “Reproductive means, to reproduce. That is, to produce, or to make again. So, for a cow to make another cow. Or for an apple tree to make another apple tree.”

“Or for a chicken to make another chicken?” said Shawncy.

“Yes! Just so,” said General Byrd. “So the parts that are used to make another cow or chicken or what have you, are called the reproductive parts.”

“I’ve learned a lot of very big words today,” said Shawncy.



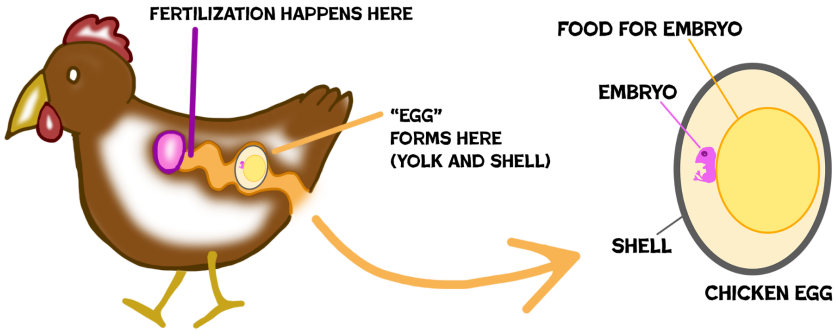
“The opening, second down from the tail, is where the top of the pistil would be,” said Erica, “if it were inside that cow.”

“So the cow seeds are somewhere in that wide bulge?” asked Shawncy.

“I don’t think he’s getting it,” suggested Butters. “Either that, or I’m not getting it.”

“A little of both, I’m afraid,” said General Byrd.

“Let’s go back to the chicken,” said Erica. “Inside the hen was an ovary which made the egg cells. Those egg cells then traveled from the ovary to the cloaca. Along the way they would be bound to a yolk and covered in a shell so the baby chicken could eat and be protected while it grew.”



“It made chicken seeds,” said Shawncy.

“Is it me?” asked Butters.

“I shall explain it later,” said General Byrd.

“The baby cow inside the mother cow,” Erica continued, “is in something somewhat similar to the egg. Imagine that the chicken egg formed right after the ovary released an egg cell and it was fertilized.”

“OK,” said Shawncy. “I think I can picture that.

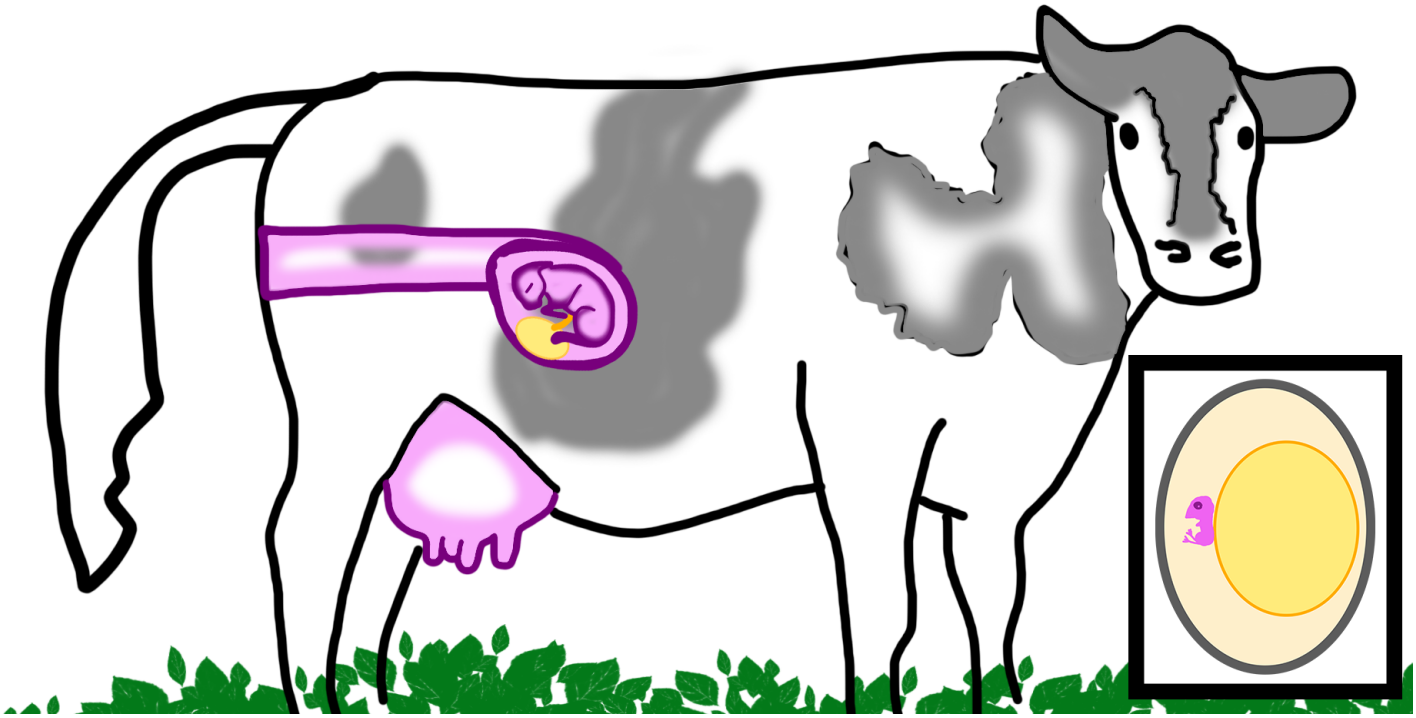
“Now imagine that the egg that the baby cow is in, instead of having a hard white egg shell, has a soft, thick shell made of muscle.”

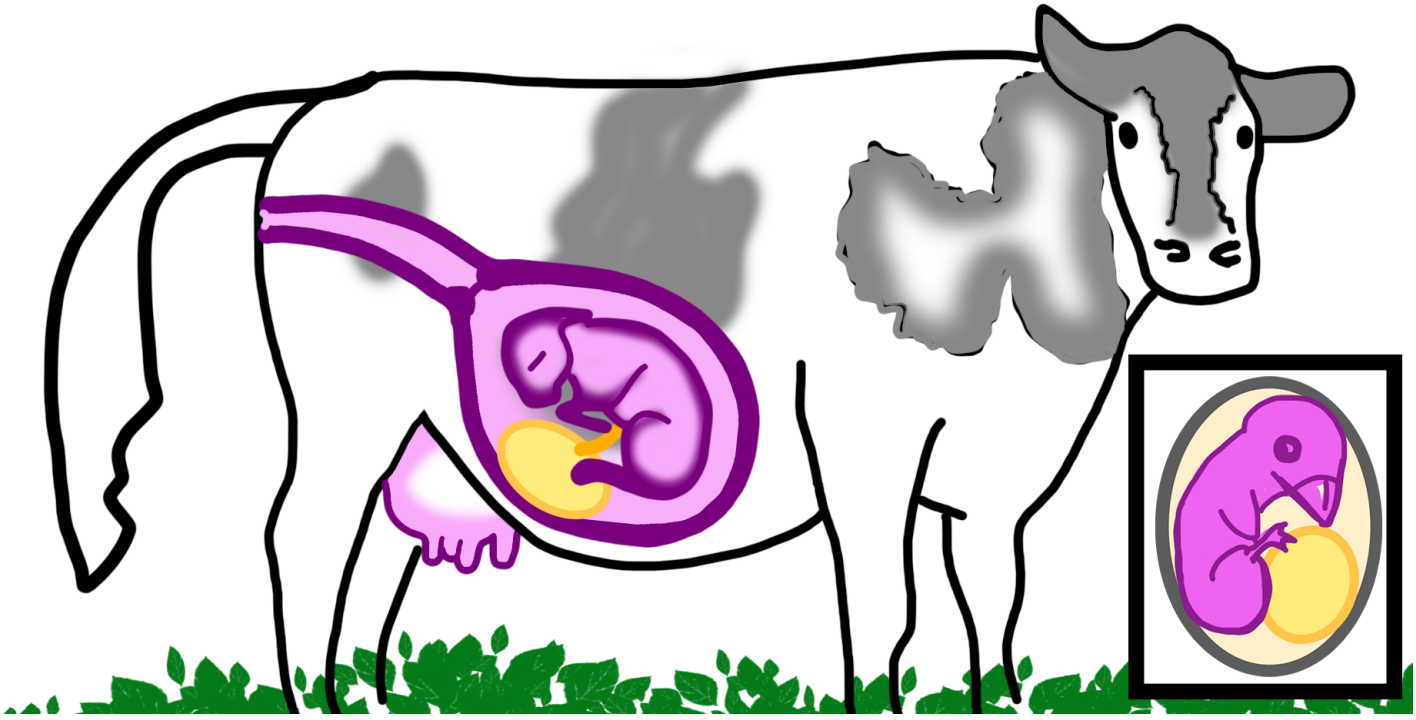
“Fascinating!” said Shawncy. “Is there really such a thing?”

“There is!” said Erica. “It’s called a **uterus**.”

“The uterus is a cow egg?” asked Shawncy.

“Sort of,” said Erica, “but it has several important differences. First of all, the uterus gets bigger as the baby cow gets bigger. Seeds and eggs don’t do that. When the chicken gets big enough to fill the shell, he breaks out of his shell. But the uterus is designed to get bigger as the baby grows.”



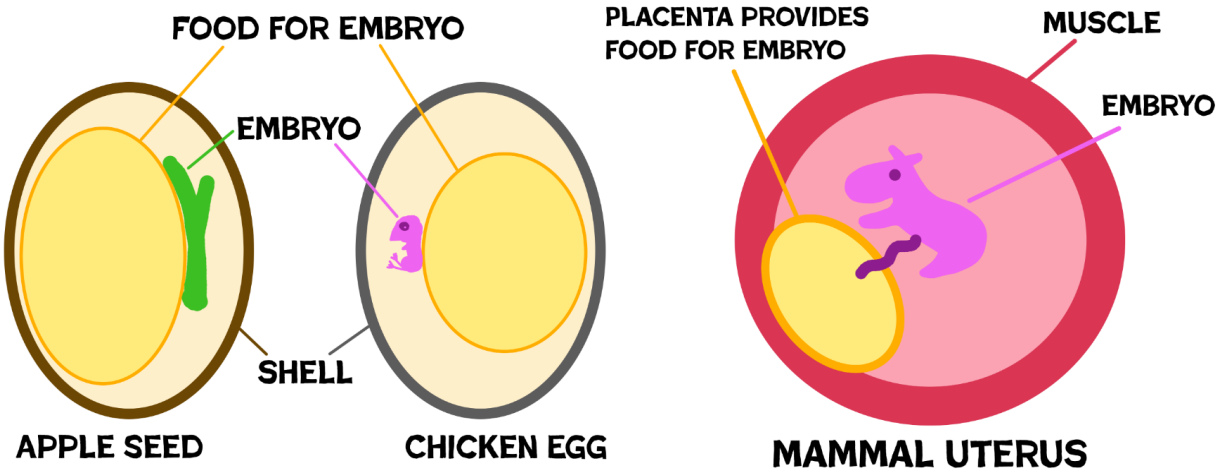


“How very clever!” exclaimed Shawncy.

“Another important difference,” Erica continued, “is that the cow doesn’t make a yolk for the baby cow.”

“What?” said Shawncy with surprise. “How is he supposed to get bigger with nothing to eat?”

“In the egg,” explained Erica, “the chicken is connected to the yolk and it uses it as a food source as he grows because nothing can get in to feed him. In the uterus, the baby cow is connected to his mother, and she provides him with what he needs to grow in a very similar fashion. **The baby cow is connected to his mother’s uterus through something called a placenta, which allows him to get nutrition from his mother while he grows**. When she eats, she is eating for her baby too.”



“So the uterus, the egg and the seed,” said Shawncy, “are each the protective home for the growing embryo. And they contain not only the embryo, but also a means of feeding the embryo while it grows.”

Butters looked at General Byrd. “Now that I understood,” she said.

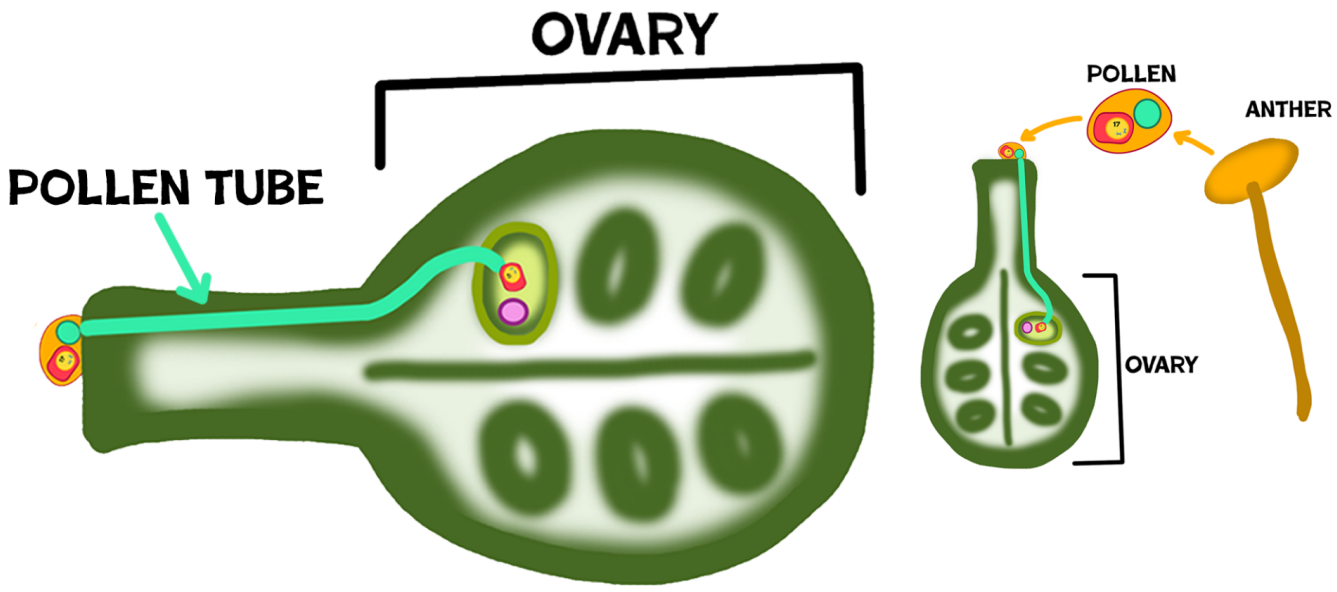
“Say, I just thought of something!” said Shawncy. “When the apple blossom is fertilized, the female part of the flower carrying the embryo grows in size, which shows that fertilization has happened! The same happened to the cow! The part of her with the baby gets bigger, and so we can look and know that her egg cell was fertilized!”

“That’s a clever observation, Shawncy,” said General Byrd.

“Oh, but I've just discovered another cow mystery,” said Shawncy. “If the cows don’t have a cloaca like the chickens do, then how do they fertilize their cow eggs?”

“I believe I can be of service on this matter,” said General Byrd. “To begin with, recall the function of the pollen tube.”

“Yes, well,” Shawncy said thoughtfully, “it grew down into the pistil to reach the ovary so that the germ cell could be delivered near the egg cells.”



“And do you recall,” General Byrd continued, “how we related that to the cloaca kiss the chickens use to fertilize their egg cells?”

“The cloaca kiss allowed there to be a long pathway from the rooster’s testes,” Shawncy recalled, “which make the sperm cells, to the ovary, where the egg cells are waiting to be fertilized. That makes it like the two chickens together have a pollen tube to carry the sperm to the eggs.”

“Very good,” said General Byrd. “And now, imagine if you would, a male cow with a special kind of pollen tube that could deliver his sperm cells *inside* the female cow so that they can reach the uterus where the egg cell has been sent after being made in the ovary.”

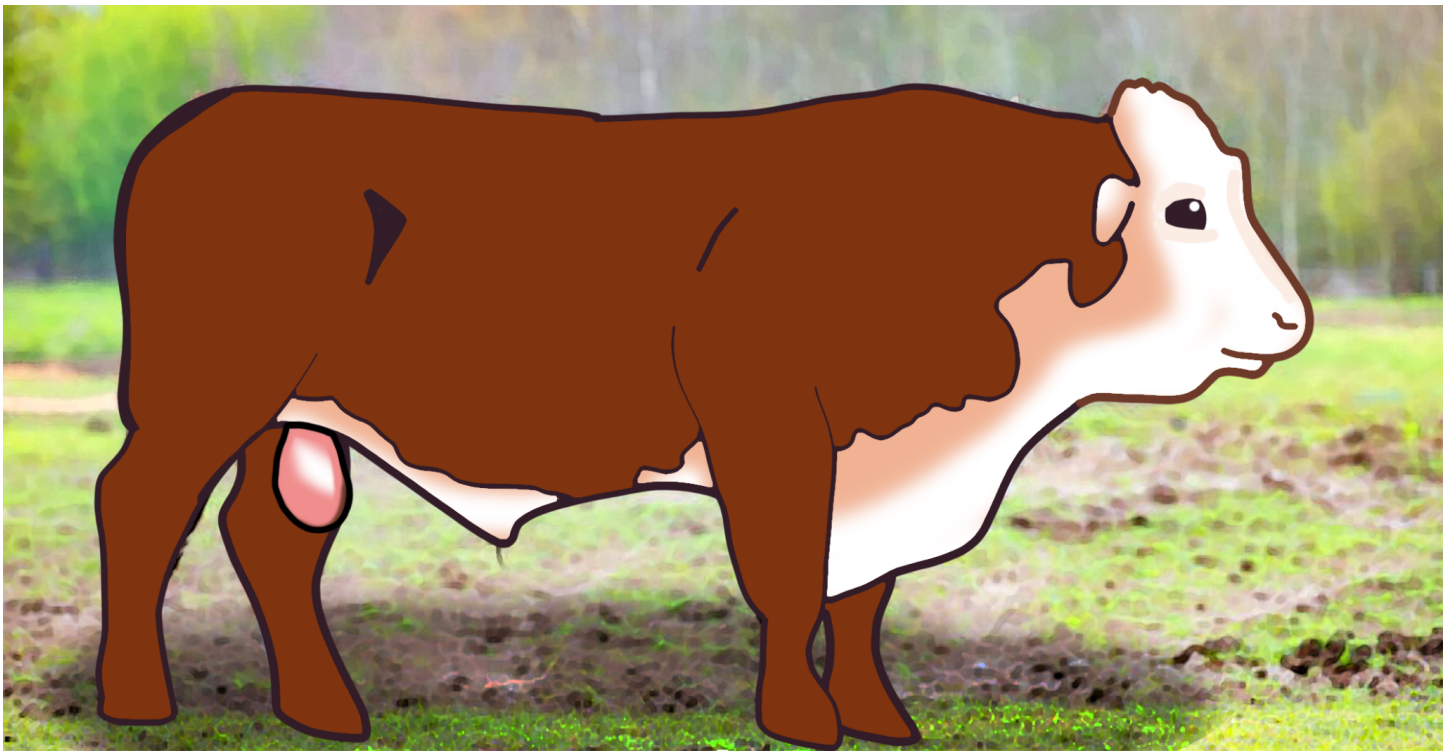
“So it’s a combination of the anther, which makes the germ cells,” pondered Shawncy, “and the pollen tube that goes into the female parts of the flower to deliver the germ cells to where the egg cells are?”

“Yes,” said General Byrd. “And it’s attached to the underside of a male cow.”

“It sounds like a very clever design,” admitted Shawncy, gazing into the sky, deep in thought. “But I just can’t see it.”

“Yes you can,” said Butters, pointing toward the barn. “It’s right there.”

General Byrd, Shawncy, and Erica turned around to see what Butters was pointing at, and there, near the barn and not terribly far from them, was the backside of a bull. Hanging on the bottom of the bull was just what General Byrd had been describing.



“Do you see those round things hanging under the bull?” General Byrd asked Shawncy. “Near his back legs.”

“I do,” he replied. “You know, I always wondered what those were for.”

“Those are the cow’s testes,” explained General Byrd. “They make sperm.”

“And he wears them on the outside?” exclaimed Shawncy. “The fish and the frogs and the chickens all had them on the inside!”

“That is true,” replied General Byrd. “But the simple fact is, a lot of larger animals have their male reproductive parts on the outside.”

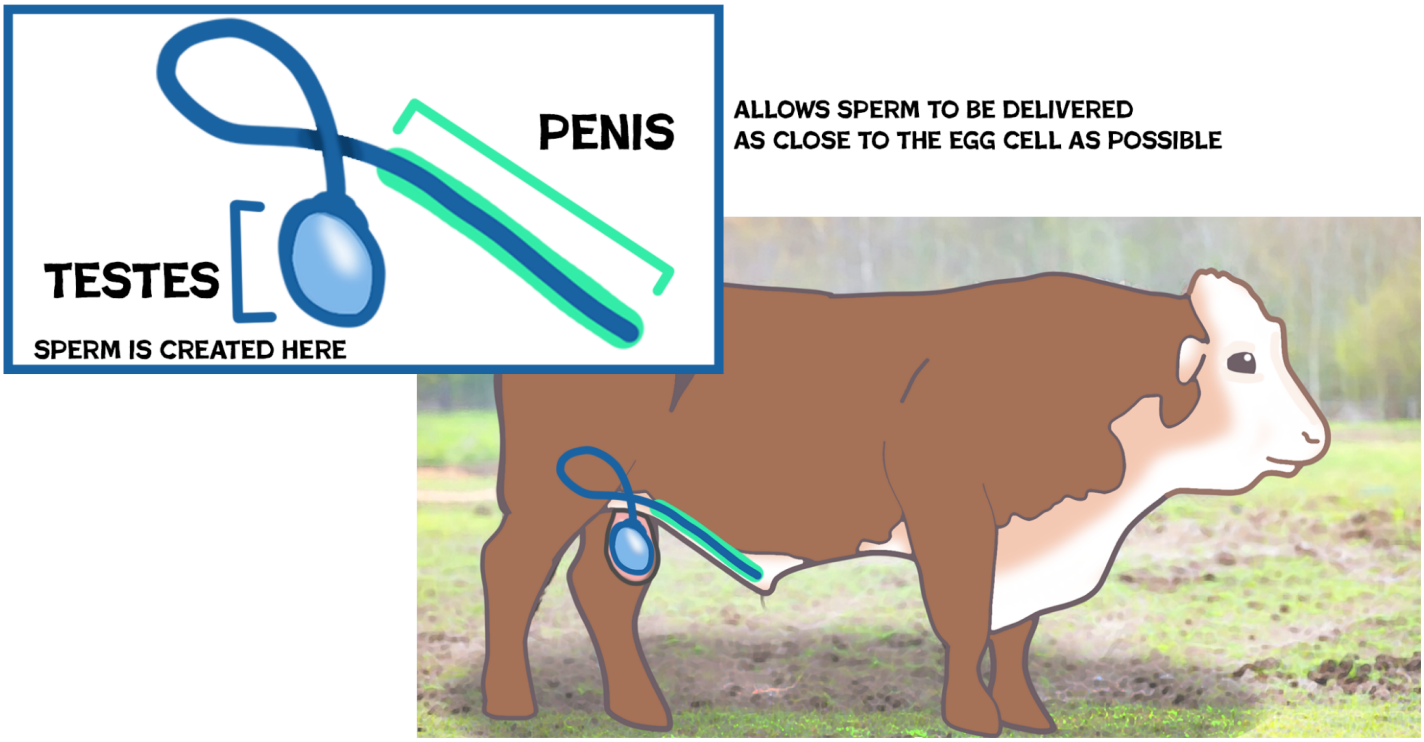
“You don't say.”

“It’s really not unusual,” said General Byrd. “Speaking of which, do you see that tube hanging just the other side of his testes?”

“Don’t tell me,” said Shawncy. “Is that his cow pollen tube?”

“Essentially,” said General Byrd. “It’s called a **penis**.”

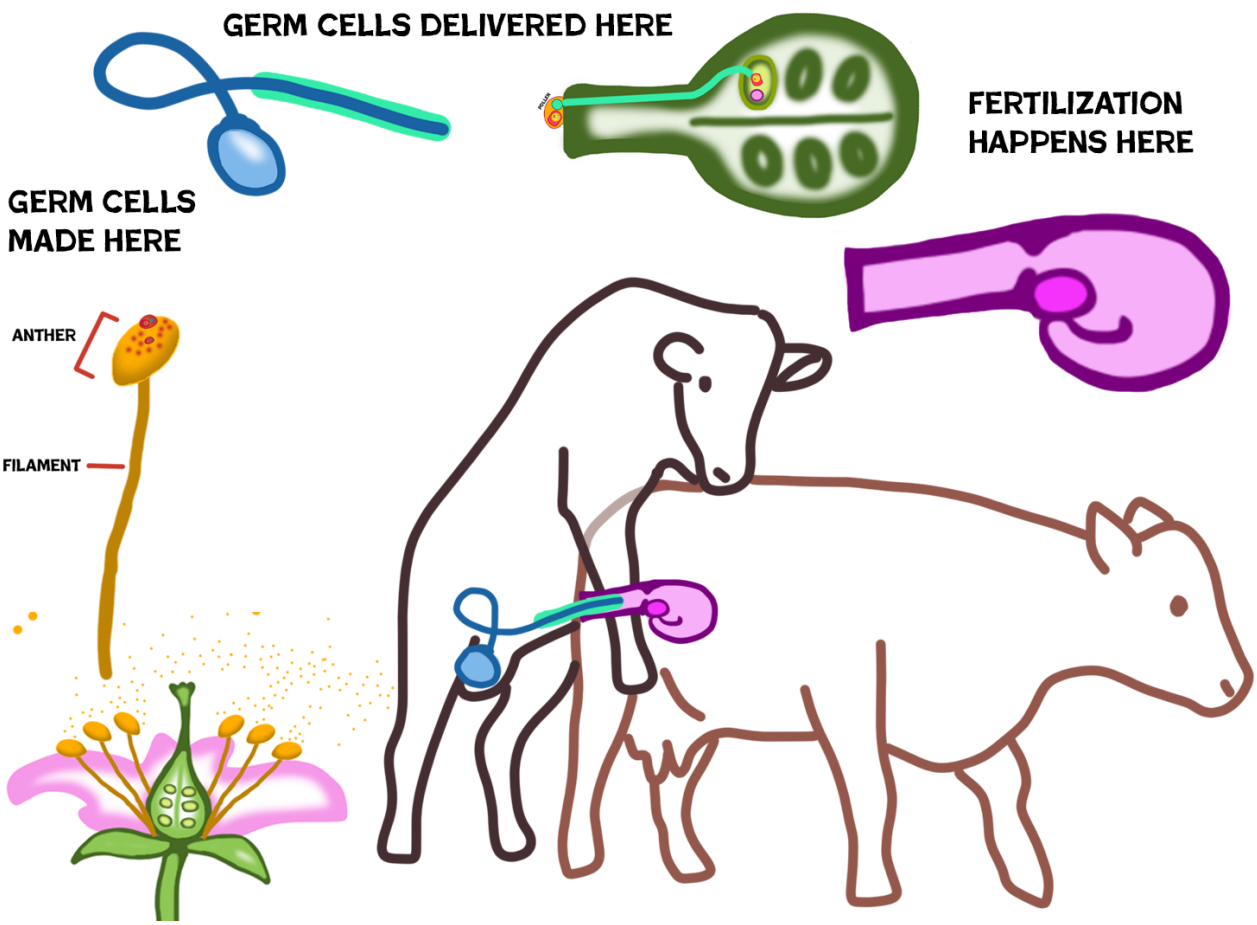
“I do declare.”



“So, the purpose of the pollen tube,” continued General Byrd, “is to deliver the male germ cells as close as possible to the egg cell so they can combine into an embryo. Well, similarly, **the cow has that tube which is called a penis, and it goes inside the female cow to deliver his sperm as close as possible to the egg cell in the uterus where they can become an embryo.**”

“It sounds like a very efficient system,” Shawncy admitted.

“Indeed,” agreed General Byrd.



“What does one call that?” asked Shawncy.

“What?” replied General Byrd.

“When a male cow puts his pollen tube…” Shawncy paused for a moment. “Excuse me, when the male cow puts his penis inside the female cow.”

“There are a couple of names for that activity,” said General Byrd. “Often it is called *mating*.”

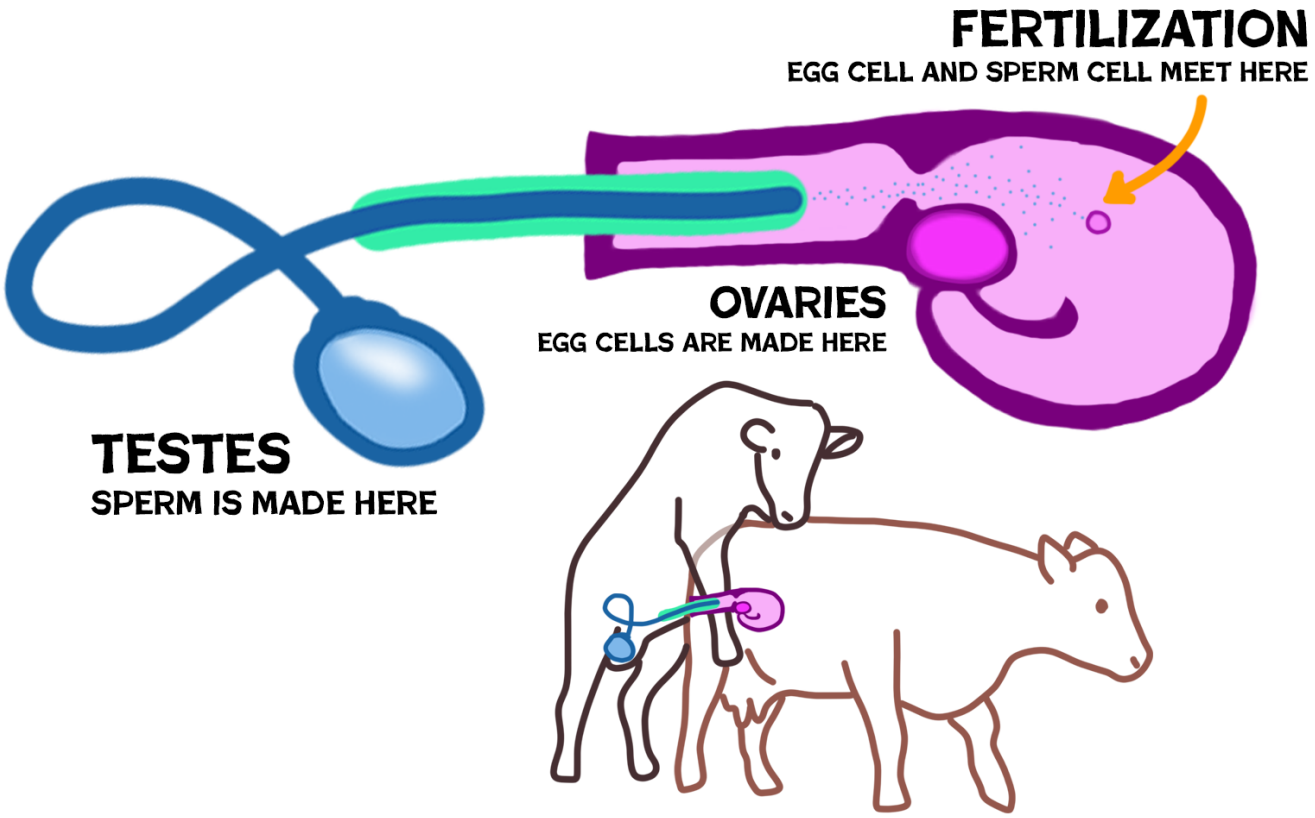
“Yes,” agreed Butters. “**When any two animals engage in whatever activity is used for their reproduction, it is called *mating*.** However, when cows do it, sometimes the farmers call it *bulling*. Also, because the bull is on top of the female, they called it *mounting*.”

“Mating is mounting?” said Shawncy.

“Well, mounting is for mating,” said Butters. “Also because I imagine climbing onto the back end of a female cow is the closest thing to climbing a mountain that most cows will ever come. So it gets an impressive name.”

“Oh,” said Shawncy. “Like *supermodel*. I mean, almost none of those women can fly or shoot lasers out of their eyes.”

“He’s not wrong,” said Erica.



“Let’s please not start discussing supermodels,” said General Byrd. “We were comparing the way in which cows mate to the ways in which other animals mate.”

“Yes, and how cow mating creates a cow egg inside the female cow,” recalled Shawncy, “which is made of muscle that can get bigger as the baby cow gets bigger. Cow seed? Cow egg?”

“I like *cow egg* better,” said Butters. “Even though I don’t understand it.”

“But now there is one last way in which the cow egg is different from the chickens or frogs,” said Erica. “What happens when the other embryos are done growing?”

“The apple tree bursts out of its seed,” answered Shawncy. “The chickens break out of their shell… say.” He looked at the cow again with a little bit of concern. “How does the baby cow get out?”

“There is the last of the cow mysteries!” replied Erica. “The baby cow breaks out of his shell too, but unlike the chicken or the apple tree, he doesn’t just find the weakest place in the shell. The uterus is designed to create an opening to let the baby cow out when he is big enough.”

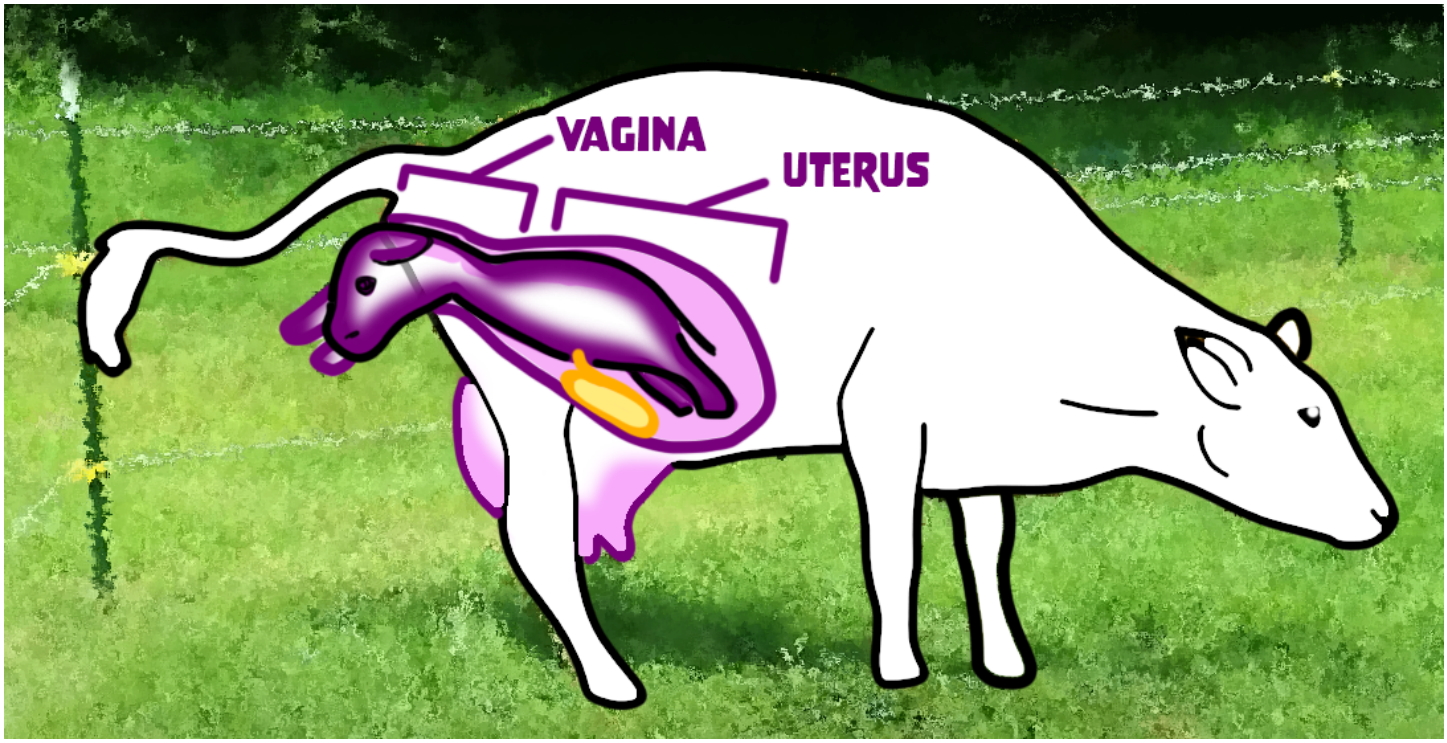
“It’s an endless parade of miracles!” exclaimed Shawncy. “How does it work?”

“When the baby cow is big enough, the uterus opens at the end near the tail of the mother cow. The opening widens until the baby cow can exit.”

“Just like that?”

“Just like that.”

“So an apple seed has a baby in it,” said Shawncy, “which pops out and grows when it’s planted. A frog, fish or chicken egg has a baby in it which grows until it’s big enough to break out of its shell. But the cow seed is like an egg that can grow with the baby, inside the mother, until he’s big enough to live on his own, and then, he just leaves out the back door?”



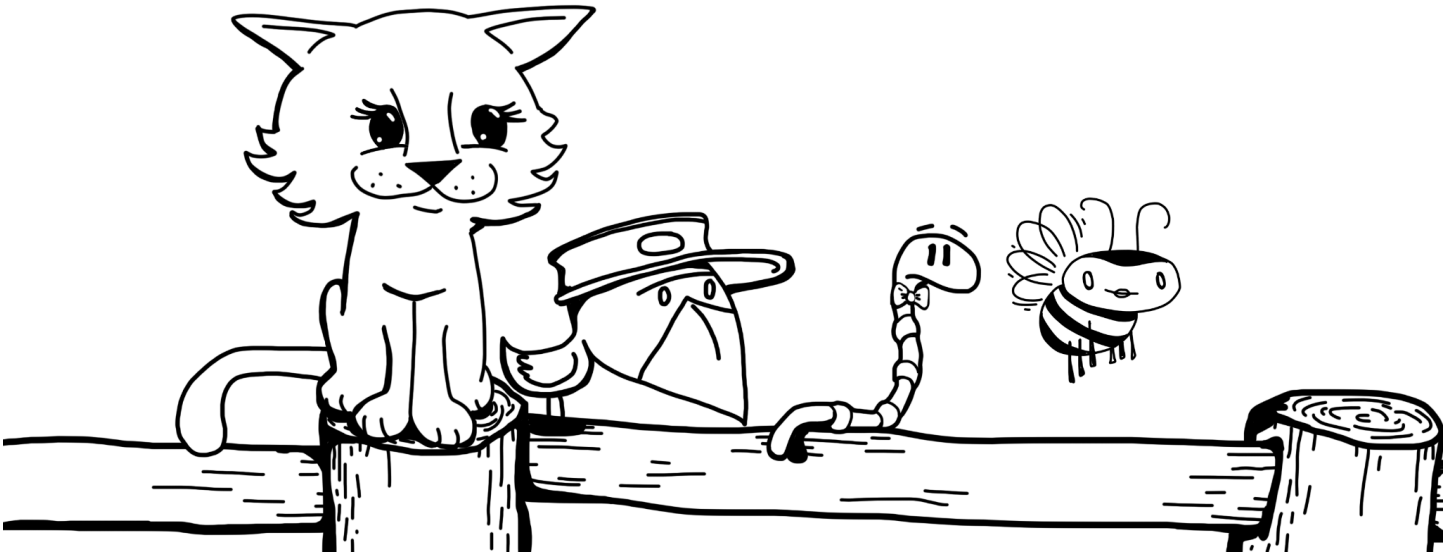
“Pretty much,” said Erica. “That back door is the same place where the bull’s penis enters to deliver the sperm that made the baby cow in the first place. It’s called the vagina.”

“Yes, that’s right,” added Butters. “The opening into the female reproductive system is called the vagina, and it’s the pathway into the uterus. When they mate, the bull puts his penis into the female’s vagina, and his sperm is sent into her uterus to fertilize the egg cell. If it’s successful, the baby is

formed, and it grows inside her for around nine months. After nine months, the baby is born by coming out through the vagina."

"How miraculous!" exclaimed Shawncy.

"Indeed," said Butters. "Birth is an amazing ordeal. Nothing short of a miracle."



"After the baby leaves," wondered Shawncy, "what happens to cow seed? Wait, I mean egg. No I don't…"

"Uterus," said Erica helpfully.

"Yes, thank you. What happens to the uterus?" asked Shawncy.

"It returns to normal," replied Erica, "like it was before she got pregnant. It shrinks down to its normal size, and the cow can get pregnant again and have more cow babies."

"You mean, it's like a reusable cow seed?" Shawncy asked in wild wonder.

"I suppose it is," said Erica. "In a manner of speaking."

"It's not a seed," said Butters.

"Let's go have a glass of iced tea," said General Byrd. "I'll explain the whole thing to you."

"I would appreciate that," said Butters.

QUESTIONS!

1. What does “pregnant” mean?

2. What happens inside the uterus when an animal is pregnant?

3. A cow doesn’t produce a yolk for the baby cow. How does the baby cow get nutrition before it is born?

4. The male cow (bull) has a ‘pollen tube’ which allows him to deliver his sperm close to the egg cell inside the uterus of the female cow. What is this cow pollen tube called?

5. What do we mean when we say two animals are “mating”? How is mating different between frogs and chickens and cows?

Chapter 8: Birds, Bees and Babies

General Byrd, Shawncy, Erica and Butters enjoyed a glass of iced tea on the porch of the farmer's house. General Byrd had explained, as best as he could manage, the reason why Shawncy insisted on referring to eggs as seeds, and not only did Butters understand, she felt he may be right.

The conversation had lagged for a few minutes as the group enjoyed a warm breeze and a cold glass of iced tea, when suddenly the quiet was broken by a high pitched cry somewhere inside the house.

"My goodness!" said Shawncy. "What do you suppose that is?"

"Didn't you know?" asked Erica. "The farmers have a baby."

"How lovely!" said Shawncy. "When did that happen?"

"Forty seven days ago," said Butters. "But who's counting?"

"Perhaps," thought General Byrd out loud, "it might be good to see how much Shawncy has learned today."

"I'm game for anything," Shawncy replied with a smile. "Hit me with your best shot."

"Very well," said General Byrd. "The Farmer and his wife have a baby. Can you guess how humans have babies?"

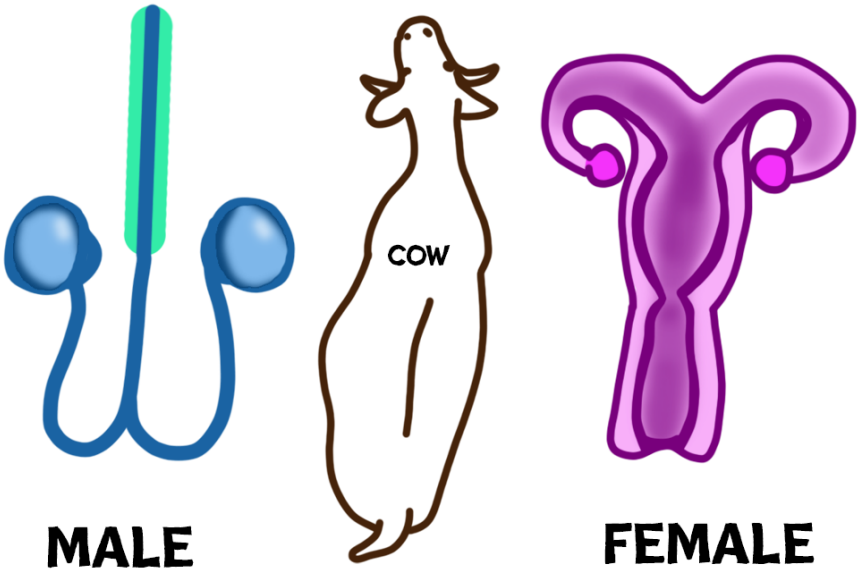
"Ah, very good," said Erica. "Yes, Shawncy! Are humans like apple blossoms, fish, frogs, chickens or cows?"

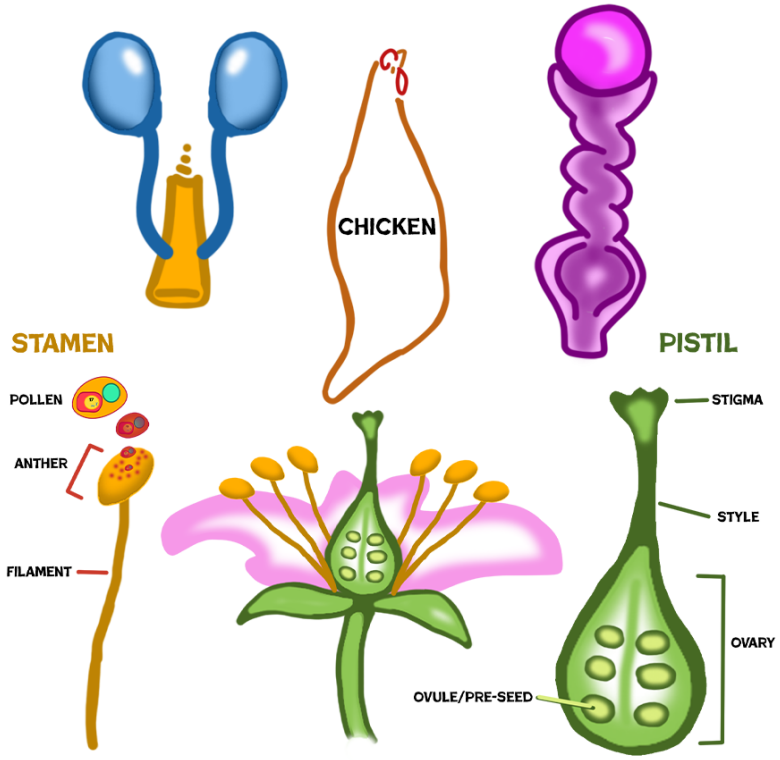
"Oh! I've never really thought about it before," said Shawncy. So he thought about it now. "They aren't plants, so I don't think they pollinate."

"That's very true," said Erica. "So far, so good!"

"And they don't spend much time in the water," Shawncy observed, "so I don't think they just release sperm and eggs into the water like the frogs and fish."

"They do not," said General Byrd.





Shawncy thought for a moment and then said, “I think they reproduce like chickens. I think humans lay eggs that hatch into little human babies.”

“I like this little worm,” said Butters. “He’s amusing.”

“What makes you think that humans are like chickens?” asked General Byrd.

“Elementary my dear General,” said Shawncy. “Chickens and humans both walk on two legs, so they are more alike than humans and cows.”

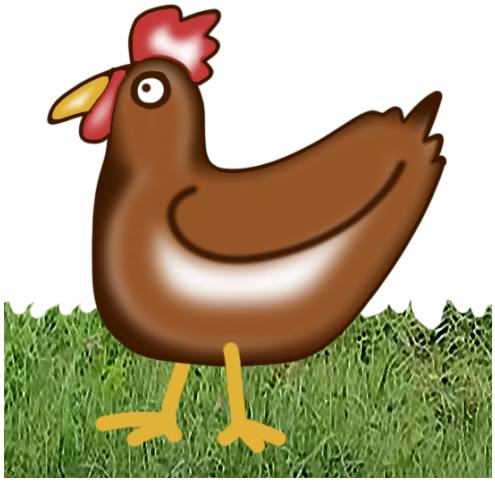
“You see what I mean?” said Butters to General Byrd. “You’re never that funny.”

“He’s not right,” said Erica, “but he’s not entirely wrong either.”

“Humans are not like chickens!” said General Byrd.

“They’re more like chickens than they are like cows,” said Erica.

“In what way?” asked General Byrd.



“They do walk on two legs,” said Erica.

“And sometimes they wear feathers,” added Butters.

“And they often run around in circles for no reason,” added Erica.

“And they make a LOT of noise,” said Butters.

“Ladies, please,” said General Byrd. “I see where you are coming from, but the focus of the question is the method by which they reproduce. Not which society in which they would feel more at home.”

“Oh, yes,” said Erica sheepishly. “I forgot.”

“I didn’t,” said Butters.

“As the resident of this farmhouse,” said General Byrd to his cat companion, “perhaps you are the most educated about the ways of the humans.”

“Yes,” she said. “I suppose that is true.”

“Then perhaps you could shed some light on the actual topic of conversation,” said General Byrd. “Where do human babies come from?”

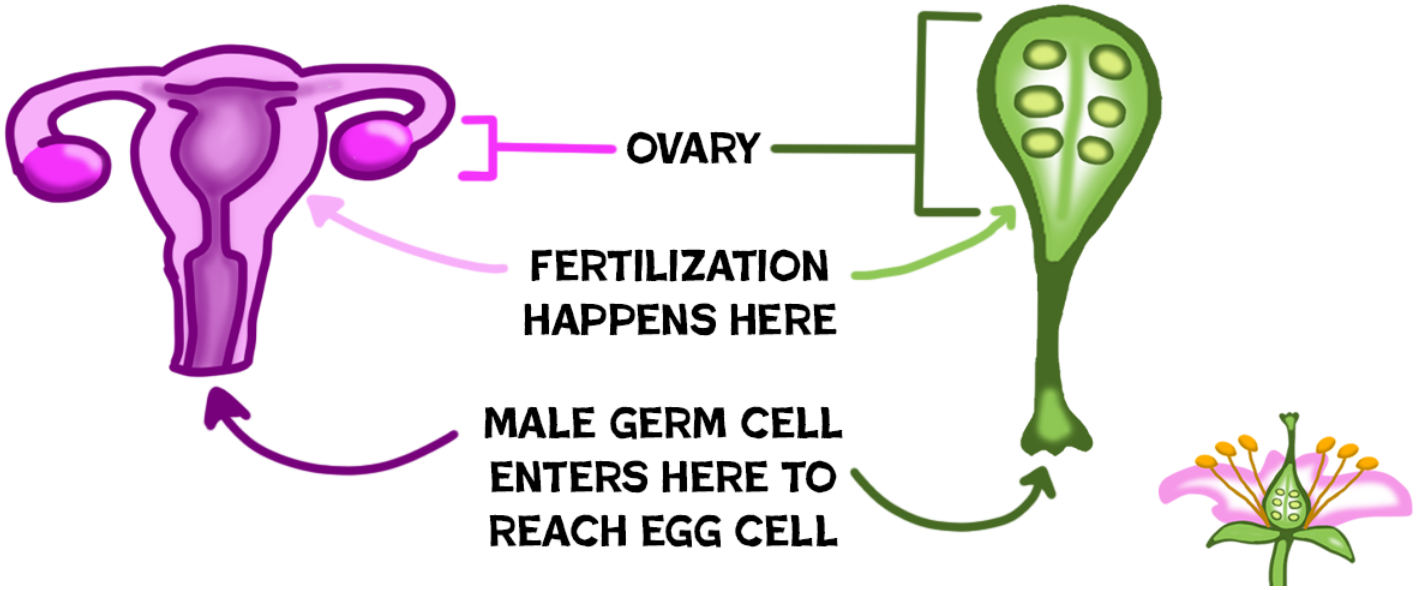
“If you like,” Butters replied. “To begin with, despite their common two-leggedness, the humans do not in fact lay eggs.”

“It was a reasonable guess,” said Shawncy.

“Life is full of surprises, my little funny worm. And humans,” Butters continued, “are full of surprises. While they are different in many ways from the cows, humans also have some important similarities. One of them is the way in which they reproduce.”

“And by *reproduce*,” said Shawncy, “you mean, they make another human.”

“Very good,” said Butters. “Unlike the chickens, the humans do not have a cloaca. The human’s reproductive parts are much more similar to those of the cows. For instance, like the female cow, the **female human has an opening that leads into her reproductive system. They call this entrance the *vagina***. Above the entrance is… what did you call it? A reusable seed?”



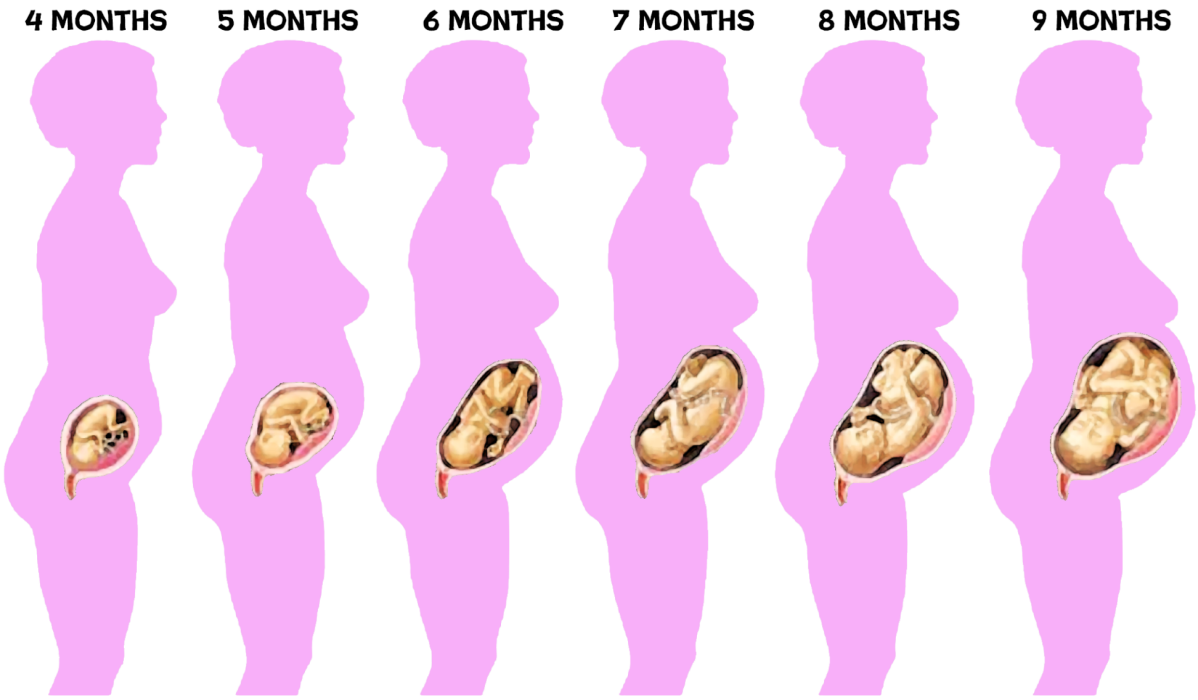
“Yes,” said Shawncy. “It reminds me of a reusable seed. Or egg.”

“I understand,” said Butters. “But I like egg. Picturing cow eggs is just funnier, and I think the same is true of humans.

“It’s all the same to me,” said Shawncy. “Whatever makes you happy, as long as we understand each other.”

“Thank you,” Butters replied. “Just like before, the human’s reusable egg is called the uterus, and just beyond that are two ovaries where the human egg cells are made.”

“So the egg cell is made in the ovaries,” Shawncy repeated, “and then, **if it is fertilized, the embryo grows in the uterus**. **And when the baby is fully grown… the baby comes out the vagina**? Have I got that right?”

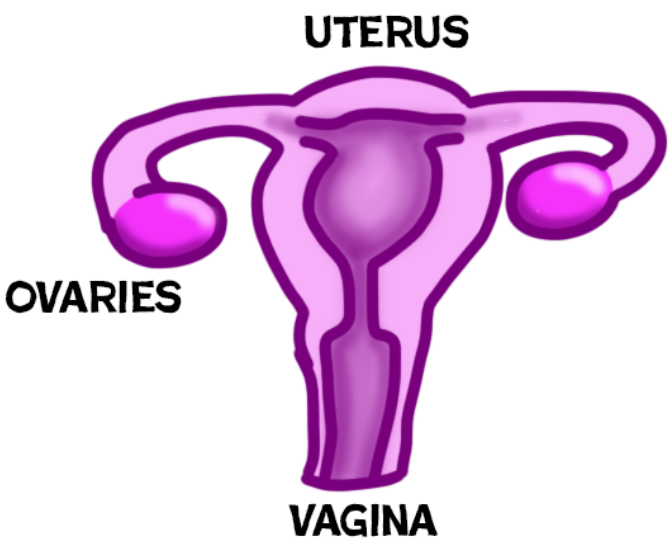


“I believe so, little worm,” said Butters. “And after the baby is born, the uterus- the reusable egg- goes back to normal and eventually she can have another baby.”

“Does anyone else call it that?” asked Shawncy. “A reusable egg I mean.”

“No one else in the world,” said Butters.

“Now, the male of the species,” said General Byrd, “is again similar in design to the male cow. **The reproductive parts are on the outside of the body. The testes are outside the body, and there is a pathway which goes from them to the penis which, again acts like the pollen tube, delivering the sperm cells as close to the egg cell as possible so that fertilization can occur**.”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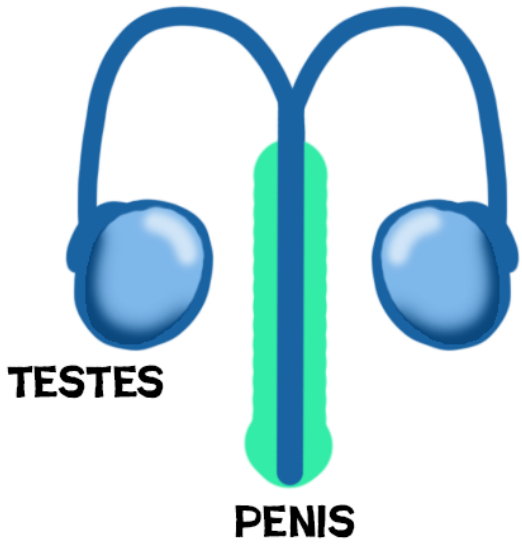

TESTES
PENIS

“It’s a system that works,” said Shawncy.

“An efficient design,” agreed General Byrd, “both for the apple blossoms and the mammals.”

“What’s a **mammal**?” asked Shawncy.

“Oh, the humans and cows are mammals,” explained General Byrd. “Science groups different things to make it easy to talk about their similarities. **Mammals are any animal which has warm blood, hair on their body, and which gives birth instead of laying eggs.**”

“Oh,” said Shawncy. “I am not a mammal. I don’t have any hair. Erica and Butters have hair.”

“But I’m cold blooded, and bees don’t give birth,” said Erica. “We’re a lot more like the frogs and fish that way.”

“I am in fact a mammal,” said Butters. “Like cows, cats do not lay eggs. And we are warm blooded.”

“What does ‘warm blooded’ mean?” asked Shawncy.

“It means that my body is always the same temperature,” said Butters,” where as our little honey bee friend is generally going to be fairly close in temperature to the environment in which she finds herself.”

“Cows and humans are also warm blooded,” said General Byrd, “which is important to that baby in the uterus. If the mother is outside on a winter day, the inside of her needs to be warmer than the snow she’s walking through.”

“Especially here in Wisconsin,” agreed Shawncy.

“There is one more thing all mammals have in common,” said Butters, “and I believe it is an important part of this topic. Come with me. It’s time to visit our cow friends again.”

QUESTIONS!

1. What is the name of the opening into the reproductive system in female humans and other female mammals?

2. What is the name of the part of the female reproductive system which acts as a reusable egg or seed where the baby grows after fertilization?

3. How does the baby get out of its mother's body once it has grown enough to live on its own?

4. How is the human male's reproductive system similar to that of the bull?

5. What are mammals? What are a few examples of animals which are mammals?

Chapter 9: Milk and The Bathing Suit Area

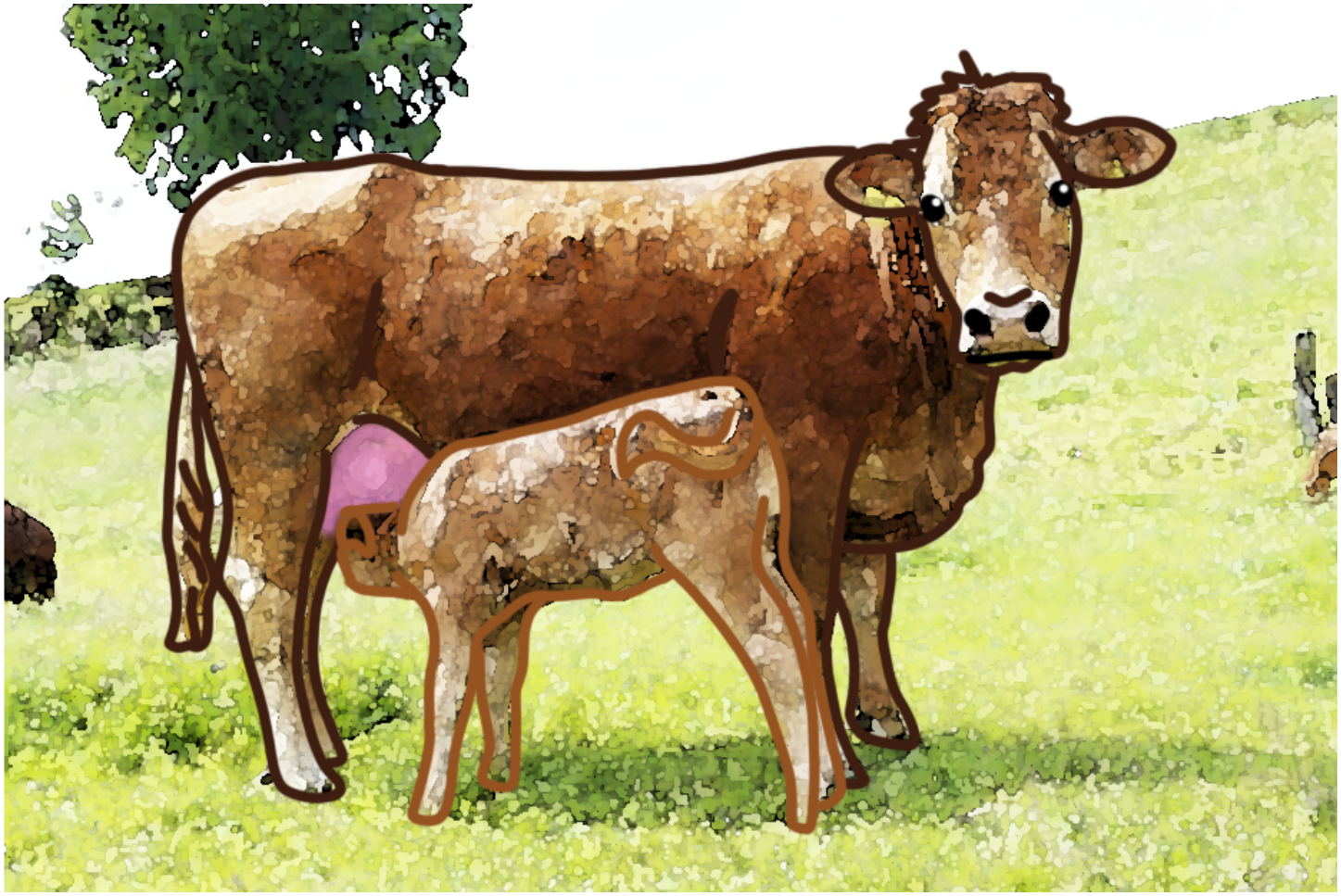
General Byrd, Shawncy, Erica the Honey Bee and Butters the cat walked back out to the field behind the barn to see the cows. They found a spot on the fence again and took a look at the cows grazing in the grass. Not far away was a cow eating grass. While they looked over the small herd, a tiny cow turned toward them and started to jog their way from the far side of the pasture.

“Ah, perfect,” purred Butters. “We’ve got here just in time.”

“For what?” asked Shawncy.

“Dinner,” said Butters.

The tiny cow looked as though it was going to visit them at the fence, but instead it turned, trotting up to the bigger cow, sticking his nose somewhere underneath her, near her back legs.



“Do you see what the little cow is doing, Shawncy?” asked Butters.

“I’m not entirely certain,” he replied. “It seems as though the little guy is sticking his nose in that bigger cow’s personal business.”

“You’re not wrong,” laughed Butters. “To begin with, that bigger cow is his mother.”

“Oh,” said Shawncy. “Well, that certainly explains why she’s taking it so well.”

“And he’s having dinner,” Butters explained. “Look at that cow over there,” she said, indicating another female cow. Do you see that part under her back legs?”

“Oh, yes,” said Shawncy. “I know what those are. Those are udders. The farmer gets milk from those.”

“Well, my little worm friend,” said Butters, “that is exactly what this tiny cow is doing.”

“He’s drinking the farmer’s milk?” asked Shawncy. “I hope the farmer doesn’t get cross about it.”

“You’re such a funny little worm,” laughed Butters.

“Thank you,” said Shawncy. “Sometimes I even mean to be. But what was funny this time?”

“Why do you think the cows make milk?” Butters asked.

“I assumed it was just their job,”answered Shawncy. “The chickens make eggs, the cows make milk, and you catch mice. Right?”

“He’s not wrong,” said Erica. “But he’s not entirely right.”

“It seems to be one of his persistent and endearing qualities,” observed General Byrd.

“The truth is,” said Butters, “the cows don’t make milk for the farmer. The **cows make milk for their babies**. This little cow is drinking milk from his mother’s udder because that is how she feeds him.”

“So the farmer is stealing milk from babies?” exclaimed Shawncy, clearly upset by this latest piece of information.

“No, my dear worm,” said Butters. “Just like the chickens lay many eggs, and most of them will not hatch into baby chicks, the cows make more milk than their babies need.”

“Oh,” said Shawncy with a sense of relief. “That’s good to hear. I always thought of the farmer as a gentleman.”

“And so he is,” said General Byrd. “You see Shawncy, the chickens will lay eggs every day. If the eggs are not fertilized, they don’t hatch into baby chickens and so are good for nothing else but breakfast. Similarly, the cows make more milk than their babies need, and as the babies grow up and begin eating grass, they need less and less milk. So, the farmer is not keeping the babies from being well fed. He’s just making sure the milk doesn’t go to waste.”

“Oh!” said Shawncy gladly. “That’s awfully good of him. I knew he was a smart fellow.”

“Now the reason I brought you out here to watch the baby cows drink milk,” said Butters, “is to show you another thing which all mammals have in common. **They all produce milk to feed their babies**.”

“Oh, goodness,” exclaimed Shawncy with a laugh. “I believe I have misunderstood something. Here I was thinking that you said humans and cats are mammals too.”

“We are,” said Butters.

“I don’t mean to get personal,” said Shawncy, “but you do not have udders and, unless I am very much mistaken, neither does the farmer’s wife.”

“I love this little worm,” Butters said.

“He’s not wrong,” said Erica.

“But he’s not entirely right,” said General Byrd.

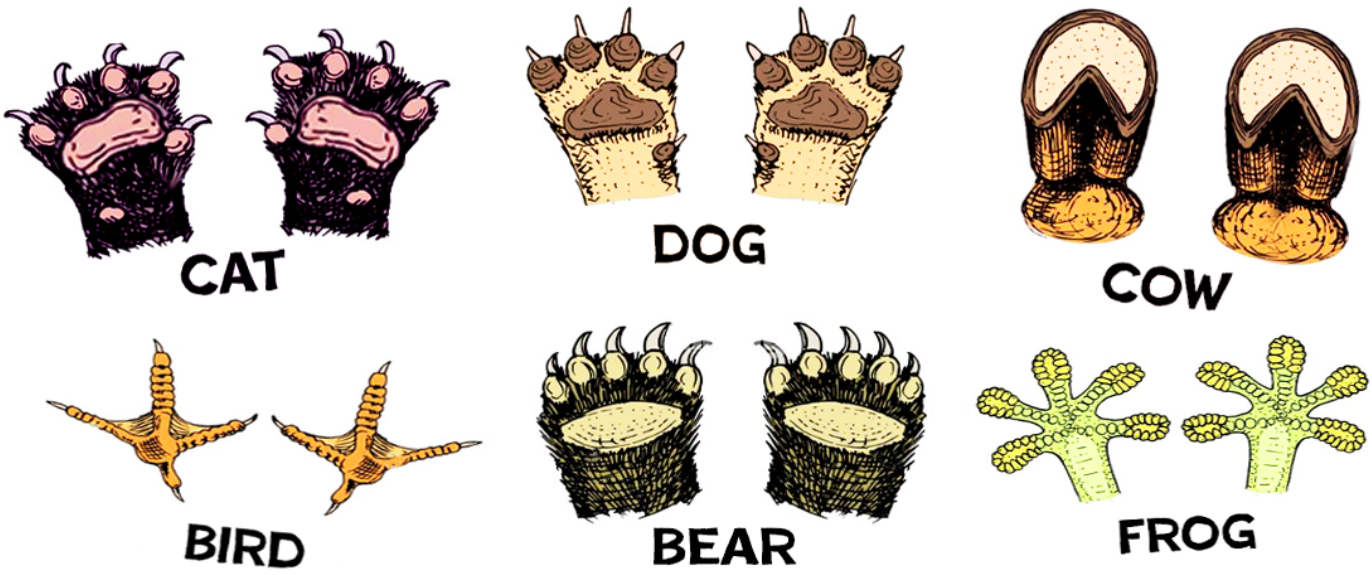
“I think I can help clear this up,” said Butters. She held up a paw and said, “Do you see this, Shawncy?” He nodded. “Do you know what it is? And what is it for?”

“Yes of course,” he replied. “It’s a foot. You walk on it.”

“And do Erica and General Byrd have feet?”

“Yes, they have feet.”

“And do their feet look like my feet?” Butters asked, still holding her paw up for Shawncy to see.



Shawncy looked at her paw, then at General Byrd’s feet, and then at Erica’s and said, “No, not at all. You all have very different feet!”

“And yet,” said Butters, “we all have feet for walking. You see, sometimes the good Lord makes interesting variations on an idea, so that the job gets done, but the style is vastly different. While all of these feet can be used for walking, they each look unique. From cat paws to little bird feet, each is good at what it needs to do, and beautiful in its own way.”

“I can definitely see that,” said Shawncy.

“So it is with mammals,” said Butters. “Come on. Let’s go back to the farmhouse.”

They hopped off the fence and as they walked back to the house, Butters continued to explain to Shawncy what she was hoping he would learn from the example of their feet.

“There are several different ways in which mothers can feed milk to their babies,” Butters continued. “Cows have one way, cats have another way, and humans yet another way. The cow has udders. We

cats have a short row of teats on our underside where our kittens can feed. Human women have breasts."

"**Breasts**?" said Shawncy. "You mean those two soft, round parts on the top half of the woman? **Those are for feeding babies**?"

"That's right," said Butters. She stopped under a windowsill and hopped up to look into the house. "Come on up. You'll see what I mean."

The trio joined her on the windowsill and when they looked in, they saw the farmer's wife sitting in a rocking chair, quietly singing to herself. Though, after looking for a moment, Shawncy realized that she wasn't singing only to herself, but to the tiny baby in her arms.

"Aw!" exclaimed Shawncy. "Tiny humans are so cute!"

"Do you see what she's doing?" asked Butters. "The tiny human I mean."

Shawncy looked closely and noticed that the baby's little face was pressed against her mother's breast. "It looks like she's doing what I thought that tiny cow was doing," he said. "Putting her nose in her mother's business."

Butters smiled at him. "I suppose she is," Butters said with a slight smile. "She is drinking milk. **After human women have babies, their breasts make milk so they can feed their babies.** The babies drink the milk by sucking on their mother's nipples."

"Well, look at that!" said Shawncy. "I never even knew the farmer's wife had nipples." He thought for a moment and then added, "I've never seen her uncovered before."

"And you're not likely to," said Butters. "Human women keep their nipples covered when others are around."

"Why?" asked Shawncy. "The men don't always keep theirs covered."

"Because the sacred should not be vulgar," said Butters.

"What does that mean?" asked Shawncy.

“**Sacred means something is of great, heavenly value,” said Butters. “And vulgar means it is common and unimportant**.”

“I think it is time for one last mystery,” said General Byrd. “This mystery goes beyond the mysteries of life, and into the mysteries of God Himself!”

“This sounds important!” Shawncy exclaimed.

“It is, my boy. It is.” General Byrd paused for a moment, looking again at the mother and child inside the house. “What we see before us,” said General Byrd, “is in one sense common, because there have been so many mothers and children in the world. But in a higher and far more important sense, we are seeing the face of God!”

“This *is* important,” said Shawncy quietly.

“The Bible tells us,” continued General Byrd, “that in six days the Lord made the heavens and the earth, the sea, and all that is in them. We are all the works of His hands, from the apple tree to the frogs and fish, the chickens, us, and those two in there. But those two are different in one way which is more important than all other ways.”

“What way is that?” asked Shawncy.

“**God created man in His own image**,” said Butters. “In the image of God He created him; male and female He created them.”

“The image of God?” repeated Shawncy. “**Humans are made in the image of God**?”

“That’s right,” said Butters. “Just like that little baby girl is made in the image of her mother and father, all of them are made in the image of God. For all of us animals, God is our creator, but for the humans, in some special way, He is their Father.”

“Shawncey, what was the very first thing that God did?” asked General Byrd. “In the beginning.”

“He created,” answered Shawncy. “He made the heavens and the earth, the sea, and all that is in them.”

“That is right,” said General Byrd. “Every act of reproduction is a miracle that echoes the song of creation, but when a human husband and wife have a baby, they are making the very image of God. And that reflects the act of God in Creation when He made them in His image.”

“A human, who is the image of God,” said Shawncy, “makes the image of God by reproducing the image of God.” He marveled at it for a moment. “I can see why you said this was sacred!”

“And it is that sacredness,” explained Butters, “which explains why the human women do not show their nipples in public.”

“How is that?” asked Shawncy.

“Think about the way they are always dressed,” Butters said to him. “What parts of the humans do you never see outside of their houses? What parts are *always* covered?”

Shawncy thought about all of the times he had seen humans. The women always covered their nipples, though the men sometimes did not. So what did they all always cover?

“Oh, I see,” said Shawncy. “All humans always cover their reproductive parts.”

“That is right,” said Butters. “And do you see why they would choose to always cover those parts?”

“Because **they are sacred,” he said. “Those parts are used to make the image of God!**”

“That is right, my boy,” said General Byrd. “A human’s hands can make wonderful things, and the human voice can be used to make great music, but there is only one part of a man and one part of a woman that can combine to make the image of God.”

“And the part of the image of God,” added Butters, “which can be used to make the image of God is sacred. It should not be treated as common, as vulgar, like an ear or an elbow or a toe. The toes can be left out in public, seen by any and all, and it is no sin because toes are vulgar- that is, common. Many creatures have toes which they use to walk. I do. Birds and bees do. But no other creature has parts by which they may make the image of God. And so those parts of humans are sacred and

should not be left out in public as though they are common or without great value. They are covered because they are sacred, special, and should be treated as sacred and special."

"The sacred should not be vulgar," said Shawncy. "But, how does that explain why men sometimes show their nipples in public? Are they making a sacred thing vulgar?"

"What are women's nipples for?" asked Butters.

Shawncy looked through the window again at the farmer's wife and her nursing baby girl. "They are for feeding new babies," he said.

"And what are men's nipples for?" asked Butters.

Shawncy paused for a moment and thought. "I have no idea," he finally said. "What are they for?"

"I have no idea," said Butters. "I think they are just for decoration."

"Like earlobes," said Shawncy.

Butters, General Byrd and Erica were silent for just a moment as they considered Shawncy's statement.

"He's not wrong," said Erica.

“No,” said General Byrd. “He's not wrong.”

“Because humans are made in the image of God,” said Shawncy, “they are different than all other animals. And because they make the image of God when they reproduce, *their reproduction is sacred* in a way that the reproduction of cows and chickens and frogs and fish is not.”

“Yes my boy,” said General Byrd. “I do think you’ve got it.”

“And because a baby is the image of God,” Shawncy continued, “then he or she is sacred as soon as he or she comes into being. As soon as they are that tiny embryo in the mother’s reusable egg.”

“Uterus,” Butters reminded him.

“Yes, uterus,” said Shawncy.

“Sometimes people say ***womb***,” added Butters.

“Womb?” repeated Shawncy. “Oh. I like that. It sounds more warm and cozy than *uterus*.”

Butters nodded.

“So, when the image of God creates the image of God,” Shawncy continued, “the mother uses her breasts to feed and care for that tiny image of God. She is giving nourishment from her own body- using her own body to care for that little image of God. So **the nipples that feed and give life to the image of God are sacred, and should be treated as sacred**. But the nipples that men have can’t do anything, and so are common like earlobes.”

“Well said, my little worm friend,” said Butters. “Come,” she said, hopping off of the windowsill. “There is one more sacred piece to this mystery that you need to learn about.”

QUESTIONS!

1. Why do cows make milk? Why do any mammals make milk?

2. What is the function of breasts on a human female?

3. When does a woman's breasts start producing milk?

4. What are the meanings of the words "Sacred" and "Vulgar"?

5. What was special about the creation of humans that makes them different from other animals?

6. In almost every human culture that has ever existed, what parts do all people cover in public? And why are those parts special, as opposed to a toe or elbow or earlobe?

7. Why do women cover their breasts and nipples in public, when men sometimes go topless in public?

8. What's another word for uterus which Shawncy feels sounds more warm and cozy?

Chapter 10: For as Long as You Both Shall Live

Butters the cat lead General Byrd, Shawncy, and Erica the Honey bee into the farm house's living room. They could still faintly hear the farmer's wife singing to her little girl. Butters lead them to the book shelf against the wall and hopped up onto a shelf, waiting for them to join her.

They were sitting in front of a collection of photos in decorative frames. Butters indicated the biggest picture on the shelf- a picture of the farmer and his wife. He was wearing all black, with a bow tie (*something Shawncy noticed immediately*). His wife was wearing a beautiful white dress and holding a large bouquet of flowers.

"Have you ever been to a wedding?" asked Butters. The others shook their heads. "Nor have I," said Butters, "but I have been able to watch the farmers' wedding until I nearly have it memorized."

"How have you watched a wedding you weren't at?" asked Shawncy.

"Through the magic of DVD," said Butters.

"Ah," said Shawncy. "I see. But to be fair, a DVD isn't *technically* magic. It's just a digital optical disc data storage format."

Butters stared at Shawncy for a moment and blinked several times.

“He’s not wrong,” said Erica.

“But… *how is he not wrong*?” asked General Byrd.

“Oh, I’ve just always been a fan of data storage technology invented in Japan in the 1990’s,” replied Shawncy.

And for the moment, that was good enough for everyone.

“Anyway,” said Butters, picking up where she had left off, “I wanted to explain this whole wedding thing. Or more accurately, I wished to explain the concept of marriage.”

“What’s the difference?” asked Shawncy. “Aren’t a marriage and a wedding kind of the same thing?”

“Not at all,” said Butters. “A wedding is merely a public ceremony to announce the beginning of a marriage.”

“I’ve heard it said,” chimed in Erica, “that a wedding is the celebration where the vows are made, and the marriage is what happens when they live those vows for the rest of their lives.”

“What are vows?” asked Shawncey.

“Vows are promises,” said Erica. “The man and the woman promise certain things to each other.”

“The marriage itself,” said Butters, “is a commitment between two people to be ONE, for the rest of their lives.”

“A commitment between two people to be one… *what*?” asked Shawncy.

“Do you know what a violin is?” Butters asked.

“Yes,” replied Shawncy. “It’s like a tiny guitar that you make music on by sliding a stick across it.”

Butters looked up, out the window. “I’ve just felt a great disturbance in the force,” she said, “as if a million music teachers cried out and were suddenly silenced.”

“Was I close?” asked Shawncy.

Butters sighed. “For now I will just say *yes* and continue making my point,” she said. “That tiny guitar, as you called it, is the violin. It’s where the music comes from, but the stick, which is called a bow, is

used to cause the strings to vibrate and make the music. The musician must have both in order to make music."

"The stick is also called a fiddlestick," said General Byrd.

Butters looked up at the window. "I hear it again," she said.

"Why are we discussing stringed musical instruments?" asked Shawncy.

"Oh, right," said Butters. "I was saying something. Consider this, little worm. The violin and bow are two separate objects. The musician holds each one in a different hand. But, when they are put together, they are a single instrument that makes music. The violin is two things that are *ONE*."

"Oh, I see," said Shawncy. "Two different things can be, not the same *thing*, but… one."

"Like pollination!" said Erica.

"How so?" replied Shawncy.

"Well, maybe it's because I'm a honey bee who loves her job, but I think about things in terms of flowers. The apple blossom has pollen. Remember? This little blue wagon with a germ cell- a complete thing all by itself. And the ovary has the pre-seed with the egg cell inside it. Again, an object totally separate from the pollen. But when they come together, they become ONE. And the ONE that they are is a totally new thing."

"I rather like that," said Butters.

“Oh, thank you!” said Erica.

“A marriage,” said Butters, “is when two people promise to be ONE, and they come together to be ONE. And their lives become like that seed- no longer two things merely near each other but, like the violin and bow, a single new thing. And, like that apple tree, a thing that can blossom and grow.”

“I believe this is part of the mystery,” said General Byrd. “Once fertilization has happened, can you turn the embryo back into an egg cell and a germ cell?”

“No,” said Shawncy. “It’s a baby apple tree. It will always be an apple tree.”

“A marriage is like an apple tree,” explained General Byrd. “When the two become one, they can no more be separated than an apple tree could be turned back into egg cells and germ cells. Every part of it is that new thing that came from their union. An apple tree will be an apple tree for as long as it lives.”

“During a marriage ceremony,” explained Butters, “the man and the woman make vows, which are promises to be ONE. The pollen which was *his life* and the pre-seed which was *her* life is now an apple tree- *their* life. ONE life.”

“And one which can bear fruit!” exclaimed Erica. “I mean, metaphorically. Babies. I meant babies. Not actual fruit.”

“We understand,” Butter assured her.

“That is a beautiful mystery,” said Shawncy.

“It is part of the mystery of life!” said General Byrd. “But in humans, there is another layer to the mystery which begins here. **It is God’s design that humans only reproduce with the one they are married to. They are commanded not to mate with anyone but their one life partner.** Husband and wife. In fact, one of the reasons for them to be married is to build the family that their babies should be born into.”

“I can see that,” said Shawncy. He could still hear the faint singing coming from the nursery.

“First comes love,” sang Erica, “then comes marriage, then comes the baby in the baby carriage!”

“But in humans,” said General Byrd, “there is another layer to the mystery which doesn’t seem to exist anywhere else.”

“Because humans are the image of God?” replied Shawncy.

“I believe so,” said General Byrd. “Consider this. When an apple blossom pollinates another apple blossom, what is the purpose?”

“To make apple tree seeds,” said Shawncy. “Which makes new apple trees.”

“Anything else?” asked General Byrd.

“Nothing apparent,” said Shawncy.

“What about when frogs or fish release their eggs and sperm in the same part of the pond?” continued General Byrd. “What is their goal?”

“To make baby fish and frogs,” said Shawncy.

“Anything else?” asked General Byrd.

“I don’t think so,” said Shawncy.

“What is the purpose of Chickens doing the cloaca kiss?”

“To fertilize the eggs and make baby chickens,” said Shawncy.

“Does it accomplish anything else?” asked General Byrd.

“I don’t think so,” said Shawncy.

“What about when cows mate?”

“It seems no different from the chickens,” said Shawncy. “They make baby cows. I don’t think mating has any other purpose.”

“I think you are correct,” said General Byrd. “Animals seem to mate for only one purpose, which is to make baby animals. They are obeying some kind of instinct. But humans are different from the animals.”

“They wear pants,” said Shawncy.

“Oh… Yes, and I think we discussed why,” said General Byrd. “But that wasn’t the difference I was discussing just now. However, since you brought it up, have you considered that humans must be undressed when mating?”

“Oh,” said Shawncy. “I suppose that would be true, since one of the purposes of the clothing is to cover the parts they use in order to mate. So when mating, that clothing has to come off.”

“While they cover those parts in public,” General Byrd continued, “a husband and wife can be naked and unashamed *together*.”

“Like Adam and Eve!” exclaimed Shawncy.

“Very good, my boy!” said General Byrd. “Yes, that is exactly right. Because they are one, they have nothing to hide from each other, like the first humans when the world was perfect.”

“If I remember correctly,” said Shawncy, “when God made the humans, He made Adam first, and then took a rib from Adam to make Eve. God turned the one into two. So, when they are married, the two become one again. Is that right?”

“Yes,” said General Byrd. “Spot on.”

“The marriage vows mean they become ONE,” said Butters, “which means they have no room for selfishness.”

“Especially because that relationship is to last for as long as they both shall live,” added General Byrd.

“Yes indeed,” said Butters. “The husband is to love his wife like she is his own body. If his body is hungry, he eats. He is to have no less care for his wife. When she is hungry, he provides for her. When she is scared, he protects her. When she is happy, he dances with her. They share everything. They have a love which is more than the love between friends. They have a love which is **intimate**.”

“What do you mean by *intimate*?” asked Shawncy.

“It means detailed,” answered Butters, “taking everything into account. Nothing is hidden or left out.”

“It means personal,” added General Byrd, “including those things which mean the most to each of them. Everything they value is shared. And it means open and honest, without fear or shame.”

“They can be more than merely unashamed,” said Butters. “They can be, how shall I put this? **JOYFULLY intimate**. Joyfully and physically intimate.”

“Physically intimate?” replied Shawncy. “Like hugs and kisses?”

“Oh, well, yes,” said Butters. “Their love for each other sometimes is expressed in hugs and kisses, or in singing and dancing. Sometimes it’s kind words and gifts and time spent together.”

“Those all sound fairly commonplace,” said Shawncy. “I mean, wonderful, but not exclusive to married couples.”

“Some forms of physical affection can be common,” said Butters, “like warm hugs. But I’m talking about a much more personal physical intimacy, where nothing is hidden and everything is shared. Because the man and woman are husband and wife- because they are ONE- they can be joyfully naked and unashamed, as Adam and Eve were at the beginning. Joyfully intimate. God has given them a special way of expressing this love for each other which is special and unique to a husband and wife, and that is mating.”

“I thought mating is for making babies,” said Shawncy.

“In one sense,” said Butters, “it very much is. But with married humans, the act of mating serves as a way for them to be intimate with each other in a way which only a husband and wife can be. As husband and wife, they have shared their love, and they have shared their lives, and then, once they are married and become ONE, they can share their bodies in a way which is sacred. The husband is to love his wife like his own body, remember?”

Shawncy nodded.

“Because they are ONE,” Butters continued, “her body *is his*, and his body *is hers*. They no longer belong only to themselves, but to each other. They can come together to be physically one in a way which is special and beautiful and sacred. What they cover in public, they share in private with each other. It is a way for them to fully share themselves with each other.”

“Joyfully?” said Shawncy.

“Very joyfully,” said Butters. “It is meant to connect them forever to that day they made those sacred vows and became ONE. Like a wedding, the act of making love for a husband and wife is a celebration of their marriage. It connects them physically and emotionally.”

“That is, as long as it is between a husband and wife,” added General Byrd. “If humans mate outside of marriage, they have separated the behavior of reproduction from the unity of being ONE. It is reduced from being a sacred form of intimacy to merely an animal act, like being two cows. It makes a sacred thing vulgar. God designed it to allow a man and woman to know each other intimately. Removing it from the ONE-ness of marriage very often makes them hide from each other emotionally even while uncovering themselves physically.”

“So when humans mate outside of marriage,” Shawncy mused out loud, “they are going through the motion of being intimate, while really they are experiencing a lie pretending to be intimacy.”

“Yes,” said Butters. “Their hearts think they are becoming ONE, but sooner or later they have to realize that there was no ONE-ness. It adds selfishness to what is intended to be sacred and intimate. It is a lie pretending to be love and intimacy, and it can cause a lot of heartache and sadness. Before a human gives himself to another person, he should have the security of knowing that she has

promised him the rest of her life so he can be at peace, and she should have the same peace from his sacred vows to her."

"If you can't be at peace," said Shawncy, " you can't be unashamed. And if you're ashamed, you will be hiding. Outside of marriage, they'll never really know each other fully because they'll both be hiding. Does that sound right?"

"Perhaps Genesis can offer some illumination," suggested General Byrd. "The book of Genesis doesn't say, 'Adam and Eve mated and made babies." And it doesn't say, 'Adam had sex with his wife.' It says, 'Adam *KNEW* his wife.' That's how the language of the Bible expresses their physical intimacy. '***Adam KNEW his wife***.' A person can know his family and friends and neighbors in a common way, but the way in which a husband and wife know each other is sacred. It is more personal and intimate than any other. They know every part of each other- heart and mind and body, shared for a lifetime. THAT is the intimacy of marriage."

"It reflects the beauty of the world when it was new," said Butters, "because they are naked and unashamed. **The intimacy of a marriage is like that, because the thing the husband and wife are sharing with each other is *themselves*.** It makes them feel special to each other because they are sharing this wonderful thing which they *only share with each other*. And sometimes it results in a baby, which gives them someone they can love together."

"It sounds like human mating is far more than just mating," said Shawncy.

"That's right," said Butters. "In fact, humans rarely ever call it mating. I've heard them call it 'Being Intimate.' Animals mate to have baby animals, but humans can be intimate even when it doesn't result in babies. It helps them create a bond between them which is unlike any other. But that's one of the reasons why it is designed by God to be *only* a part of their marriage. **That bond is special, because it only exists in being ONE**."

"In marriage," said General Byrd, "intimacy is the result of giving one's whole self to the other. The man gives his heart, life, and body to his wife completely, and only to her. If he were to try and do the same with other women, he would not create more intimacy, but rather he would destroy the intimacy he had with his wife. One cannot give one's self completely to more than one other, which is why marriage is one man with one woman for as long as they both live."

"I'm only a bee," said Erica, "but I think I understand a little. We bees love our queen. Loving our queen is something we can all do together, so it's not the kind of intimacy that married humans have. But loving our queen is special because we have ONLY that one queen. But if we tried serving another queen, we would not be serving either very well. Instead of being good servants to two queens, we would be very bad servants to two queens."

“Yes,” said General Byrd. “The only way to be a good servant to the crown is to serve only one crown. Similarly, the only way for a man to be a good husband and father is to be a good husband to one woman, and to be the father of only her children.”

“God created mankind in his own image,” said Butters, “in the image of God he created him; male and female he created them. Each human is a little picture of God, but in some mysterious way, they are even more a picture of God when they are married.”

“And the image of God, “added General Byrd, “is made complete in the two becoming one in the marriage. Having multiple wives or mating with multiple others is a distortion of the sacred image of God, just as if we drew a picture of Butters with four tails, six eyes, and scales instead of fur.”

“Ew,” said Shawncy. “Instead of a cat, she would look like a spider fish.”

“Just as the humans are sacred,” said Butters, “and their ability to make a new picture of God is sacred, the bond between them that makes them ONE is sacred. That bond makes them one. That intimacy makes them one. That intimacy can also make babies.”

“But it doesn’t have to,” said Shawncy, the light of understanding in his eyes.

“That’s right,” said Butters. “When humans engage in mating, which they call *having sex*, or *making love*, or various other names, it’s not just to make baby humans, like the animals do. **They share themselves in a special way that builds their bond and makes them ONE. It’s an expression of love and friendship and intimacy.** It’s that wonderful secret, beautiful thing that they only share with each other. It’s their own personal rainbow, or sunset, or song.”

“And when that bond is strong,” added General Byrd, “the home is strong, and is able to make the children feel safe and loved. A strong marriage makes for happy and healthy children.”

“And still,” said Butters, “how wonderful is it that a human baby can be the result of a sacred act of loving intimacy? Surely the method of making the image of God should be loving, intimate, and joyful!”

“Wow,” said Shawncy. I’ve never seen so many miracles in one day before. Humans have something very special.”

“Something sacred,” said Butters.

“Yes,” said Shanwcy. “Something sacred.”

QUESTIONS!

1. A marriage is a commitment between two people. What are they committing to?

2. What's the difference between a wedding and a marriage?

3. What is God's design when it comes to human reproduction and how is it different from the way animals treat the act of mating?

4. When Butters describes the joyful intimacy of marriage, what does she say the husband and wife are sharing?

5. Why did God forbid men from marrying and/or mating with multiple women?

6. Human mating (which is sometimes called 'having sex' or 'making love') can result in reproduction, but it often does not. What other purpose does it serve in a marriage?

Epilogue

That night in the apple tree, as General Byrd was tucking Shawncy in for the night, they were talking about their day.

“It was good to spend time with our friends today,” said General Byrd.

“Very good,” said Shawncy. “Our friends are kind, and they know a lot of interesting things!”

“That they do, my boy,” said General Byrd.

“They helped me learn a lot of things. You did too. Thank you, General Byrd.”

“Anytime, Shawncy.”

“And guess what?”

“What?”

“I know why these apples are red now.”

“You are a worm who has been blessed with the mysteries of life.”

“I did have one more question.”

“Oh yes?”

“Yes,” said Shawncy thoughtfully. “Butters said that mammals are warm blooded animals that give birth and make milk for their babies. But, platypuses are warm blooded and make milk for their babies, but they lay eggs like chickens. Are they still mammals?”

General Byrd paused for a moment. “I think,” he said, “that is a mystery for another day.”

“All right. Good night General Byrd.”

“Good night Shawncy.”