



# A Model for Metastasis for Hybrid Cancer Cells

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## Abstract

Hybrid cancer cells have been recently discovered. They have greater ability to form metastasis. Here a simple mathematical model is given for this phenomenon. Some comments about the possibility of their reaching brain are given.

## Hybrid Tumor Cells

Recently [1,2,3,4] hybrid tumor cells have been discovered. They have the following properties:

- i. They circulate more than ordinary tumor cells.
- ii. They have greater ability to migrate and invade other tumors.
- iii. They have greater ability to form metastasis.

## The Metastasis Model

Metastasis comprises a sequence of linked steps leading to the dissemination of cancer cells from a primary tumor to other distant tissues the overwhelming majority of cancer-related deaths still result from the progressive growth of metastasis that are resistant to conventional therapies [1,2].

Motivated by this the following model is presented for the metastasis of hybrid cancer cells:

Let  $T_1$ ,  $H_1$  be the ordinary and hybrid tumor cells respectively of the first tumor. Let  $N=T_1+H_1$ . The second tumor is assumed to contain ordinary tumor cells  $T_2$ . Hence the model can be represented by

$$\begin{aligned} dH_1/dt &= a_1H_1 - N - c_2H_1, & dT_1/dt &= b_1T_1^{2/3} - N, \\ dT_2/dt &= (b_2 - 1)T_2 + c_2H_1 \end{aligned} \quad (1)$$

where  $a_1, b_1, b_2, c_2$  are positive constants. The metastasis term is  $c_2H_1$ .

The reason for the power  $2/3$  is that ordinary tumor cells grow due to surface cells [3,4].

The equilibrium solution for the coexistence of both tumors is:

$$H_1eq = T_1eq / (a_1 - c_2 - 1)$$

$$T_1eq = [b_1(a_1 - 1 - c_2) / (a_1 - c_2)]^{3/2} \quad (2)$$

$$T_2eq = c_2H_1 / (1 - b_2)$$

It is locally asymptotically stable if:

$$b_2 < 1,$$

$$[1 - (2/3)(a_1 - c_2) / (a_1 - c_2 - 1)][1 + c_2 - a_1] - 1 > 0 \quad (3)$$

$$[1 - (2/3)(a_1 - c_2) / (a_1 - c_2 - 1)] + [1 + c_2 - a_1] > 0$$

Since hybrid cells have a greater ability to invade other cells, it is expected that they will invade brain cells. Hence brain tumors can be a good source for identifying them. Moreover trying to attract them to less important sites can be a feasible strategy to deal with them. It may be difficult to test this idea experimentally, because the hybrid state, in general, is unstable [5].

## References

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