COME ONE

COME ALL

A SCIENCE VARIETY SHOW
LIKE NOTHING YOU'VE EVER SEEN!

FEATURING:

The science rock stylings of

LEUCINE ZIPPER

and the

ZINC FINGERS

hilarious

SCIENCE STAND-UP FROM

PETE LUDOVICE *and* **LEW LEFTON**

MYSTERIOUS SCIENCE AND MATH MAGIC WITH

DAR~WEI CHEN *and* **MATT BAKER**

PERFORMANCES BY

THE DANCING FLOWERS FOR PEACE

TEEN UNICYCLIST **RACHEL BLOOM**

PHYSICS GRAD STUDENT BAND **SU(2)**

and much much more!

FRIDAY, MARCH 27, 2015

HISTORIC ACADEMY OF MEDICINE

DOORS@6:30 SHOW STARTS@7:30

$5 Students, $10 Adults, Children 4 & under are free

GOURMET POPCORN BUFFET INCLUDED WITH TICKET

Ticket information available at

LEUCINEZIPPER.COM

AN ATLANTA SCIENCE FESTIVAL EVENT SPONSORED BY GEORGIA TECH

CASH BAR

BE AMAZED

Welcome to the Leucine Zipper Science Show!

When my bandmates and I were growing up in the top-secret sterile test facility where we were born (backstory page 4), we never expected that we would one day meet as many other science freaks as we have assembled for you tonight at this science variety show. Who knew so many scientists were also dancers, musicians, magicians? Who knew so many REAL performers loved science so much? We are truly humbled to be in such fabulously geeky company.

We hope that tonight you will learn something new, explore, and most of all have a fun scienc-y evening! In this program, you will find descriptions of the science and humanity of each of the performances you'll be seeing tonight, and don't forget to stroll down the hall to the library to see the "science peep show" featuring naked atoms on display in a real fusion reactor built just for tonight! Now sit back, relax and let science entertain you!

Leucine Zipper

PROGRAM:

7:30 Show begins

Set 1
Leucine Zipper and the Zinc Fingers (LZZF) perform *We're a Science Band*
Act 1. Dar-Wei Chen *Card Trick Science*
LZZF *Stuck on you*
Act 2. Lew Lefton *Math Comedy*
LZZF *Time Warp*
Act 3. Dana Higgins *Water Cycle Song*
LZZF *Bed of fossils*
Act 4. X.O. Therm and friends present: *Chemistry Slam*
LZZF *Fickle Finger of Fate*

8:23-8:35 Intermission

Set 2
LZZF *Let's test it*
Act 5. Rachel Bloom *The Physiology of the Unicycle*
LZZF *I know the world is round*
Act 6. Earl & Meyer *Chemistry*
Act 7. Matt Baker *Math Magic*
LZZF *Joss Paper*
Act 8. Dancing Flowers for Peace
LZZF *Entropy: Atomic Anarchy*
Act 9. Pete Ludovice *Science Comedy*
LZZF *GMO ROCK*

Set 3 - A special performance Su(2) - a rock band full of physicists(!)

The History of Leucine Zipper and the Zinc Fingers

For years, Professor Morte, host of the Silver Scream Spookshow, collected, sequenced and analyzed the DNA from some of the most celebrated rock musicians of our time. While he has never divulged his subjects in fear of prosecution, burglaries were reported at the homes of Joan Jett, Iggy Pop, and Alice Cooper. The only items reported missing in these break-ins were hair brushes.

Morte now claims to have taken a common sequence of rock star DNA and inserted it into stem cells derived from tissue samples taken from immunologist Jennifer Leavey, organic chemist Michael Evans, amphibian ecologist Joe Mendelson, and biologist Ben Prosser, all Georgia Tech faculty or alumni. Using a mysterious accelerated aging protocol, adult specimens have grown from the stem cells and have formed the world's first genetically engineered rock band, Leucine Zipper and the Zinc Fingers. When allowed to leave their top-secret sterile test facility, band members Leucine Zipper (guitar, vocals), Gringo Perdido (guitar), X.O. Therm (bass) and Sonic Hedgehog (drums) play live, loud, science punk rock.

The Zinc Fingers are:

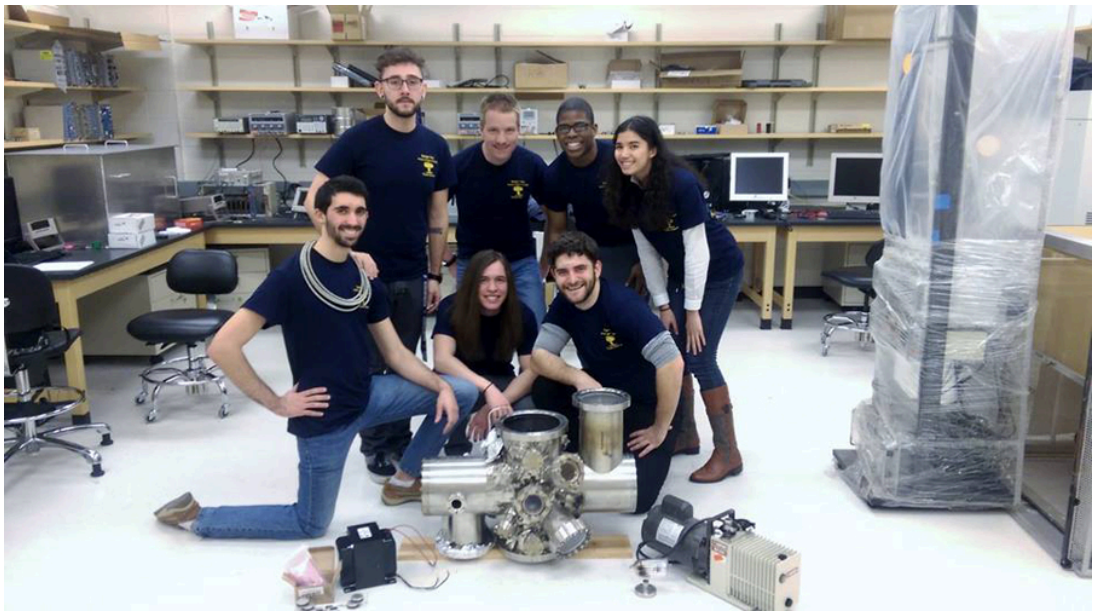

Gringo Perdido


X.O. Therm


Sonic Hedgehog

About the Fusion Reactor (located in the library – don't miss it!)

Witness the magic of the mysterious glow generated from tiny atoms fusing together inside one beautiful machine. Besides demonstrating this scientific feat, our local Society of Physics Students chapter will illuminate to all the processes behind it, as well as shed some light on the construction of a fusion reactor and how modern fusion reactors came into being.



Reactor Team: (starting from bottom left and going clockwise) Neil Hardy (PHYS, EE), Steven Forsyth (PHYS), Dr. A. Nepomuk Otte (PHYS), Robert Leonard (PHYS), Natalie Murray (PHYS), Jacob Elias (ME), and Connor Herndon (PHYS). Also not pictured are Jeff Miller (PHYS), Jacob Morello (CompE and PHYS), John Bollenbacher (PHYS), and Shadrach Hepner (PHYS).

Act 1 - Dar Wei Chen - Card Trick Science

Dar-Wei is a third-year PhD student in psychology at Georgia Tech. He never stops working, so don't be alarmed if he spends a little too much time observing your behavior tonight. It's for research.

When you watch Criss Angel and David Blaine on TV, it's easy to think that they have talents that we don't. Many people think that magicians are supernatural, but all they usually do is exploit scientific laws to their advantage; only occasionally do they break scientific laws. In this show, watch as a playing card is stolen right through someone's hands, an audience member's mind is read, and the laws of entropy are defied (!!!) in a sorting task.

Act 2 - Lew Lefton - Math Comedy

Dr. Lew Lefton received his Ph.D. in Mathematics from the University of Illinois in 1987. After positions at UC Riverside and the University of New Orleans, he moved to Georgia Tech in 1999 where he is currently on the Mathematics faculty and serving as the Director of Information Technology for the College of Sciences.

But Lefton is not just your ordinary geek. He is an accomplished and experienced comedian who has done stand up and improv comedy for over 25 years. Lefton's comedy career has taken him around the country to share his broad experiences, sharp wit, and unique perspectives. Perhaps his talents are best summed up by his business card that reads:

Lew Lefton
Mathematician/Comedian
"He's funny and he can prove it"

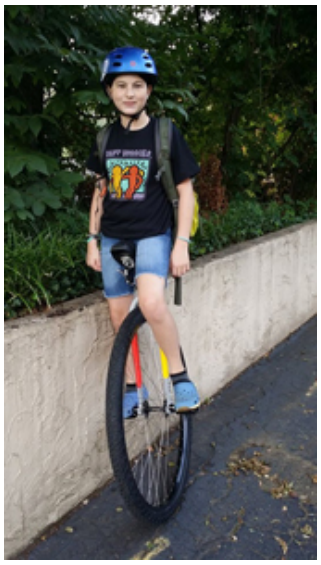
Act 3 - Dana Higgins - Water Cycle Song

Dana Higgins is 10 years old and in the 5th grade. She attends Dunwoody Elementary School. Dana is a happy, outgoing kid. Science is a favorite subject because she enjoys the many science experiments she does in school. As a small child Dana was curious as to "Why is the sky blue?", "Where do the stars come from?" She has embraced science because it's hands on and lab experiments are fun.

Act 4 - X.O. Therm's Chemistry Slam

With special guest stars Worm Hole (genetically modified clone of Paul Goldbart) on conga drums and Capsid Vicious (genetically modified clone of M.G. Finn) on flute.

Act 5 - Rachel Bloom - The Physiology of the Unicycle



Ever since she was told at age 7 by a circus camp counselor that she wasn't old enough to take the unicycling class, Rachel has been passionate/obsessed with mastering it. She not only unicycles to 7th grade everyday, she finds ways to unicycle through her life. At age 9, she did the board-breaking part of her Tae Kwon Do black belt test on it. She solves a Rubik's cube in under a minute while riding, has unicycled in many parades and even presented a FLL Robotics project while on her unicycle. Rachel's favorite past times include playing the guitar, figuring out snarky responses to typical questions such as, "Where's your other wheel?" (Oh, you mean the training wheel?) and reading as much as possible about strange medical conditions. Rachel hopes to one day be a surgeon.

Act 6 - Earl & Meyer – “Chemistry”

Famed Science-Rock / Pop / Chamber Metal / Smooth Jazz Fusion duo Earl & Meyer began their musical careers performing singing telegrams for geriatric veterinary hospitals in and around southeastern North Dakota, where neither of them lived. Citing "creative quotients," they parted ways in 1964, Earl soon becoming the 4th-highest-grossing bassoonist in Queensland, while Meyer tended his flock of non-GMO dairy llamas. A chance meeting at a vegan diner in Sacramento brought the pair into the same room again, and, remembering their shared love of polka music and braised short ribs, they decided to get the band back together. 26 critically-acclaimed cassingles later, Earl & Meyer are taking a break from their 2014-2015 "Flask Me No More Questions" Tour of Saskatchewan and Surrounding Provinces to perform their booty-shaking hit "Chemistry" tonight.

Act 7 - Matt Baker - Math Magic

Mathematics professor at Georgia Tech by day and magician by night, Matt regularly volunteers his time performing magic at the Shepherd Center as well as at fundraisers and holiday parties. A winner of the 2010 University System of Georgia Board of Regents Teaching Excellence Award, Matt is also the reigning "Top Dog" of the Atlanta Society of Magicians. His act will explore the magic of quantum mechanics, the predictions of knot theory, and the mysteries of the number 58008.

Act 8 - Dancing Flowers for Peace

The Dancing Flowers for Peace are women over fifty who are committed to living fully in our own bodies, restoring the health of our planet, bringing diverse communities of people together, and developing a stronger relationship to the natural world through the art of movement and dance.
Visit us at www.dancingflowersforpeace.org

Act 9 - Pete Ludovice - Science Comedy

Associate professor of chemical & biomolecular engineering by day, and stand-up comedian by night, Pete Ludovice's research activities include the simulation of synthetic and biological polymers, and the use of humor to enhance technical education, communication and innovation. He is currently engaged in a National Science Foundation project on the use of humor to improve engineering education. Pete is currently touring with his one-man show, "Feel the Power of the Dork Side," a hilarious look at science and technology and their practitioners. When not tormenting is students at Georgia Tech, he hosts a weekly radio show on science and technology with Leucine Zipper herself, whose motto is "Science, only funnier," and a weekly podcast on the intersection of science and the humanities.

SU(2)

SU(2) is Simon Berman, Kevin Chow, Stephen Spitz, and Jean-Philippe. The four members first met as physics PhD students at the Sorbonne. After graduating in 1987, they brought their unique mix of science and music stateside. Best known for their work on the soundtrack of the recent international hit Interstellar, they have also collaborated with bands as acclaimed as Ratatat and as unheralded as Radiohead.

Science: Sometimes you are working on science and you realize there is a spin half particle. Then you must use SU(2) to describe the spin degree of freedom.

The Science Behind The Entertainment

The Song: **We're a Science Band**

The Science: Punk rock and scientific research have a lot in common---namely, a fearless and boundless drive to explore, understand, and embrace all aspects of the cultural, biological, and physical worlds around us. This song proclaims our creative vision for scientific and artistic inquiry.

The Lyrics:
We're a science band/ we use data to understand/ we'll impress you with the things we can do/ cuz we're a science-based punk-rock band

We'll collect data from you/ we'll analyze it through and through/ we'll find out all the things that you do/ cuz we're scientists just like you

Third verse, same as the first!

We're a science band x4
We're a science band, yeah yeah

The Song: **Stuck on you**
The Science: People usually think of bacteria as single celled organisms, but many kinds of bacteria like to live together! Bacteria live together in structures that are mixtures of cells and adhesive molecules called biofilms. Living in a biofilm makes it easier for bacteria to capture nutrients, exchange genetic information and can protect the bacteria from antibiotics or from drying out. It takes a lot of energy to make a biofilm and so bacteria float around and don't bother to make one unless there are a lot of other bacteria around. The way they can tell how many other bacteria are around is through a process called "quorum sensing". Basically, the bacteria call out to each other with chemical signals that they detect with receptors in their cells. Once it gets "loud enough," they turn on genes that help them start making sticky stuff that holds them together. Probably the most famous biofilm in our bodies is the plaque on our teeth. This song is a love song about quorum sensing!

The Lyrics:
When I'm alone/ there is nothing I want to do./ I just sit by myself./ I just drift by myself.
But when I'm with you/ everything changes/ you turn me on.

Now I'm stuck stuck stuck stuck on you
And I can't can't can't can't get loose
I'm stuck stuck stuck stuck on you
You turn me on.

When you're nearby/ I can sense that you're around/ I can sense you deep inside/ Feel you're near me deep inside
And when you're close/ I want to keep you close/ I'm stuck on you.

Now I'm stuck stuck stuck stuck on you
And I can't can't can't can't get loose
I'm stuck stuck stuck stuck on you
You turn me on.

I'll never make it on my own (Let's stick together)
I get so scared when I'm alone (Let's stick together)
There's just so much that we can do (When we're together)
Let's stick together, me and you!

Now I'm stuck stuck stuck stuck on you
And I can't can't can't can't get loose
I'm stuck stuck stuck stuck on you
You turn me on.

The Song: **Bed of fossils (Sung to the tune of "Lake of fire" written by the Meatpuppets, performed by Nirvana)**
The Science: Much of what we know about life long ago comes from our study of mineralized remains, or fossils. Fossils form when a living thing gets covered by soil or silt and its soft tissues are slowly replaced with minerals. Fossils are rare because most of the time soft tissue decomposes before it can be preserved. Everyone I know loves dinosaurs and we certainly wouldn't know about them without their fabulous fossils!!!

Chorus:
I know a place where dinosaurs toiled
Then they sunk down into the soil
Became a bed of fossils, made oil
In the tar pits you can watch them boil

Apatosaurus, neck so tall
Chewing on branches until they fall
This gentle giant didn't consume meat
Never met a plant he didn't want to eat
Chorus
Velociraptor, sleek and spry
Pack runs by in the blink of an eye
Better watch out when you hear that screech
Got a big ol' claw foot to help him reach
Chorus

Tyrannosaurus, king of the crew
Feared by all and a carnivore too
Made it a point to really harm
Every little creature who mocked his little arms

***The Song:* Fickle finger of fate**

The Science: Honey bees are social insects. This means that they divide up the tasks of life between different "castes". Each honey bee colony has two castes of female bees, the workers and the queen. When a fertilized egg is laid and hatches into a larva, it can develop into a worker OR a queen depending on what the other worker bees feed it. If the larva is fed royal jelly, a delicious mixture of hormones, vitamins and growth factors, it will develop into a queen. The queen is the only bee (out of ~50,000 bees!) that reproduces and lays eggs. Worker larvae are fed royal jelly for a couple days but then are fed "bee bread", a mixture of honey and pollen. This diet causes certain genes to be turned on and others to be turned off and the workers don't grow to be as large as the queen. They also don't mate, so they can never lay fertilized eggs! Workers, as their name suggests, work their entire life to make a nest and secure food for their sisters and their sister's children. This song is about a worker bee and her sister, the queen.

The Lyrics:
I am a worker bee/ I love my family
I fly and forage/ the whole day through/ but there is one thing/ I'll never do
I'll never do-ooh-ooh

I see my sister fly/ into the open sky
She goes and looks for love/ and finds a mate/ but when it comes to love/ I'll have to wait and wait, and wait (like, forever!)

But I will sacrifice myself (3X)
I'll sacrifice for you. I will sacrifice for you.

When sis and I were laid/ They said we were the same
They fed me bread/ to fill my belly/ but to my sister/ they fed royal jelly

My sis grew long and tall/ but me I hit the wall
And now there is no need for me to ovulate/ Our paths were sealed by the fickle finger of fate!

But I will sacrifice myself (3X)
I'll sacrifice for you. I will sacrifice for you.

***The Song:* Let's test it**

The Science: Science is based in reason and much of modern sciences has its foundations in the scientific method: observe, predict, test, analyze, conclude. You may have a great idea about why things work the way they do in the world, but you'll never know whether your hypothesis is correct unless you test it!

The Lyrics

I got a problem, facing me now
I've got correlation, but no causation how
I will consider it under the whole ray of light
But I need a method to help me get it right

So let's test it
And then we'll know
Scientific method
A way to show

Line 'em up, lay 'em oiut, and put 'em on their back
I will observe which characters they lack
Spin 'em over, flip 'em, put 'em on their side
I will use a ruler to determine which is wide

So let's test it
And then we'll know
Scientific method
A way to show

Correlation, causation confusing me now
A need an answer, what's causing this and how
I will submit my results to consider
But I won't give up
I'm no scientific quitter

So let's test it (x 2)
And then we'll know
Scientific method
A way to show

The Physiology of the Unicycle

Everybody loves a unicyclist. However, riding a unicycle isn't as simple as it looks; it requires training in balance and coordination to develop proprioception. So, what is proprioception? Proprioception is a "sense of self," or in other words, it is the ability to sense the position and movement of one's own body. It is the sense that will enable you to close your eyes and still be able to touch your nose. Like other physical attributes, such as endurance and strength, proprioception can be trained. Unicycling is an excellent method of training proprioception, as it requires extreme accuracy in placement and balance, especially in the trunk and lower extremities, in order to stay upright. Whether it's through riding a unicycle or dancing, what are you doing to train your proprioception?

***The Song*: I know the world is round (Sung to the tune of "I want you around" by The Ramones)**

The Science: Many many ancient cultures believed that the world was flat, but as early as the 6th century B.C., philosophers like Pythagoras made observations that were only consistent with a round Earth. Some early Christian sects revived the flat earth idea due to references to the flat earth in the Bible, but most scholars were confident that the earth was round, a fact indisputably confirmed when Magellan's expedition successfully circumnavigated the globe. (In fact, Magellan did not make it home, but it was because he was killed in a battle in the Philippines, not because he fell off the edge of the earth!) There is a lot you can learn from careful observation and mathematical modeling!

The Lyrics:
I know the world is round, I know the world is round
Ancient cultures made a big fuss
If they were here they'd argue with us
They said the world was flat (us)
I know the world is round, I know the world is round
I know what you're thinking about
How does water stay on something that's round
I know what you're thinking, when you find out that your world is round

They said the world was flat
Pythagoras wasn't down with that
Watch the stars and do some math
And you'll know the world is round
I know the world is round, I know the world is round

Magellan took a big chance
He sailed for Spain and not for France
He got home and did a victory dance
He knows the world's round
I know the world's round

They said the world was flat
Pythagoras wasn't down with that
Watch the stars and do some math
And you'll know the world is round
I know the world is round, I know the world is round
Ancient cultures made a big fuss
If they were here they'd argue with us
They said the world was flat (us)
I know the world is round, I know the world is round

***The Song*: Chemistry**

We orbited each other like two magnetic poles
We felt electrostatic forces 'tween our bodies and souls
And so we bonded over sigma and we bonded over pi(e)
And the chain reaction begun.

It started as a synthesis, a joining of lives
Our reaction yield was stable; it was certain to thrive
But then the little things compounded; equilibrium was off
And the chain reaction begun.

> *We shared a life, we shared a home, we shared our energy*
> *Our attraction and repulsion led to chemical stability*
> *So much time we spent together, isn't it ironic*
> *That the bonds that used to be covalent, now they've turned ionic?*

As time went by I started feeling strong polarity
My outer shell broke down, I couldn't take your negativity.
It was a one-sided equation with a factor of none
And the chain reaction was done.

> *We shared a life, we shared a home, we shared our energy*
> *Our attraction and repulsion led to chemical stability*
> *So much time we spent together, isn't it ironic*
> *That the bonds that used to be covalent, now they've turned ionic?*

Movin on's a scary step I can't quite get my toes on
I'm splitting into quantum parts and feeling like a boson
I've lost the spark, I've lost a quark, so baby please be gentle
With my atoms smashed to quantum bits I'm going elemental

> *We shared a life, we shared a home, we shared our energy*
> *Our attraction and repulsion is the reason that there's chemistry*
> *So much time we spent together, isn't it ironic*
> *That the bonds that used to be covalent, now they've turned ionic?*
> *That the bonds that used to be covalent, isn't it ironic*
> *That the bonds that used to be covalent, now they've turned ionic?*

Dancing Flowers for Peace:
Flowers are symbols of beauty and love, but unknown to many, the appearance of these plants represents one of the greatest moments in the history of life on this planet. Flowering plants, or angiosperms, first appeared about 160 million years ago and diversified enormously throughout the Cretaceous period. Angiosperm fertilization begins with pollen grains landing on a sticky female stigma, and ends with the formation of a seed, an embryonic plant enclosed in a protective coat. A defining trait for all angiosperms is that they all enclose their seeds in fruit, which may actually be key to their success. Almost all of the food we consume has either started out as a flowering plant or was fed flowering plants. These plants have sent their roots not only deep into the earth, but into our hearts as well. They have been here long before we have, and may very well remain long after we are gone!

***The Song:* Joss Paper**
The Science (and culture!): Joss paper or ghost money is used by some asian cultures as a way to pay tribute to deceased ancestors. The paper is printed to look like money or sculpted in the shape of valuable items like clothing, homes or even electronics! It is believed that burning this paper will ensure wealth for relatives in the afterlife. When paper burns, a chemical reaction (pyrolysis) occurs and the cellulose fibers are broken down into carbon dioxide and water and also release energy in the form of heat. This song mixes the science of combustion with the sociology of ancestor worship into one STEAMy mess!

The Lyrics:
In China, people take cardboard clothes and houses, phones and refrigerators to the graveyard
where they put them in metal cans around the tombstones of the people they love
and they watch them burn
They're sending them riches in the afterlife

But what makes a house a house, and what makes a phone a phone
Is getting lost as heat (lost as heat, lost as heat lost as heat)
But maybe heat is what ghosts need

Slips of paper, printed up like $100 bills with Confucius Benjamins are going up in smoke
And the atoms split apart from each other as they rise in the heated air
And we watch them burn. We're sending them riches
In the world beyond

But what holds the atoms of a $100 bill together
Is getting lost as heat (lost as heat, lost as heat lost as heat)
But maybe heat is what ghosts need

***The Song:* Entropy - Atomic Anarchy**
The Science: Entropy is a measure of disorder in a system and it increases over time. It is kind of like if you walk a bunch of kindergarteners out to the playground in a straight line and then let them loose. They get disordered quickly (and it takes a lot of energy to get them back in line!). Understanding entropy is essential for understanding chemistry, but in this song we make it easy….Entropy is ATOMIC ANARCHY! ROCK AND ROLL!!!

The Lyrics:
Why are you always trying to organize things?
Can't you understand simple entropy?
Why put order, where it's not meant to be?
You can't control atoms, and you can't control me

Entropy: atomic anarchy (x 4)

Entropy versus thermal energy
My second favorite topic after pleiotropy
I don't want order, I don't want synchrony
I just want entropy to proceed

Entropy: atomic anarchy (x 4)

Make like a cow and ruminate with me
Help those microbes set the sugars free
Gases expand, and smells they flow
Lose control, let entropy go

Entropy: atomic anarchy (x 4)

The Song: **GMO ROCK**

The Science: Genetically modified organisms (or GMOs) are living things that have been engineered to contain (or lack) genes that do cool things. Some bacteria have been genetically modified to produce insulin, a hormone that is important for treating people who suffer from diabetes. Rice has been genetically modified to produce beta-carotene, which is converted to vitamin A. Almost 200 million children in the world suffer from vitamin A deficiency, and eating this rice could help prevent them from going blind. Even animals have been genetically modified, including many strains of lab mice that are used for cancer and autoimmune disease research. What if people could be genetically modified? How would you like to have the gene that could make you run fast, calculate math problems in your head or have perfect pitch? This song is a hypothetical song about creating GMO humans that have "the rock gene". Wouldn't it be cool if everyone rocked?!?!? *Note: this song assumes that to rock is a dominant trait.

The Lyrics:

You think you've got it but you don't
You keep on trying but you won't
It takes genetics, it's not luck!
You keep on playing but your band still sucks

but…
What if we all had the rock gene?
What if we all sang in tune?
What if the world had the rock gene?
Rock and roll for me and you!

Little plastic balls…..watch them scatter as they fall (ad nauseum)
Twist and shout
Move all about
Lose control
This is atomic rock and roll

Sing along with me: Entropy
Shout it on out: Atomic Anarchy

Chemistry Poems by X.O. Therm

The End
They told me it would be
Much hotter than this at the end
Turns out that molecular equality
Isn't so ideal
No more entropy, everything in the same state
No more energy, all dynamism sapped
Everything is gray
The heat death of the universe
How can I even write this?

The Science Behind: The End
The second law of thermodynamics posits that all spontaneous processes result in an increase in the entropy of the universe. However, the universe is an isolated system, and so it will eventually reach a state of total uniform equilibrium, at which point the entropy of the universe is at a maximum and all allowed processes are associated with zero entropy change. This state is known as "heat death."

Gibbs's Lament
Chained
Wound up
Pressed like a spring, ready to burst
Free my Gibbs energy!
Pushing, pressing ever outward
Against the surroundings I struggle
Never able to reach my full potential
Drained of energy by the second law
Crushed by the irreversibility of existence

The Science Behind: Gibbs's Lament
A common expression of the first and second laws of thermodynamics is: "you can't win, and you can't break even." Gibbs free energy is a state function that captures the energy actually *available* for a system to do work, which (according to the second law) is necessarily less than its total energy. Is thermodynamics bleak or what?!

Ideal Gas Haiku
Much more to me than
PV equals *nRT*
Tiny billiard balls

The Science Behind: Ideal Gas Haiku
The ideal gas law is based on an ideal model of gases that treats their particles as infinitely rigid, infinitely small points without any attractive or repulsive forces between them. Although billiard balls do take up volume, their elastic collisions and independent behavior make them a nice analogy for particles in the ideal gas model.

The Carnot Cycle
Rigid and isolated in my lonely existence
Hark! A source of heat
Expansion, breathing in warm air
In just as quick a moment the heat disappears
Loneliness builds as expansion
Slows to a stop
The delicate touch of a cool bath
Brings on exhalation
In isolation once again, the breath peters out

The Science Behind: The Carnot Cycle
A “Carnot engine” converts a temperature difference between hot and cold reservoirs into useful work. Heat transfer from the hot reservoir expands gas in the engine, pushing a piston out. The piston expands briefly in isolation until it reaches the temperature of the cold reservoir. In contact with the cold reservoir, gas in the chamber compresses, pulling the piston in again. The gas continues to compress in isolation until it reaches the temperature of the hot reservoir, at which point the cycle begins anew. The Carnot engine possesses the maximum possible efficiency of any conceivable heat engine, but thanks to the second law of thermodynamics, it is not able to convert all the heat it pulls from the hot reservoir into work.

Activation Energy
Your activation energy
Seems insurmountable
A fickle disposition and delicate tastes
Make it impossible to connect
Digging in with a pickaxe
I begin breaking down the wall
Catalysis

The Science Behind: Activation Energy
Chemical reactions are associated with a free energy barrier called *activation energy*: molecules must collide with sufficient energy and in the right orientation to react. Catalysts alter the mechanisms of chemical reactions such that activation energy is decreased, speeding things up.

Not My Standard State

Who decided where to put sea level?
Climbing Everest, my zero of height
Is very different from yours.
I never liked atmospheric pressure
That most pedestrian of pressures.
Zeroing on the elements was the idea
Of a bunch of old, white, bearded male skeletons.
Let's reclaim thermodynamics!

The Science Behind: Not My Standard State

Enthalpies are most useful in *relative* terms: we're interested in a difference between two states, not absolute values. This creates issues, however, for expressing the enthalpies of *substances*. How do we define a zero of enthalpy? Ultimately, the choice is arbitrary. To enable thermodynamicists across the globe to understand one another and to allow thermodynamics to develop without confusion, "standard conditions" for the zero of enthalpy were defined. The zero of enthalpy is defined as the elements in their most stable forms at 1 bar of pressure (and usually, a temperature of 298.15 Kelvin). This poem remarks with a punk-like spirit on the arbitrariness of this convention.