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IMPROBABLE RESEARCH



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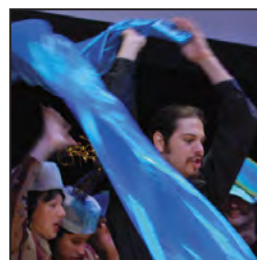
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On the Front Cover

Bacteriologist Richard Losick lets his intestinal bacteria have their say, concluding the keynote speech at this year's Ig Nobel Prize Ceremony. Performing chemist Daniel Rosenberg wields the microphone. Photo: Kees Moeliker.



On the Back Cover

The thrilling conclusion to The Bacterial Opera: mouthwash overwhelms the plucky bacteria on an obvilious woman's tooth. Photo: Mike Benveniste.

Coming Events

- | | | | |
|-------------------|--|--------------------|---------------------------------|
| February 19, 2011 | AAAS Annual Meeting, Washington, DC, USA | April 2011 | Cambridge (MA) Science Festival |
| March 2011 | Ig Nobel Tour of the UK | June 2011 | Cairo, Egypt |
| April 2011 | Edinburgh Science Festival | September 2011 | Geneva, Switzerland |
| April 2011 | Ig Nobel Scandinavia Tour | September 29, 2011 | Ig Nobel Prize Ceremony |
| | | October 1, 2011 | Ig Informal Lectures |

See WWW.IMPROBABLE.COM for details of these and other events.

LIBRETTO: The Bacterial Opera

Words: Marc Abrahams

Music: Jacques Offenbach, Giuseppe Verdi, and Arthur Sullivan

(And thanks to Mary Ellen Davey, Harriet Provine, Dany Adams, and Carl Zimmer for bacteriological insights, and Robert Csillag, DDS, and his staff for inspiration on microbial matters.)

The Bacterial Opera premiered as part of the 20th First Annual Ig Nobel Prize Ceremony, at Sanders Theater, Harvard University, Cambridge, Massachusetts, on September 30, 2010. Video of the performance can be seen at www.improbable.com.

Original Cast

Stage manager and conductor:
David Stockton

Kirkospockococcus: Maria Ferrante

Gallileococcus: Ben Sears

Sidekickococcus: Roberta Gilbert

Accordionococcus: Thomas Michel

Bacillusnameless: Marc Andelman

The woman: Jenny Gutbezahl

Supporting bacilli: Sheldon Glashow, Roy Glauber, William Lipscomb, James Muller, Frank Wilczek, Neil Gaiman, Amanda Palmer, Jason Webley, Mary Ellen Davey, Rich Losick, and a multitude of bacteria.

Pianist: Branden Grimmett

Costume designer: Jenn Martinez.

The characters are a WOMAN, who spends the entire time—except at the very end—sitting on a chair napping with her mouth open so we can see her teeth, and the BACTERIA who live on one of her front teeth. Those bacteria, KIRKOSPOCKOCOCCUS, SIDEKICKOCOCCUS, and GALLILEOCOCCUS, do all the singing. Most of the characters on stage are non-singing bacteria. In the premiere one bacterium played the accordion.

TOP CENTER: Kirkospockococcus and Sidekickococcus. Photo: Mike Benveniste.



ACT 1—Stuck on This Tooth

NARRATOR: Tonight's opera stars several trillion bacteria—would you all please take a bow?—several trillion bacteria... and one human being—a woman, who as you can see, is asleep on a chair, with her mouth hanging open. The action takes place on one tooth inside that woman's mouth. The main characters are called KIRKOSPOCKOCOCCUS, SIDEKICKOCOCCUS and GALLILEOCOCCUS. We have arranged a sort of microscope so you can see them. Let's take a look. Will one of the technicians please turn on the microscope?

[KIRKOSPOCKOCOCCUS AND SIDEKICKOCOCCUS AND GALLILEOCOCCUS COME ON STAGE AND TAKE A BOW.]

Ah. Here they are, magnified so very much that—believe it or not—these teeny-tiny, liddle-widdle bacteria appear to be the SAME SIZE AS THE HUMAN BEING. Isn't that a hoot? Here in Act 1, KIRKOSPOCKOCOCCUS and SIDEKICKOCOCCUS will explain why they hate being stuck, their whole lives, on this tooth. But you know, and I know, that what they REALLY hate are all the many, many other bacteria species in their crowded neighborhood. Let's listen to them gripe...

Kirkospockococcus and Sidekickococcus try to ignore a nasty neighbor bacterium. Photo: Alexey Eliseev.

[TUNE: "Barcarolle" by Offenbach, from "Tales of Hoffman"]

KIRKOSPOCKOCOCCUS and
SIDEKICKOCOCCUS:

Nasty neighbors! Nasty neighbors!
Nasty neighbors! Nasty neighbors!
Nasty neighbors! Nasty neighbors!

[HERE IS WHERE WORDS BEGIN IN ORIGINAL
OFFENBACH VERSION]

Streptococcus! Stuck on this tooth,
With neighbors who hurt and mock us.
Let's name names. Let's tell the
whole truth.

Let's name the scum on this tooth!

TrepoNEEma dentiCola! What a
loathsome neighbor!

Squirts and leaks and drips and drools
Such stinky molecules.

Such stinky molecules! Prob'ly some
kind of peptide...

Those stinky molecules—They eat
holes in my hide.

Stinky molecules. Stinky molecules.
Pee yooo!

Porph'ro-MO-nas gingi-VA-lis! What
a loathsome neighbor!

Night and day, they spew and they
spray / Bacteriocin spray.

Bacteriocin spray / Makes our guts
leak away.

Our guts leak away. They leak away.
Oooh! Oooh!





Galileococcus uses a mock-up to show his fellow bacteria what a human being looks like and which portions of it are good habitats for bacteria. Photo: Eric Workman.

ACT 2—A Vision of Distant, Bigger Things

NARRATOR: Among the billions of bacteria on this crowded tooth, there is a great—truly great—scientist, a microbe named Gallileococcus. Gallileococcus has just invented the telescope! Here’s how he did it. As you know, the bacteria that live on teeth produce a kind of slime. You probably call it “biofilm,” or even “a matrix of excreted polymeric compounds”. But it’s slime. One day, Gallileococcus burrowed down deep into that slime. And from down there, he looked back up, through the slime, toward the light. The slime acted as a lens, a sort of telescope. Looking through that telescope, Gallileococcus saw things that—until that moment—microbes believed were merely myths and legends. He saw.... human beings! And when he focused the telescope, he saw that those human beings are covered with—yes!—bacteria! Alien bacteria! Let’s watch now, as GALILEOCOCCUS tells his fellow tooth bacteria that... they are not alone in the universe!

[TUNE: “I’ve got a little list” from “The Mikado,” Gilbert and Sullivan]

[OPTIONALLY, HE CAN BRING OUT A TRADITIONAL TELESCOPE—IF SO, THEN WHEN HE FIRST SHOWS IT, PROJECT A SLIDE THAT SAYS: “NOTE: Telescope shown here is not actual shape”]

*The sleeping woman.
Photo: Kees Moeliker.*

GALILEOCOCCUS:
My fellow microbes! Listen! I have got a new machine.
It’s called a telescope! It’s called a telescope!
Now it’s possible to look at distant things we’ve never seen.
Just look through the telescope! Look through the telescope!
Folks, I found this telescope by going deep into the slime
That we all make from schmutz that we secrete from time to time.
Then I gazed back, up toward the sky—
And through that slimy lens,
I saw some human beings! I saw homo sapiens!
THEN... I saw something BETTER—so good I can barely cope!
It filled me full with hope! Now I am filled with hope!

ALL [sing the second line slowly, enunciating each word distinctly]:
You scientific dope! Now WE are filled with hope!
Tell us what you saw, you dope, in that damn telescope!

[TUNE: “La donna e mobile” from “Rigoletto,” Verdi]

[MAYBE HAS A STICK POINTER, USING IT TO POINT TO A WEIRD DRAWING OF A HUMAN ANATOMY CHART AS DRAWN BY A BACTERIUM]

I saw bacteria /In far off places.
I saw their faces./
They look quite friendly.
They live in domiciles, /
On human creatures,
Lodged in the features /
That are uncleanly.
Beneath the toenails! Inside the entrails!
Under the armpits! Where it is moist.
It must be moist! Not dry! They’d die!
It must be moist.
Nice human real estate / In such variety
Fosters society /Among the microbes!
All the best neighborhoods /
Have some concavity.
[ASIDE:] (You want depravity? /
Go live on ear lobes!)
Caudal and rostral! Anus and nostril!
Stomach and colon! Where it is moist.
It must be moist! Not dry! They’d die!
It must be moist.

ACT 3 “Stand on the Shoulders of Giant Piles of Bacteria”

NARRATOR: Having seen that they are not alone in the universe, the bacteria want to leave their leave their detested home tooth, and voyage off to make contact with those far distant microbes. They have a plan. They will get all their neighbors—all the tooth bacteria—to reproduce madly. The bodies will pile up high, building a tower that will grow





Flossing overcomes the bacteria.
Photo: Kees Moeliker.

It's just the residue.
Life here will struggle on without us,
without us.
Scre-e-e-ew you, you residue!

Now let us make our getaway! Cast the
past away—
Far, far, far, far away!
Throw the old life away! Throw it all
away! Throw it all away!
Scrape the old life away! Scrape the
life away!
Brush the old life away! Brush the
life away!
Scrub, scrub the old life away!
Scrub it all away! Scrub it away!
Rinse it away! Yes—flush everything...
Flush everything away! Flush
everything away!

[THE WOMAN AWAKENS, STANDS UP,
BEGINS CLOSING AND OPENING AND
FLEXING HER MOUTH. LIGHTS FLASH OFF
AND ON DISTURBINGLY, IN SYNCH WITH
HER MOUTH CLOSING AND OPENING. THE
BACTERIA PANIC.]

[TUNE: "Vedi! Le fosche notturne
spoglie" (the anvil chorus) from
"Il Trovatore," Verdi]

ALL THE SINGING BACTERIA:
Darkness and lightning!
It's frightening! It's frightening! It's
frightening! It's frightening!
Hey, what just happened?

Darkness and lightning!
It's frightening! It's frightening! It's
frightening! It's frightening!
Hey, what just happened?
I don't know what the... What the...???
What happened???

[A GIANT TOOTHBRUSH IS CARRIED ON
STAGE. A PROJECTED SLIDE SAYS: "NOTE:
Toothbrush shown here is not to scale"]

[THE WOMAN BRUSHES HER TEETH,
RHYTHMICALLY AND RATHER VIOLENTLY. A
TREMENDOUS ANVIL-BANGING SOUNDS—AND
LIGHTS FLASH ON AND OFF—EVERY TIME SHE
BRUSHES ACROSS HER TEETH.]

Brush! Brush! This brushing is
crushing us to pieces!
Brush! Brush! This brushing is
crushing us to pieces!
Brush! Brush! Brush! Brush! Brush!
Brush! Brush!
Hey, what just happened? Hey, what
just happened? Hey, what just
happened?

Hey—what just happened?
Can anyone tell us?—Or even hint?—
Hey, what just happened?

Thunder and lightning!
It's frightening! It's frightening! It's
frightening! It's frightening!
Is this the end? It's oblivion!

[A GIANT ROPE IS CARRIED ON STAGE. A
PROJECTED SLIDE SAYS: NOTE: "Dental floss
shown here is not to scale"]

[THE WOMAN FLOSSES HER TEETH,
RHYTHMICALLY AND RATHER VIOLENTLY. A
TREMENDOUS ANVIL-BANGING SOUNDS—AND
LIGHTS FLASH ON AND
OFF—EVERY TIME SHE
SWEEPS THE FLOSS
THROUGH HER TEETH.
THE BACTERIA DIE OFF
IN WAVES BETWEEN
HERE AND THE END OF
THE SONG.]

Floss! Floss! This flossing is tossing us
to pieces!
Floss! Floss! This flossing is tossing us
to pieces!

[A GIANT FILMY CLOTH, MEANT TO
REPRESENT A WAVE OF MOUTHWASH, IS
CARRIED ON STAGE. A PROJECTED SLIDE
SAYS: "NOTE: Mouthwash shown here is not
to scale"]

[THE WOMAN GARGLES WITH MOUTHWASH,
RHYTHMICALLY AND RATHER VIOLENTLY. A
TREMENDOUS ANVIL-BANGING SOUNDS—AND
LIGHTS FLASH ON AND OFF—EVERY TIME SHE
DOES.]

Flush! Flush! Flush! Flush! Flush!
Flush!

[THE WOMAN SPITS OUT THE MOUTHWASH
INTO THE AUDIENCE (OR, IF PROPRIETIES
MUST BE OBSERVED, INTO A VAT)]

[ALMOST ALL OF THE BACTERIA ARE NOW
DEAD. THE REMAINING FEW ARE BARELY
STANDING—THEY WILL MANAGE TO SING THE
FINAL WORDS, AND THEN THEY WILL DIE.]

This is the end of... This is the
end of...
Bacte-e-e-ria!

[ALL THE BACTERIA ARE NOW DEAD. THE
WOMAN STANDS, SMILING, STRETCHING
JOYOUSLY, AND NOW FULLY AWAKE. FOR HER
IT'S JUST THE START OF ANOTHER DAY.]



*Mouthwash
overwhelms the
bacteria.*

*ABOVE Photo:
Eric Workman.*

*LEFT Photo:
Mike Benveniste.*