

# Koch's Postulates: Have They Been Proven for Viruses?

or

(The Rooster in the River of Rats)

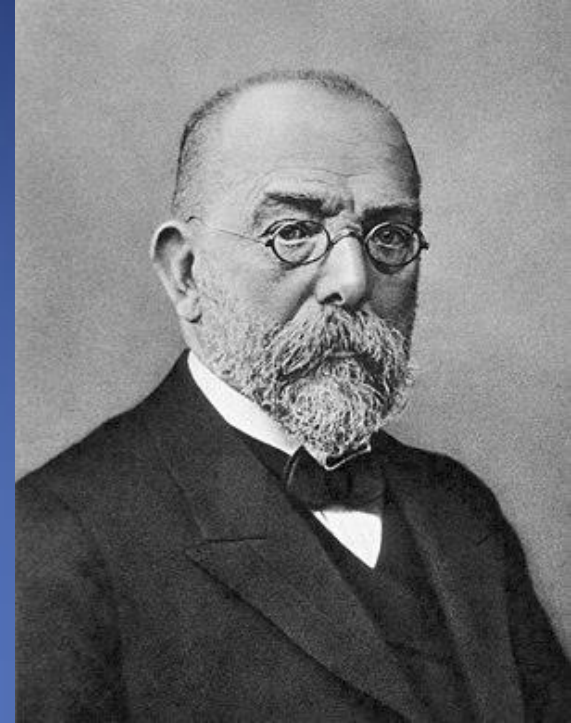


**Andrew Kaufman, M.D.**

[andrewkaufmanmd.com](http://andrewkaufmanmd.com)

# Koch's Postulates

1. The microorganism must be found in abundance in all organisms suffering from the disease, but should not be found in healthy organisms.
2. The microorganism must be isolated from a diseased organism and grown in pure culture.
3. The cultured microorganism should cause disease when introduced into a healthy organism.
4. The microorganism must be re-isolated from the inoculated, diseased experimental host and identified as being identical to the original specific causative agent.



# Nature

Ron Fouchier et al.

15 May 2003

<https://www.nature.com/articles/423240a#Sec2>

Second paragraph:

“According to Koch's postulates, as modified by Rivers for viral diseases, six criteria are required to establish a virus as the cause of a disease<sup>1</sup>.”

## brief communications

California 91125, USA  
e-mail: [djs@gps.caltech.edu](mailto:djs@gps.caltech.edu)

1. <http://www.gps.caltech.edu/faculty/stevenson/coremission>
2. Turcotte, D. L. & Emmerman, S. H. *J. Geophys. Res.* **88**, B91–B96 (1983).
3. Schubert, G., Turcotte, D. L. & Olson, P. *Mantle Convection in*

- the Earth and Planets* 166–176 (Cambridge Univ. Press, 2001).
  4. Weertman, J. *J. Geophys. Res.* **76**, 1171–1183 (1971).
  5. <http://www.worldsteel.org>
  6. Landau, L. D. & Lifshitz, E. M. *Fluid Mechanics* (Pergamon, London, 1959).
  7. Anderson, D. L. & Given, J. *J. Geophys. Res.* **87**, 3893–3904 (1982).
  8. <http://www.ligo.caltech.edu>
- Competing financial interests: declared none.

### Aetiology

## Koch's postulates fulfilled for SARS virus

Severe acute respiratory syndrome (SARS) has recently emerged as a new human disease, resulting globally in 435 deaths from 6,234 probable cases (as of 3 May 2003). Here we provide proof from experimental infection of cynomolgus macaques (*Macaca fascicularis*) that the

the World Health Organization's definition of SARS<sup>6</sup> in Hong Kong, 86 (90%) yielded laboratory evidence of SCV infection.

We have tested for the three remaining criteria: production of comparable disease in the original host species or a related one, re-isolation of the virus, and detection of a specific immune response to the virus. We inoculated two macaques with Vero-cell-cultured SCV isolated from a fatal SARS case, and monitored their clinical signs, virus excretion and antibody response. The

# Koch vs Rivers

## Koch (1884)

1. The microorganism found in the ill but not the healthy
2. The microorganism must be isolated from a diseased organism and grown in pure culture.
3. Produce same disease in host
4. Re-isolation of microorganism

## Rivers (1937)

1. Isolation of virus from diseased host
2. Cultivation of virus in host cells
3. Proof of filterability
4. Produce same disease in host
5. Re-isolation of virus
6. Detection of a specific immune response to virus

# What is missing from Rivers?



- Genetic material (DNA, RNA) is not mentioned in any criteria!!!

# What did Rivers say?

- “...now it is possible to bring excellent evidence that an organism is the cause of a malady without the complete satisfaction of the [Koch’s] postulates.”
- “...particularly those [diseases] caused by viruses, the blind adherence to Koch’s postulates may act as a hindrance instead of an aid.”

# What did Rivers say?

- “It is obvious that Koch’s postulates have not been satisfied in viral diseases.”
- “In the first place it is not obligatory to demonstrate the presence of a virus in every case of the disease produced by it.”
- “Viruses, whether they are parasites or the fabrications of autocatalytic processes, are intimately associated with host cells...”

# What did Rivers say?

- “... by means of inoculation of material... obtained from patients with the natural disease”
- “If the inoculated animals become sick or die in a characteristic manner, and, if the disease in them can be transmitted from animal to animal by means of inoculations with blood or emulsions of *involved tissues* free from ordinary microbes or rickettsiae, one is *fairly confident* that the malady in the experimental animals is induced by a virus.”



# Nature

15 May 2003

<https://www.nature.com/articles/423240a#Sec2>

## brief communications

California 91125, USA  
e-mail: [djs@gps.caltech.edu](mailto:djs@gps.caltech.edu)

1. <http://www.gps.caltech.edu/faculty/stevenson/coremission>
2. Turcotte, D. L. & Emmerman, S. H. *J. Geophys. Res.* **88**, B91–B96 (1983).
3. Schubert, G., Turcotte, D. L. & Olson, P. *Mantle Convection in*

- the Earth and Planets* 166–176 (Cambridge Univ. Press, 2001).
  4. Weertman, J. *J. Geophys. Res.* **76**, 1171–1183 (1971).
  5. <http://www.worldsteel.org>
  6. Landau, L. D. & Lifshitz, E. M. *Fluid Mechanics* (Pergamon, London, 1959).
  7. Anderson, D. L. & Given, J. *J. Geophys. Res.* **87**, 3893–3904 (1982).
  8. <http://www.ligo.caltech.edu>
- Competing financial interests: declared none.

### Aetiology

## Koch's postulates fulfilled for SARS virus

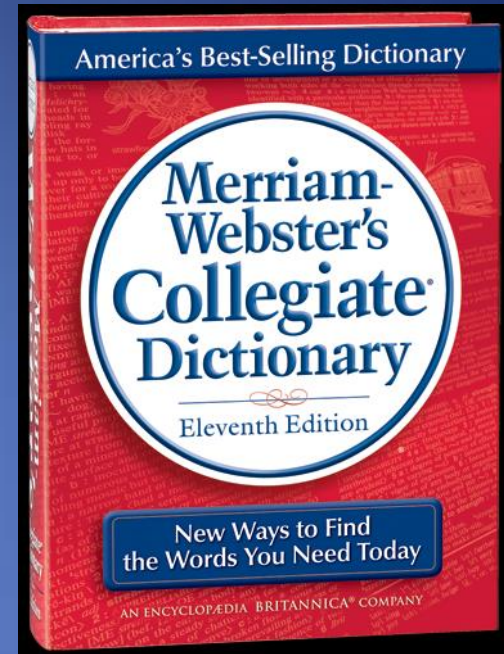
Severe acute respiratory syndrome (SARS) has recently emerged as a new human disease, resulting globally in 435 deaths from 6,234 probable cases (as of 3 May 2003). Here we provide proof from experimental infection of cynomolgus macaques (*Macaca fascicularis*) that the

the World Health Organization's definition of SARS<sup>6</sup> in Hong Kong, 86 (90%) yielded laboratory evidence of SCV infection.

We have tested for the three remaining criteria: production of comparable disease in the original host species or a related one, re-isolation of the virus, and detection of a specific immune response to the virus. We inoculated two macaques with Vero-cell-cultured SCV isolated from a fatal SARS case, and monitored their clinical signs, virus excretion and antibody response. The

“The first three [Rivers] criteria — isolation of virus from diseased hosts, cultivation in host cells, and proof of filterability — have been met for SCV by several groups<sup>2,3,4,5</sup>.”

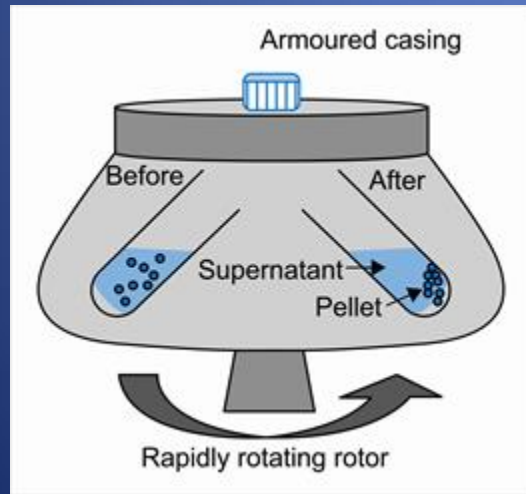
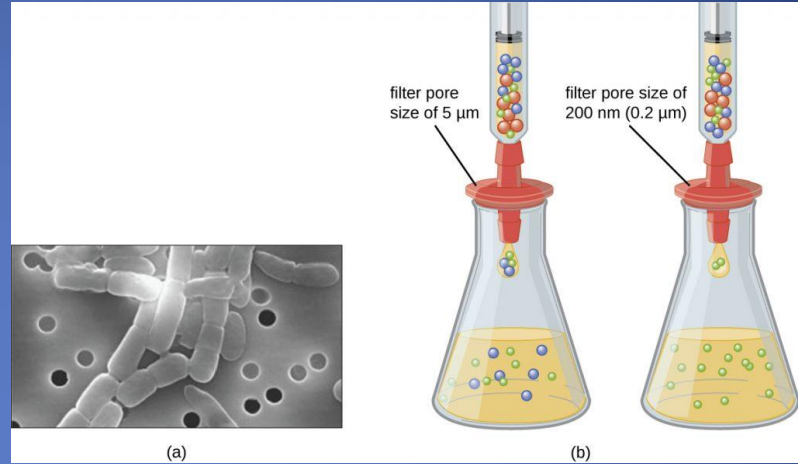
# Merriam-Webster Collegiate



isolate

*“especially: to separate from another substance so as to obtain pure or in a free state”*

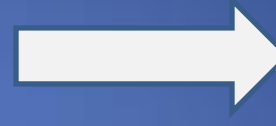
# Method for Isolating Virus



# What They are Calling Isolation...



RNA



RT-PCR



+/- filtration

Non-host cell cx



+ antibiotics



# Papers that “met criteria” for Rivers 1-3

1. Poutanen SM et al. Identification of Severe Acute Respiratory Syndrome in Canada, *N Engl J Med* 2003; 348:1995-2005
2. Drosten C et al. Identification of a Novel Coronavirus in Patients with Severe Acute Respiratory Syndrome, *N Engl J Med* 2003; 348:1967-1976
3. Ksiazek T et al. A Novel Coronavirus Associated with Severe Acute Respiratory Syndrome, *N Engl J Med* 2003; 348:1953-1966
4. Peiris JS et al. Coronavirus as a possible cause of severe acute respiratory syndrome, *Lancet* 2003; 361: 1319–25.

# Poutenan Paper

- Did not isolate any virus: “Routine direct virologic examination of all respiratory and stool specimens received from 9 of the 10 patients was completed, yielding negative results. This included negative electron-microscopical examination.” Only obtained genetic material
- Did not cultivate in host cells, instead used Vero cells (monkey kidney epithelium)
- Did not prove filterability, instead used various screening tests for presence of bacteria and other viruses, showed presence of metapneumivirus in 4 patients.

# Drosten Paper

- Did not isolate any virus, only obtained genetic material, observed “paramyxovirus-like particles” in one specimen under electron microscope
- Did not cultivate in host cells, instead used Vero cells (monkey kidney epithelial cells)
- Did not prove filterability, instead used various screening tests for presence of bacteria and other viruses

# Ksiazek Paper

- Did not isolate any virus, only obtained genetic material
- Did not cultivate in host cells, instead used “Vero E6, NCIH292, MDCK, LLC-MK2, and B95-8 cells, and into suckling ICR mice...”
- Did not prove filterability, instead used various screening tests for presence of bacteria and other viruses



# Peiris Paper

- Did not isolate any virus, only obtained genetic material
- Did not cultivate in host cells, instead used fetal rhesus kidney cells
- Did not prove filterability, instead used various screening tests for presence of bacteria and other viruses

# Nature

15 May 2003

<https://www.nature.com/articles/423240a#Sec2>

## brief communications

California 91125, USA

e-mail: [djs@gps.caltech.edu](mailto:djs@gps.caltech.edu)

1. <http://www.gps.caltech.edu/faculty/stevenson/coremission>
2. Turcotte, D. L. & Emmerman, S. H. *J. Geophys. Res.* **88**, B91–B96 (1983).
3. Schubert, G., Turcotte, D. L. & Olson, P. *Mantle Convection in*

- the Earth and Planets* 166–176 (Cambridge Univ. Press, 2001).
  4. Weertman, J. *J. Geophys. Res.* **76**, 1171–1183 (1971).
  5. <http://www.worldsteel.org>
  6. Landau, L. D. & Lifshitz, E. M. *Fluid Mechanics* (Pergamon, London, 1959).
  7. Anderson, D. L. & Given, J. *J. Geophys. Res.* **87**, 3893–3904 (1982).
  8. <http://www.ligo.caltech.edu>
- Competing financial interests: declared none.

### Aetiology

## Koch's postulates fulfilled for SARS virus

Severe acute respiratory syndrome (SARS) has recently emerged as a new human disease, resulting globally in 435 deaths from 6,234 probable cases (as of 3 May 2003). Here we provide proof from experimental infection of cynomolgus macaques (*Macaca fascicularis*) that the

the World Health Organization's definition of SARS<sup>6</sup> in Hong Kong, 86 (90%) yielded laboratory evidence of SCV infection.

We have tested for the three remaining criteria: production of comparable disease in the original host species or a related one, re-isolation of the virus, and detection of a specific immune response to the virus. We inoculated two macaques with Vero-cell-cultured SCV isolated from a fatal SARS case, and monitored their clinical signs, virus excretion and antibody response. The

“We have tested for the three remaining criteria: production of comparable disease in the original host species or a related one, re-isolation of the virus, and detection of a specific immune response to the virus.”

## Criterion 4:

### Produce same disease in host

- Did not obtain material for inoculation from patients with natural disease. “We inoculated two macaques with Vero-cell-cultured SCV *isolated (was it?)* from a fatal SARS case.”
- Only 1 of 2 inoculated macaques had respiratory symptoms. The other has a skin rash. Lung pathology findings also different.

## Criterion 5&6:

### Re-isolation of virus, Specific Immunity

- Did not re-isolate virus. Did genetic testing and mixed with Vero cells.
- “Antibody response” claimed not described as specific in paper

CONCLUSION

0/6 criteria met!!!!

# What about Covid-19?

1. Peng Zhou et al. Discovery of a novel coronavirus associated with the recent pneumonia outbreak in 2 humans and its potential bat origin. <https://doi.org/10.1101/2020.01.22.914952> doi: bioRxiv preprint
2. Na Zhu et al. A Novel Coronavirus from Patients with Pneumonia in China, 2019. *N Engl J Med* 382;8
3. Jeong-Min Kim et al. Identification of Coronavirus Isolated from a Patient in Korea with COVID-19. *Osong Public Health Res Perspect* 2020;11(1):3-7
4. McMaster University, Canada: <https://brighterworld.mcmaster.ca/articles/i-study-viruses-how-our-team-isolated-the-new-coronavirus-to-fight-the-global-pandemic/>

# What about Covid-19?

- No studies met first 3 criteria
- No studies addressed criteria 4 or 5:
  4. Produce same disease in host
  5. Re-isolation of virus

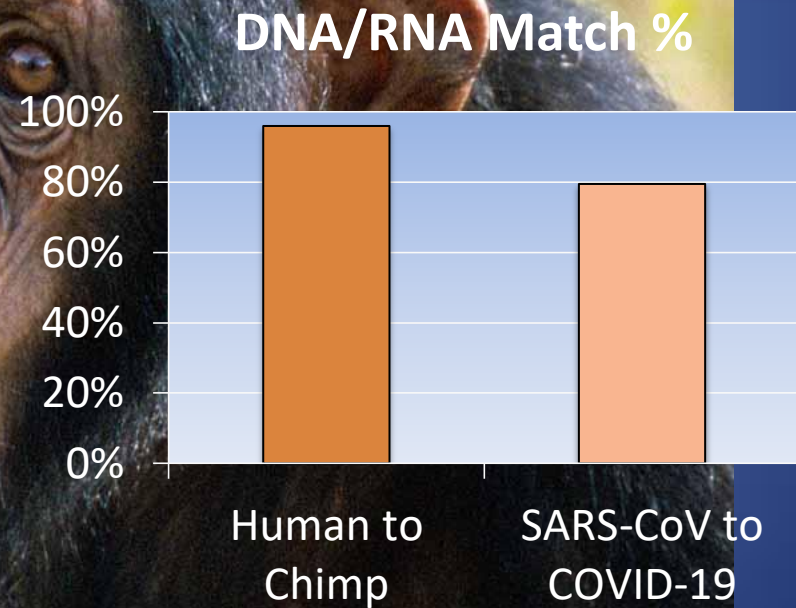
# Zhou Paper

- Did not isolate any virus, only obtained genetic material
- Did not cultivate in host cells, instead used “...Vero and Huh7 cells” from only 1/7 patients
- Did not prove filterability

“The study ... provides evidence of an association between the disease and the presence of this virus. However, there are still many urgent questions to be answered. We need more clinical data and samples to confirm if this virus is indeed the etiology agent for this epidemic.”

# Zhou Paper: Sequence Homology

- “They are almost identical to each other and share 79.5% sequence identity to SARS-CoV.”
- Humans share 96% of genetic sequence with chimpanzees!\*



\* <https://www.genome.gov/15515096/2005-release-new-genome-comparison-finds-chimps-humans-very-similar-at-dna-level>



# Zhu Paper

- Did not isolate any virus, only obtained genetic material
- Did not cultivate in host cells, instead used lung cancer cells
- Did not prove filterability (used only centrifugation)

“Although our study does not fulfill Koch’s postulates, our analyses provide evidence implicating 2019-nCoV in the Wuhan outbreak.”

# Kim Paper

- Did not isolate any virus, only obtained genetic material
- Did not cultivate in host cells, instead used Vero cells plus antibiotics
- Did not prove filterability

# McMaster University Team

- Did not isolate any virus, only obtained genetic material
- Did not cultivate in host cells, instead used unspecified mammalian cells

# Kim Paper Introduction: How a Rumor Starts!

“Following the first outbreaks of unexplained pneumonia in Wuhan, China, in late 2019, a new coronavirus was identified as the causative agent in January 2020 [7].”

[7] Paraskevis D et al. Full-genome evolutionary analysis of the novel coronavirus (2019-nCoV) rejects the hypothesis of emergence as a result of a recent recombination Event. *Infection, Genetics and Evolution* 79 (2020)

# Kim Paper Ref 7: How a Rumor Starts!

- INTRO: “A novel coronavirus (2019-nCoV) associated with human to human transmission and severe human infection has been recently reported from the city of Wuhan in Hubei province in China (World Health Organization, 2020; Hui et al., 2020).
- CONCLUSION: The unique genetic features of 2019-nCoV and their potential association with virus characteristics and virulence in humans remain to be elucidated.

# McMaster University: The Rumor Continues!

- INTRO: “The emergence of a new coronavirus in a market in Wuhan, China, in December 2019 set in motion the pandemic we are now witnessing in 160 countries around the world.”

# The Rumor Mill

- **Association/Implication (study conclusions)**
  - Changed to “causative agent” (Intro)
  - Changed to “set in motion the pandemic” (web article ahead of pub)
  - No additional evidence provided

# Conclusions

- Despite the claim of satisfying Koch's postulates, not one of 6 Rivers (Koch) criteria was met for SARS (SARS-CoV)
- None of the Rivers criteria were met for COVID-19 (except possibly specific immunity)
- Rumors and lies placed COVID-19 as the cause of a pandemic without any proof



# The Players

- The Rooster – Robert Koch
- The River – Thomas M. Rivers
- The Rats – Any author who made misleading, dishonest, or fraudulent statements in a scientific paper

[andrewkaufmanmd.com](http://andrewkaufmanmd.com)