

incomplete or arrested.) However, viewing mtDNA as inefficient may just be a reflection of our own ignorance of the fine details of mitochondrial function. Deeper knowledge may show that manufacture of certain mitochondrial protein subunits ‘on-site’ is very efficient, just as the energy-harnessing chemistry of the mitochondrial enzymes has been shown to be.

Conclusion

Given the enormous leaps of biochemical and genetic integration which are demanded by the endosymbiont theory, creationist skepticism is entirely justified. There is no compelling reason to believe it unless one has already decided that evolution is true. The creationist model, holding that structures may look similar because they were designed to do similar jobs, is a more reasonable way to view the miracle of mitochondria.

References

1. DiMauro, S. and Schon, E., Mitochondrial respiratory-chain diseases, *New England Journal of Medicine* **358**:2656, 2003.
2. Karp, G., *Cell Biology*, 2nd edition, McGraw-Hill, New York, p. 773, 1984.
3. Karp, ref. 2, p. 775.
4. Alberts *et al.*, *Molecular Biology of the Cell*, 3rd edition, Garland Publishing Inc., New York, p. 715, 1994.
5. Alberts *et al.*, ref. 4, pp. 708, 709.
6. DiMauro *et al.*, ref. 1, p. 2665.
7. Tallini, G., Oncocytic tumors, *Virchow's Archives* **433**:5, 1998.
8. Jih, D. and Morgan, M., Oncocytic metaplasia occurring in a spectrum of melanocytic nevi, *American Journal of Dermatopathology* **24**(6):468, December 2002.
9. DiMauro *et al.*, ref. 1, pp. 2656–2665.
10. Leonard, J. and Schapira, A., Mitochondrial respiratory chain disorders I: mitochondrial DNA defects, *The Lancet* **355**:299–304, 2000.
11. Alberts *et al.*, ref. 4, pp. 714–715.

Biological view of viruses: creation vs evolution

Manbok Kim

Since their first discovery in the 19th century, viruses have been widely recognized as disease-causing (pathogenic) agents. In fact, history records that virus-mediated diseases such as small pox and influenza, and now AIDS, have devastated human populations. Such pandemics have motivated molecular biologists to intensively study these pathogenic agents in order to find ways to eradicate them. As a result, many of the important findings of modern molecular biology have been derived from extensive work on the interaction between viruses and their host cells. From an evolutionary perspective, however, the origin of viruses is not fully understood.

Cancer-killing viruses

In contrast to the conventional view of viruses, cancer biologists have recently discovered that many viruses function as cancer-killing agents in humans and animals. It now appears that many non-pathogenic or attenuated viruses¹ specifically target cancer cells while sparing their normal counterparts. This has led to the use of viruses in clinical trials as powerful anti-cancer agents.^{2–4} Oncolytic (cancer-killing) viruses—such as adenovirus, vaccinia virus, measles virus, polio virus, herpes simplex virus, vesicular stomatitis virus and reovirus—preferentially infect cancer cells. This is mainly due to their specificity for the abnormal regulation displayed by cancer cells but not found in normal cells.^{3–12}

Paradoxical nature

How can we understand this contradictory nature of viruses? It cannot easily be explained from an evolutionary perspective, where gradual, constructive genetic changes are the driving force for biological evolution. For creation biologists, however, this can easily be understood by starting with a

perfect, original creation, followed by subsequent corruption of this creation after the Fall. The Bible tells us,

‘For by him were all things created, that are in heaven, and that are in earth, visible and invisible, whether they be thrones, or dominions, or principalities, or powers: all things were created by him, and for him’ (Colossians 1:16).

This therefore indicates a beneficial/support role for viruses in the beginning. Thus, before Adam’s sin, it is likely that viruses were non-pathogenic and actually designed to protect and maintain the cellular integrity of all living creatures. After the Fall, however, genetic corruption produced disease-causing viruses. This fits the description given of the current state of creation in Romans 8:20–21a:

‘For the creature was made subject to vanity, not willingly, but by reason of him who hath subjected the same in hope. Because the creature itself also shall be delivered from the bondage of corruption ...’.

Even after these deleterious modifications, today the original support nature of viruses is still evident as shown by oncolytic viruses.

What happened since creation?

Compared to cells, viruses have a high mutation rate. This is due to their unique mode of replication which relies on the enzymes RNA polymerase and reverse transcriptase for the synthesis of the viral genome. Unlike DNA polymerase, which is produced and used in all cells but not in RNA viruses, RNA polymerase and reverse transcriptase do not have a proofreading/checking function. This considerably increases the number of random genetic changes that can be introduced into viral genomes during their replication. For instance, the mutation rate of the poliovirus RNA-dependent RNA polymerase is about 4.5×10^{-4} mutations per base (i.e. one error in 2,200 bases),¹³ in comparison to a 1,000-fold lower mutation rate of DNA polymerase.¹⁴

	In the beginning	→	At present
Creation	Human (~25,000 genes) Non-pathogenic Viruses (5–10 genes) - God's creation - After their kind	Adam's fall: same viral genome but genetic degeneration (viral pathogenesis)	6,000 years later Humans (~25,000 genes) Pathogenic Viruses (5–10 genes)
Evolution	Primordial life (~250 genes) Pathogenic Viruses (5–10 genes) - Big bang, - Random process	Accumulation of genetic information by random mutation in highly mutable viruses	Billions of years later Humans (~25,000 genes) Pathogenic Viruses (5–10 genes) What happened to the viruses? → Still 5–10 genes after billions of years?

Flow of genetic information (creation vs evolution).

Evolutionary theory proposes that life gradually arose from non-living organic matter via random chance. For the purpose of this argument, let's assume that these primordial living forms contained only basic genetic information (i.e. 250 genes) and that subsequent random genetic changes over eons of time somehow resulted in the accumulation of genetic information in a constructive manner giving rise to man (about 25,000 genes). Although modern virology can not determine when viruses originated, some viruses such as retroviruses and RNA viruses (with less than 10 genes in their genome) may have co-existed with these primordial living forms as viral hosts. However, there is not a single observed case where these highly mutable viruses have naturally evolved into single cell-bacteria or even into different families of viruses. In reality, as more mutations accumulate in their genomes, viruses instead lose biological function and become defective.¹⁵

Adopting a creationary view of biology, despite viruses having a high mutation rate, their genetic and functional rigidity can be seen as the result of being one of many unique designs created to replicate non-pathogenically after their kind. Nevertheless, the accumulation of mutations

has resulted in viruses losing their biological function—such as a non-pathogenic, viral mode of replication used for killing cancerous cells or for regulation and/or communication with a host environment—in many of their genes and becoming defective rather than gaining novel functions, as evolution requires. After the Fall, non-pathogenic, support viruses also mutated into pathogenic forms, but still within this genetic and functional rigidity. Nonetheless, due to their genetic flexibility, some viruses today still display some of their original functions, such as oncolytic activity.

References

1. Viral attenuation (reduction of viral pathogenicity) is a critical factor in the use of viruses to treat cancer. Attenuation is normally induced by genetically modifying viral virulence genes, although it sometimes occurs naturally. For instance, a naturally attenuated strain of the vaccinia virus (normally a pathogenic virus that causes the deadly smallpox) has been used as a vaccine to eradicate smallpox in the world. This strain later turned out to be an effective oncolytic virus. See Thorne, S.H., Bartlett, D.L. and Kirm D.H., The use of oncolytic vaccinia viruses in the treatment of cancer: a new role for an old ally? *Curr. Gene Ther.* **5**:429–43, 2005; and Ahmed, R., Canning, W.M., Kauffman, R.S., Sharpe, A.H., Hallum, J.V. and Fields, B.N., Role of the host cell in persistent viral infection: coevolution of L cells and reovirus during persistent infection, *Cell* **25**:325–332, 1981.

2. Kirm, D., Oncolytic virotherapy for cancer with the adenovirus dl1520 (Onyx-015): results of phase I and II trials, *Expert Opin. Biol. Ther.* **1**:525–538, 2001.
3. Ring, C.J., Cytolytic viruses as potential anti-cancer agents, *J. Gen. Virol.* **83**:491–502, 2002.
4. Norman, K.L. and Lee, P.W., Not all viruses are bad guys: the case for reovirus in cancer therapy, *Drug Discov. Today* **10**:847–855, 2005.
5. Bischoff, J.R., Kirm, D.H., Williams, A. *et al.*, An adenovirus mutant that replicates selectively in p53-deficient human tumor cells, *Science* **274**:373–376, 1996.
6. Coffey, M.C., Strong, J.E., Forsyth, P.A. and Lee, P.W., Reovirus therapy of tumors with activated Ras pathway, *Science* **282**:1332–1334, 1998.
7. Duncan, M.R., Stanish, S.M. and Cox, D.C., Differential sensitivity of normal and transformed human cells to reovirus infection, *J. Virol.* **28**: 444–449, 1978.
8. Everts, B. and van der Poel, H.G., Replication-selective oncolytic viruses in the treatment of cancer, *Cancer Gene Ther.* **12**:141–161, 2005.
9. Heise, C., Hermiston, T., Johnson, L. *et al.*, An adenovirus E1A mutant that demonstrates potent and selective systemic anti-tumoral efficacy, *Nat. Med.* **6**:1134–1139, 2000.
10. Nemunaitis, J., Oncolytic viruses, *Invest. New Drugs* **17**:375–86, 1999.
11. Stojdl, D.F., Lichty, B., Knowles, S., Marius, R., Atkins, H., Sonenberg, N. and Bell, J.C., Exploiting tumor-specific defects in the interferon pathway with a previously unknown oncolytic virus, *Nat. Med.* **6**:821–825, 2000.
12. Varghese, S. and Rabkin, S.D., Oncolytic herpes simplex virus vectors for cancer virotherapy, *Cancer Gene Ther.* **9**:967–978, 2002.
13. Wells, V.R., Plotch, S.J. and DeStefano, J.J., Determination of the mutation rate of poliovirus RNA-dependent RNA polymerase, *Virus Res.* **74**:119–132, 2001.
14. Doming, E., Holland, J.J., Biebricher, C. and Eigen, M., Quasispecies: the concept and the world; in: Gibbs, A., Calisher, C. and Garcia-Arenal, F., (Eds.), *Molecular Evolution of the viruses*, Cambridge University Press, New York, pp. 171–180, 1995.
15. Ahmed, R. and Fields, B.N., Reassortment of genome segments between reovirus defective interfering particles and infectious virus: construction of temperature-sensitive and attenuated viruses by rescue of mutations from DI particles, *Virology* **111**:351–363, 1981.