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Highlights

Pathogenesis and Malignancy

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Discovering Thoughts, Inventing Future

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Viral Latency, Molecular Pathogenesis and Malignancy

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Abstract- Viruses are a major component of the biosphere, entering cells and genomes to insert their own genetic material. Herpesvirus lies hidden for years in the cells of the nervous system before emerging to cause herpes vesicles at the body surface. In the 'virosphere' there are the retroviruses, whose RNA genome can be converted to DNA by the reverse transcriptase enzyme carried in their viral particles, integrating their genes into the host cell genome and becoming one with it. When, for any of a number of reasons, the host immune system undergoes degrees of immunosoppression, the virus can reactivate, replicate, and cause disease. Even when this does not occur, oncogenic virus latency can induce malignancy in host cells.

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Viral Latency, Molecular Pathogenesis and Malignancy

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Abstract- **Viruses are a major component of the biosphere, entering cells and genomes to insert their own genetic material. Herpesvirus lies hidden for years in the cells of the nervous system before emerging to cause herpes vesicles at the body surface. In the 'virosphere' there are the retroviruses, whose RNA genome can be converted to DNA by the reverse transcriptase enzyme carried in their viral particles, integrating their genes into the host cell genome and becoming one with it. When, for any of a number of reasons, the host immune system undergoes degrees of immunosoppression, the virus can reactivate, replicate, and cause disease. Even when this does not occur, oncogenic virus latency can induce malignancy in host cells.**

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I. Latent and Persistent Infection

It is common knowledge that a virus penetrates into the host cell through a specific receptor in an interaction that can be analogized as a 'lock and key'. The infection may be productive for the virus and lytic for the cell (an acute infection), or the virus may remain latent in the living cell and occasionally replicate over time (Roizman et al 2012). In the latter case the infection may be persistent, and can be characterized either by periodic cycles of viral replication, or continual virus production as part of a chronic infection (Held and Derfuss 2012).

The *Herpesviridae* family is the typical example of a group of viruses that can give rise to a latent infection in animals (Cohrs and Gilden 2012). These viruses are very diffuse in humans, and after entering the body may establish a relationship that lasts until the death of the host. After the initial infection Herpesviruses localize to a specific compartment of the host, according to their tropism, and remain there extended periods. For example, the varicella zoster virus (causative agent of chickenpox) remains in nerve cells for the life of the host, or until a lack of the host immune defense let it reactivate, migrate to the body periphery and form herpes zoster vesicles (shingles) (Cohrs and Gilden 2012, Zerboni and Arvin 2011, Chen and Gershon 2011, Kinchington and Goins 2011). The clinical manifestations can be more or less severe according to the virus strain and the body immunity (St. Leger and Hendricks 2012, Sawtell et al 2011, Thompson and Sawtell 2011), and recently some viral genes have been identified as being responsible for the molecular mechanisms that allow the viral genome to exit latency; the 'pacemaker' triggering virus reproduction and the lysis of infected cells (Bowles and Blaho 2011).

Every subfamily of herpesviruses occupies a different compartment in latency, but they mostly remain in immune-privileged areas of the host. Therefore this human–virus interaction can last for extended periods: the virus is protected from humoral antibodies and lymphocyte attack, but the immune system isolates the virus, limiting its harmfulness even if it cannot be eradicated from the body.

Herpes simples virus (HSV) types 1 and 2 cause infection of epithelial cells and then lie hidden in the neurons: HSV 1 yields oropharyngeal lesions (cold sore) that can recur and, rarely, cause encephalitis, whereas HSV2 infection begins at the genital mucosa.

II. Molecular Pathogenesis and Malignancy

The *Polyomaviridae* family includes JC Virus (JCV), BK Virus (BKV) and SV40. As with the *Herpesviridae* family, these viruses are capable of establishing latent infection in the human host, and often initially infect children without causing clinical symptoms. JCV is mostly found in the kidney, but can be found also in lymphocytes, bone marrow, lung, intestine and brain. The host immune system plays an important role in the reactivation of the virus from the latent stage, which can occur as a consequence of immunosuppression, allowing JCV to replicate and cause disease.

Before being associated with colon cancer (Boland et al 2010) and brain tumors (Reiss et al 2010), JCV provided information that allowed a better understanding of the relationship between human immunosuppression and the molecular origins of tumor immunology (Finn 2008). JCV can be reactivated in the nervous system, causing encephalopathy (Ellis et al 2012) or potentially progressive multifocal leucoencephalopathy (PML), a fatal demelinating

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disease of the central nervous system observed in immunosuppressed individuals.

BKV is pathogenic in humans with haemorrhagic cystitis, nephropathy and has been recently associated with prostate cancer (Imperiale and Das 2010).

III. The Oncogenic Viruses

The correlation between virus and tumors goes back to the beginning of the last century when, in 1911, the American researcher Peyton Rous observed the role of viruses in causing sarcoma in chickens (Zur Hausen 2008). It is worth noting that this research was treated with some skepticism and even derision by the academic world for many years, such that it was only in 1966, at 87 years of age, that he was honored with the Nobel Prize for Medicine. Today, epidemiological investigations and research have allowed the identification of numerous viruses as causes of tumors in man (Table 1) (Zur Hausen 2008). For example, the hepatitis viruses B and C are particularly involved with hepatocellular carcinoma (Block and Mehta 2010, Sir and Ou 2010). Altogether, over the 50% of all the tumors of the liver in the world are attributable to a hepatitis B infection, for which an effective preventative is available (Table 2) (Chang and Chen 2010). At least 300.000 cases of liver cancer could be prevented per year, for which mortality is nearly 100%. HCV, aside from its role in liver cancer, is also involved in the development of some malignant lymphomas (Sir and Ou 2010).

HPV infection has been correlated with carcinoma of the cervix of the uterus, particularly genotypes 16 and 18, and is considered to be carcinogenic in humans (Katrenellenbogen and Galloway 2010). The prevalence of this infection is very high among sexually active adults, and increases with the number of sexual partners. Insofar as persistent infection is important in the carcinogenesis(. Baldwin and Munger 2010), this is therefore a cancer type that is 'transmitted by sex'. HPV is responsible for 80% of the carcinomas of the cervix and uterus that occur in the industrialized countries, and 90% of those in the developing world (Zur Hausen 2007), 70.000 and 260.000 new cases annually, respectively. HPV can also cause squamous carcinomas of the vulva, penis and anus. One can calculate that these viruses cause almost 30.000 cases of carcinoma of the vulva per year worldwide. Other tumors are also potentially associated with HPV, particularly cancers of the head and neck, of the esophagus and of the skin, although these associations remain to be confirmed ((Katrenellenbogen and Galloway 2010).

There is then the AIDS-associated virus, HIV, that is indirectly associated with two cancer types, Kaposi's sarcoma and non-Hodgkin lymphoma (De Falco et al 2010), as the immunodeficiency that it causes allows these conditions to develop (Finn 2008). In the patients with HIV over the sarcoma of Kaposi and the non-Hodgkin lymphomas, also . Hodgkin lymphoma frequency is significantly increased in HIV-seropositive individuals from an epidemiological point of view, as are other types of cancer, such as head and neck, testicular, anal and melanomas, based on cohort studies. Other oncogenic viruses include: human herpes virus type 8 (HHV8) (Minhas and Wood 2010, Hayward et al 2010), which is considered to be the cause of Kaposi's sarcoma when enabled by HIV (that is, the so-called 'classical Kaposi'). It is furthermore associated with various other cancer types, such as the body-cavity-based lymphomas, and Castleman's lymphadenopathy. The Epstein Barr virus (EBV) is considered a carcinogenic herpetic virus with conclusive evidence of its association with Burkitt's lymphoma, which often appears in immunosuppressed patients; in Hodgkin T-lumphoma; and in nasopharyngeal carcinoma (Pagano 2010, Dar and Sugden 2010). HTLV1 is considered carcinogenic as it causes acute T-cell leukemia (Matsuoka 2010, Marriott 2010).

IV. Virally-Induced Tumor Antigens

Some antigens have been very well-studied, especially in cell lines and in the newborn hamster model, particularly SV40 (Butel 2010) and the polyoma virus (Figure 1), (Sabin and Koch), in which it has been possible not only to show the presence of the normal antigens (enzymes) of the early viral replication, but also the so-called non-structural antigens, not present in the viral particle, but present in the cells infected and transformed by that virus (Rathi and Pipas 2010). Much has been contributed on this topic by the studies of the American groups lead by Huebner (NCI) and Green (Saint Louis) for the adenoviruses, by Sabin and Tarro (Cincinnati) for some herpes- and pox-viruses, by Melnick (Houston) for other herpesvirus (VZV) and by Rapp (Hershey, Pennsylvania) for the rest of the herpetic family (CMV). The epidemiological risk factors for the papilloma viruses are now well established in the literature. The proteins E6 and E7 are of particular interest because they are able to inactivate oncosuppressors during the process of malignant transformation (Thomas et al 2010). Therefore in the interpretation of the various stages of the cervical cancerogenesis it is important to establish that exist at least two mechanisms: the first tied up to the effect of papilloma viruses, agents of sexually transmissible diseases, and then that tied up to papilloma virus that has the DNA responsible of dictating a code of malignancy as the types 16, 1 8, 31 and others (Zur Hausen 2007). The passages from a stage to the other of the cell proliferation, can be triggered by other factors, such as HSV-2, hormones, contraceptives etc.. Following a publication from the Carbone group in

Chicago, SV40 has been implicated not only in CNS glioma, but also in mesothelioma, a cancer of the pleura (Baranova et al 2010), however this was not confirmed recently. In June 2006 the Food and Drug Administration (FDA) approved the release of the first vaccine against HPV, targeting two oncogenic (16 and 18) and two non-oncogenic (6 and 11) genotypes (Table 2).

V. Conclusions

At this point I would like to take the HCV (hepatitis C virus) from the Flaviviridae family as model of virus that causes primary infection mostly by infected blood. HCV is eliminated by the host in about 15% of cases whereas its infection remains in the body in about 85% of cases. In the latter event the outcome might be quite different going from mild hepatitis and stable infection with different degrees of seventy till liver cirrhosis and also hepatocellular carcinoma 10-30 years later (Feitelson 2010).

Although the human being develops a strong immunoresponse to the virus, HCV yields a defense based overall on genetic variation that allowes viral strains to survive. The viral strategy explains therefore the increased chronic infections, the reinfection with different genotypes, the unsatisfactory therapy and the chimerical project of producing a vaccine in short times.

The influenza virus of the *Orthomixoviridae* family possesses a very high rate of genetic variation (Tarro and Esposito 2011). During its replication, one virus can experience genetic mutation equal to 2% of its total genome in 5 days' time; compared with this, a similar proportion of evolution from monkey to man took eight million years. Of course, this process is much faster in viruses with a simpler, more mutation-prone RNA genome. Haemagglutinin (HA) and neuraminidase (NA) are critical virulence determinants for influenza virus type A (Esposito et al 2012), and these viruses circulate in animals and humans with 16 subtypes of HA, 9 subtypes of NA, and 144 identified combinations in total. The previously-mentioned tendency towards mutation of the viral particle and its genome in general allows influenza A to undergo antigenic drift into minor changes – resulting in sporadic or small outbreaks of flu – or to undergo antigenic shift, resulting in major changes, new subtypes, and often large epidemics and pandemics (Chowell et al 2009, Lister et al 2009, Dawood et al 2009, Zimmer and Burke 2009, Morens et al 2009, Enserink and Cohen 2009).

Current and upcoming methodologies for extracting viral and non viral antigens (Tarro 2009), and techniques of cancer vaccine development (Vergati 2010) will allow further progress in understanding the role of viruses and the strategies of the immune system to produce humoral and cellular antibodies against them (Stix 2007). These tools have helped immunology to become a science, and are not simply a means to push sophisticated laboratory setups on to higher targets. Along these lines, non-invasive tumor monitoring (Schiller 2008) as well as mass spectrometry-based proteomics (Indovina et al 2012) may be a path to biomarker discovery. Peptide search in the tumor liberated protein (Tarro et al 2005) and cancer proteomics (Indovina et al 2011) represent the most advanced discovery in anticancer peptide vaccines (Perez 2010) Finally it is noteworthy to mention the emerging role of cytomegalovirus in malignant glioma (Cobbs 2012). Against this background, antiviral developments may well usher in a new era in anticancer strategies.

The author declares no conflict of interests

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References Références Referencias

1. Baldwin A, Munger K (2010) Molecular events associated with human papillomavirus-induced human cancers in Viral Oncology Khalili K., Jeang K-T. (Eds), Wiley – Blackwell, Hoboken, New Jersey, USA, 23-55.
2. Baranova N, Carbone M (2010) Simian virus 40 and mesothelioma in Viral Oncology Khalili K., Jeang K-T. (Eds), Wiley – Blackwell, Hoboken, New Jersey, USA, 191-209.
3. Block TM, Mehta AS (2010) Molecular immunobiology of hepatitis B-associated viral cancer in Viral Oncology Khalili K., Jeang K-T. (Eds), Wiley – Blackwell, Hoboken, New Jersey, USA, 211-224.
4. Boland RC, Ricciardiello L, Goel A (2010) Involvement of the polyomavirus, JC virus, in colorectal cancer in Viral Oncology Khalili K., Jeang K-T. (Eds), Wiley – Blackwell, Hoboken, New Jersey, USA, 113-128.
5. Bowles NR, Blaho AJ (2011) A truncation mutation of the neurovirulence ICP22 protein produced by a recombinant HSV-1 generated by bacterial artificial chromosome technology targets infected cell nuclei. J of NeuroVirol 17:559-569.
6. Butel JS (2010) Simian virus 40, human infections, and cancer: emerging concepts and causality considerations in Viral Oncology Khalili K., Jeang K-T. (Eds), Wiley – Blackwell, Hoboken, New Jersey, USA, 165-189.
7. Chang M-H, Chen D-S (2010) Hepatitis B vaccine and hepatocellular carcinoma in Viral Oncology Khalili K., Jeang K-T. (Eds), Wiley – Blackwell, Hoboken, New Jersey, USA, 225-242.

8. Chen JJ, Gershon AA, Li Z, cowls RA, Gershon MD (2011) Varicella zoster virus (VZV) infects and established latency in enteric neurons. J of NeuroVirol 17:578-589.
9. Chowell G, Bertozzi SM, Colchero MA, et al (2009) Severe respiratory disease concurrent with the circulation of H1N1 influenza. N Engl J Med 361:674-679.
10. Cobbs CS Emerging role of cytomegalovirus in malignant glioma. (2012) 11th International symposium on Neurovirology. New York, NY, USA29 May-2June session IV.
11. Cohrs R, Gilden D (2012) Alphaherpesvirus latency. J of NeuroVirol 17:509-511.
12. Dar WA, Sugden B (2010) Epstein-Barr virus as a pathogen. In: Viral Oncology Khalili K., Jeang K-T. (Eds), Wiley – Blackwell, Hoboken, New Jersey, USA, 425-451.
13. Dawood FS, Jain S, Finelli L, et al (2009) Emergence of a novel swine-origin influenza A (H1N1) virus in humans. N Engl J Med 360:2605-15.
14. De Falco G, Bellan C, Lazzi S, Leoncini L (2010) HIV-related lymphoma in Viral Oncology Khalili K., Jeang K-T. (Eds), Wiley – Blackwell, Hoboken, New Jersey, USA, 337-349.
15. Ellis L, Dang X, Norton E, Koralnik (2012) Role of agnogene deletion and archetype-like regulatory region in a JCV strain isolated from the brain of a patient with JCV encephalopathy (JCVE). Presented at: 11th International symposium on Neurovirology. New York, NY, USA. 29 May-2 June J of Neurovirol 18: suppl 1, 69.
16. Enserink M, Cohen J (2009) Virus of the year. The novel H1N1 influenza. Science 326:1607.
17. Esposito C, Di Spirito A, Cuomo N et al (2012) Tracking the 2009 H1N1 influenza virus in the Italian region Campania. Journal of Cellular Physiology 227:2813-2817.
18. Feitelson MA, Reis H, Pan J, Sun B (2010) Pathogenesis of acute abd chronic hepatitis C virus infection in Viral Oncology Khalili K., Jeang K-T. (Eds), Wiley – Blackwell, Hoboken, New Jersey, USA, 243-266.
19. Finn OJ (2008) Molecular origins of cancer. Cancer immunology N Engl J Med 358:2704-2715.
20. Hayward GS, Donald JA, Arav-Boger R (2010) The role of KSHV in pathogenesis of Kaposi's sarcoma in Viral Oncology Khalili K., Jeang K-T. (Eds), Wiley – Blackwell, Hoboken, New Jersey, USA, 377-407.
21. Held K, Derfuss T (2012) Control of HSV-1 latency in human trigeminal ganglia – current overview. J of NeuroVirology 17:518-527.
22. Imperiale MJ, Das D (2010) Possible association of BK virus with prostate cancer in Viral Oncology Khalili K., Jeang K-T. (Eds), Wiley – Blackwell, Hoboken, New Jersey, USA, 129-148.
23. Indovina P, Marcelli E, Pentimalli F, Targenelli P, Tarro G, Giordano A (2012) Mass spectrometry-based proteomics: the road to lung cancer biomarker discovery. Mass Spectrometry Reviews Published on line in Wiley onlinelibrary.com.
24. Indovina P, Marcelli E, Maranta P, Tarro G (2011) Lung cancer proteomics: recent avances in biomarker discovery. International Journal of Proteomics 2011, 1-7.
25. Katrenellenbogen RA, Galloway DA (2010) Human papillomavirus-associated cancers in Viral Oncology Khalili K., Jeang K-T. (Eds), Wiley – Blackwell, Hoboken, New Jersey, USA, 1-21.
26. Kinchington PR, Goins WF (2011) Varicella zoster virus-induced pain and post-herpetic neuralgia in the human host and in rodent animal models. J of NeuroVirol 17:590-599.
27. Lister P, Reynolds F, Parslow R et al (2009) Swine-origin influenza virus H1N1, seasonal influenza virus, and critical illness in children. Lancet 374:5-7.
28. Marriott SJ (2010) Oncogenic potential of the HTLV-1 tax protein in Viral Oncology Khalili K., Jeang K-T. (Eds), Wiley – Blackwell, Hoboken, New Jersey, USA, 279-293.
29. Matsuoka M (2010) Clinical aspects of HTLV-1-associated cancer in Viral Oncology Khalili K., Jeang K-T. (Eds), Wiley – Blackwell, Hoboken, New Jersey, USA, 279-293.
30. Minhas V, Wood C (2010) Biology and epidemiology of HHV-8 in Viral Oncology Khalili K., Jeang K-T. (Eds), Wiley – Blackwell, Hoboken, New Jersey, USA, 351-375.
31. Morens DM, Taubenberger JK and Fauci AS (2009) The persistent legacy of the 1918 influenza virus. N Engl J Med 361:225-9.
32. Pagano JS (2010) Molecular pathobiology of EBV infection in Viral Oncology Khalili K., Jeang K-T. (Eds), Wiley – Blackwell, Hoboken, New Jersey, USA, 409-423.
33. Perez S et al (2010) A new era in anticancer peptide vaccines. Cancer 116:2071-2080.
34. Rathi AV, Pipas JM (2010) Oncogenic transformation by polyomavirus large T antigen in Viral Oncology Khalili K., Jeang K-T. (Eds), Wiley – Blackwell, Hoboken, New Jersey, USA, 149-164.
35. Reiss K, Khalili K, Del Valle L (2010) JC virus association with brain tumors: the role of T antigen and insulin-like growth factor 1 in DNA repair fidelity in Viral Oncology Khalili K., Jeang K-T. (Eds), Wiley – Blackwell, Hoboken, New Jersey, USA, 89-111.
36. Roizman B, Zhou G, Du T (2012) Checkpoint in productive and latent infections with herpes simplex virus 1: conceptualization of the issues. J of NeuroVirol 17:512-517.
37. Sawtell NM, Triezenberg SJ, Thompson RL (2011) VP16 serine 375 is a critical determinant of herpes

simplex virus exit from latency in vivo. J of NeuroVirol 17:546-551.
38. Schiller LH (2008) Noninvasive monitoring of tumor. N Engl J Med 359:418-420.
39. Sir D, Ou J-H J (2010) Molecular Mechanisms of hepatitis C virus-induced cellular transformation in Viral Oncology Khalili K., Jeang K-T. (Eds), Wiley – Blackwell, Hoboken, New Jersey, USA, 267-277.
40. Stix G (2007) A malignant flame. Scientific American 297:60-67.
41. St. Leger AJ, Hendricks RL (2012) CD8+ T cells patrol HSV-1-infected trigeminal ganglia and prevent viral reactivation. J of NeuroVirology 17:528-534.
42. Tarro G (2009) Tumor liberated protein from lung cancer and perspectives for immunotherapy. Journal of cellular Physiology 221:26-30.
43. Tarro G, Esposito C (2011) Emerging viral agents at risk in global health approaches to early diagnosis and prompt therapy. International Conference on Bioinformatics and Computational Biology (BIOCOM'11). Las Vegas, Nevada, USA. July 18-21 CS REA Press.
44. Tarro G, Perna A, Esposito C (2005) Early diagnosis of lung cancer by detection of tumor liberated protein. J Cell Physiol 203:1-5.
45. Thomas M, Pim D, Banks L (2010) The role of the human papillomavirus E6 oncoprotein in malignant progression in Viral Oncology Khalili K., Jeang K-T. (Eds), Wiley – Blackwell, Hoboken, New Jersey, USA, 57-58.
46. Thompson RL, Sawtell NM (2011) The herpes simplex virus type 1 latency associated transcript locus is required for the maintenance of reactivation competent latent infections. J of NeuroVirol 17:552-558.
47. Vergati M et al (2010) Strategies for cancer vaccine development. Journal of Biomedicine and Biotechnology 2010. Published online www.hindawi.com/journal/jbb/2010/596432.
48. Zerboni L, Arvin A (2011) Investigation of varicella-zoster virus neurotropism and neurovirulence using SCID mouse-human DRG xenografts. J of NeuroVirology 17:570-577.
49. Zimmer SM, Burke DS (2009) Historical perspective--Emergence of influenza A (H1N1) viruses. N Engl J Med 361:279-85.
50. Zur Hausen H (2007) Infections causing human cancer. Wiley – VCH: Weinheim, Germany, 532 p.

Table 1 - Cancer AssociatedViruses of Man

- **Proven**

Certain strains of papillomavirus (Papovaviridae)
Epstein-Barr virus (Herpesviridae)
Hepatitis B virus (Hepadnaviridae)
HTLV-I and –II (Retroviridae)
Human herpes virus-8 (Herpesviridae)
Merkel cell polyomavirus (MCV)

- **Suspect**

Hepatitis C virus (Flaviviridae)
Herpes simplex virus (cofactor) (Herpesviridae)
HIV-1 and -2 (Retroviridae)
Polyomavirus (BKV, JCV) (Papovaviridae)

- **Possible**

Adenovirus (Adenoviridae)

Table 2 - Examples of Licensed and Experimental Vaccines against Established or Putative Virus Cancers of Man

- Licensed

Hepatitis B (plasma-derived and recombinant)
Adenovirus (live and killed)
Papillomavirus

- Experimental-Investigative

Retrovirus	
HIV-1 and -2	AIDS
HTLV-1 and HTLV-2	Leukemia
Epstein-Barr virus	
Hepatitis C	

Source: Modified from annals N.Y. Academy of Science

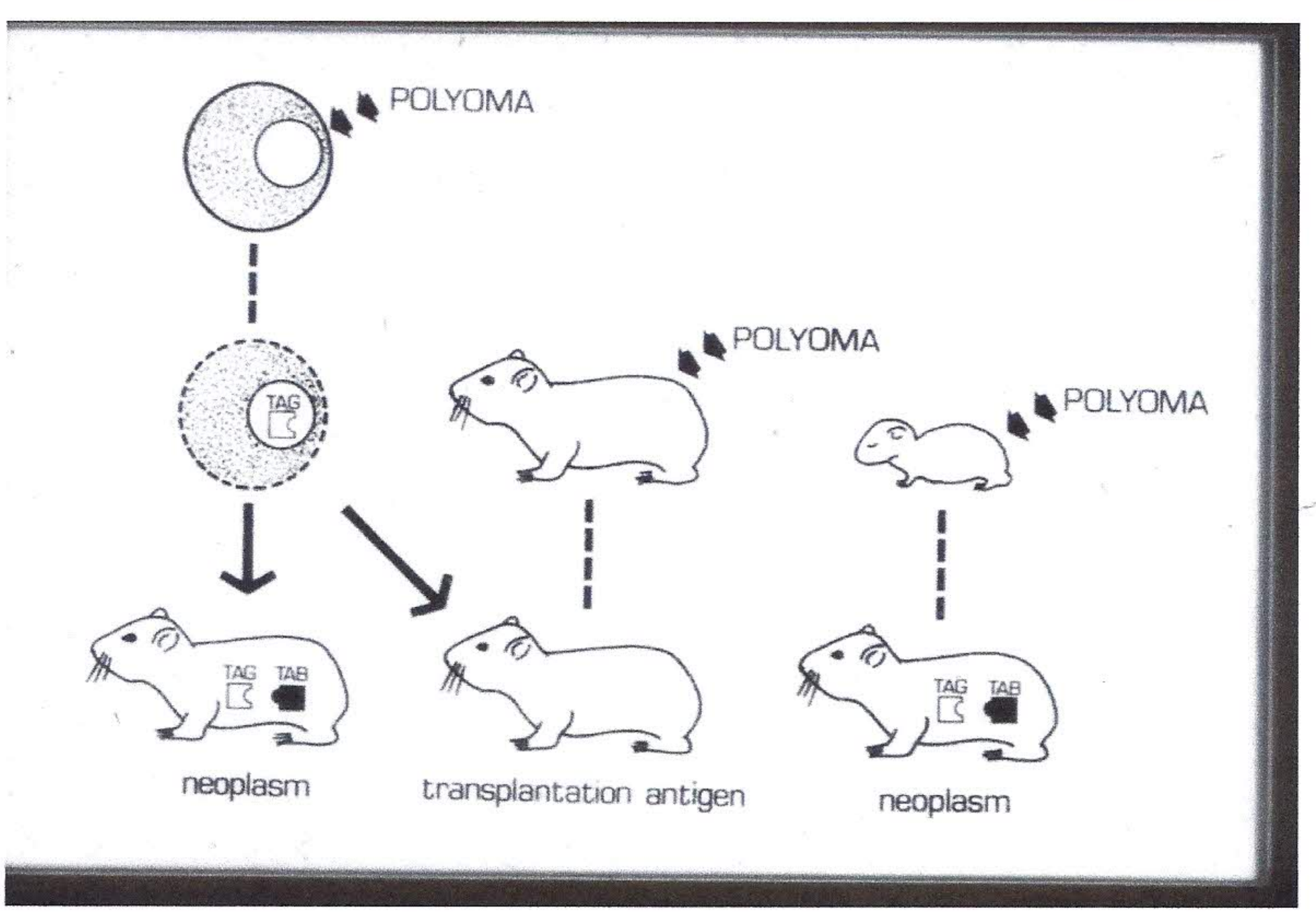

Figure 1 : The polyoma virus inoculated in tissue culture (left) transforms the cells that injected into adult hamster cause cancer with production of a transplantation antigen that protects the adult animals preinoculated by the virus (middle). In newborn hamsters the polyomavirus yields straight tumors (right)