Viruses and Evolution – Friends not Enemies

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Abstract **Do todays viruses reflect evolution and origin of life?**

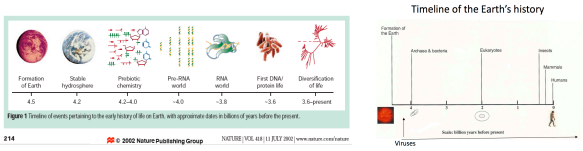
Virus-first hypothesis: Contemporary viruses can be organized to reflect evolution ranging from the RNA world to the DNA world. Replication and evolution are the criteria for the beginning of life. Todays virus world after subtraction of proteins may teach us about evolution of life. Earliest replicating and evolving entities could be the ribozymes - todays plant viruses, the viroids, or Hepatitis Delta virus. Size limitations of the RNA may have been overcome by gene shuffling as reflected by Influenza virus segmented genomes. Circular RNA as in Hanta viruses are alternatives. Virus-like liposomes may have allowed compartmentaliziation. Transition to a more stable DNA world via hybrid intermediates may be reflected by todays retro-and para-retroviruses. This could have started slowly without proteins. Pararetroviruses do not integrate but their DNA could have increased in size by allowing integration of DNA by horizontal gene transfer possibly by retroviral DNA proviruses and cellular proto-concogenses. 50% of our genome are known retroelements today, perhaps 100% in distant times. Todays retroelemnts are still shaping our genome. Endogenization of viruses in Koala bears took 100 yeas only! RNA-to-DNA transition occurs every day in the telomeres at the ends of our chromosomes during embryogenesis or cancer through the reverse transcriptase-related telomerase. Transition forms of viruses to bacteria are the Mimiviruses, suggesting that viruses preceded bacteria.

Cell compartments may have been formed by uptake of bacteria and viruses, leading to mitochondria and the nucleus. After cells arose, viruses may have undergone loss of genes, from free-living to parasites, to gain virulence.

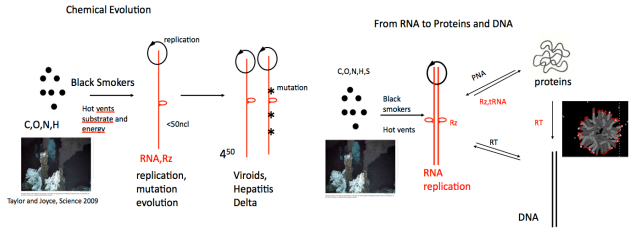
Why do bacteria lack retrovirus—like phage? Without a nucleus and high replication rates bacteria could not afford such a burden. Their replication rate is million times faster than ours, retroviral footprints may haved evolved away.

DNA viruses may be later developments with cell-first hypothesis. There are 10exp33 viruses, most of them are not pathogens, they started life and are the drivers of evolution.

Timeline of earth and beginning of life



Timeline of life, RNA was first



▲Fig. 1 Timeline of earth, first biomelecules, beginning of life|. Lire started with RNA in the deep seas at black smokers. RNA was enzymatic active as ribozyme , can replicate and mutate and ligate..Ribozymes ar the basis of ribosomes to make proteins and enzymes such as reverse transcriptase to make DNA. Liposomes made compartments.

From RNA to Proteins to DNA to cells

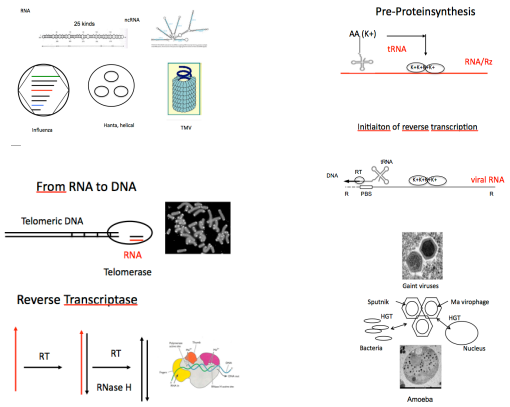


Fig. 2 Viruses were around during evolution from the beginning. They witness what may have happened during evolution. Pre-protein synthesis resembles initiation of reverse transciption. DNA is made today from RNA by telomerase and reverse transcriptasee. The giant viruses link the viruses to bacteria.

Endogenization, RE, Nucleus and DNA viruses

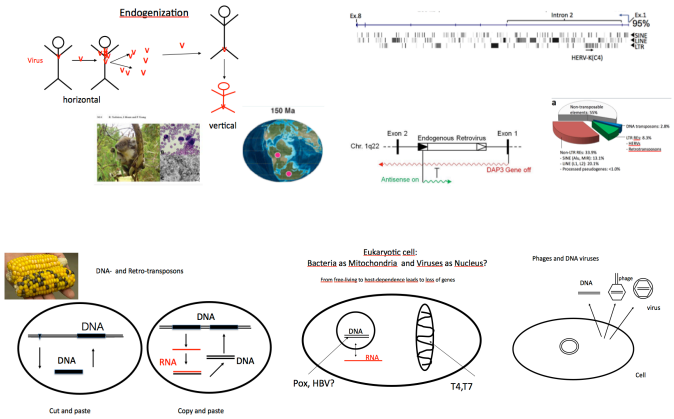
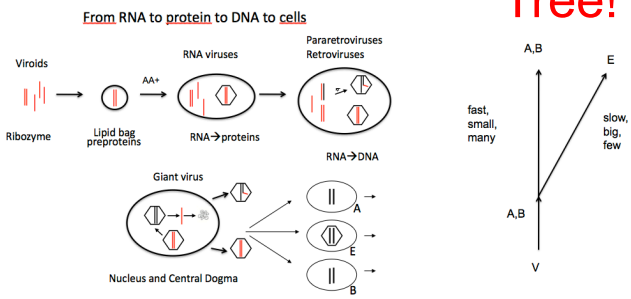


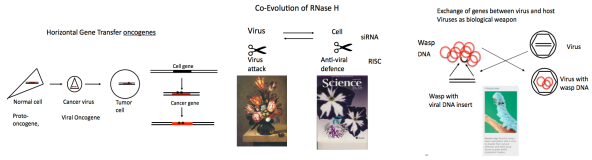
Fig. 3 Retro elements (RE) are incomplete retroviruses present in all genomes. They regulate gene expression. Transposons and retrotransposons build genomes. Viruses may have made the nuclei. Cells allowed DNA viruses to arise.

RNA viruses were first, then cells, then DNA viruses



▲Fig. 4 and 5. Who was first virus or cell? Both, RNA viruses were before cells, cells before DNA viruses. Viruses built genoemes by HGT, viruses and cells co-evolved, e.g RNase H and PIWI. How to define a virus? Polydna,viruses, PDV, havve no viral genomes.. Mobility, gene transfer and gene regulation makes viruses our best freineds during evolution. Only opportunistic events make them pathogens.

Horizontal gene transfer, co-evolution, friend-viruses



Conclusions

- **RNA viruses were first, then cells, then DNA viruses arose**
- **Bacteriophages are DNA viruses and front-runners in evolution,**
- **Plant viuses are RNA viruses and lag behind**
- **Giant viruses are links to bacterial cells**
- **Gene loss may have made viruses mobile and parasites later**
- **Viruses are only opportunistic pathogens. No arms-race!**
- **Viruses co-evolved and are drivers of evolution**
- **How to define a virus? PDV?**

References