Tumour Proto-cognition

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Introduction

When abnormal cells grow in an uncontrolled way, cancer can occur and these abnormal cells have potential to spread surrounding tissues and other organs. Once cancer has reached invasion and metastasis stage, treatment options are very few and the disease is usually fatal. Different factors of the tumour microenvironment (TME) are affect for the tumour progression[1]. Hence it is important to study cell behaviour of tumour cells.

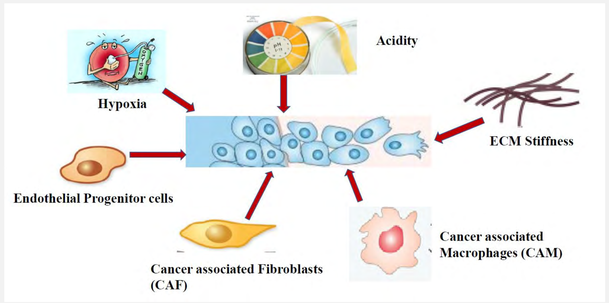

Figure 1: TME factors affecting for cell motility

Protocognition is the ability to acquaint information, recognition of stimulatory spaces, building up knowledge, and developing wisdom, sensing, decision mapping, learning, reasoning, believing, being erroneous, showing feeling and emotional states by chemical and physical substrates and living creatures without a nervous system [2]. Tumour cells can survive in an the TME, resist treatments, induce cell plasticity, invasion and metastasis. Those activities shows protocognitive abilities of the tumour cells.

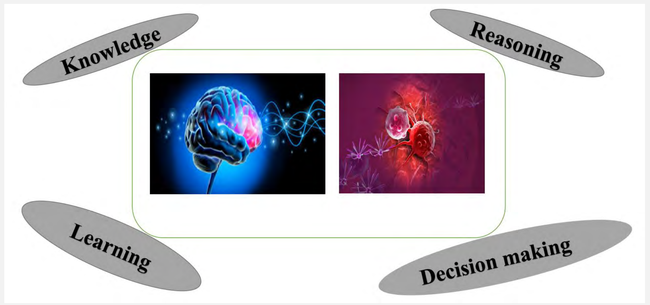

Figure 2: Do tumours have proto-cognitive abilities

In this research work, spatial stochastic model is developed to study the protocognitive abilities of tumour cells.

Agent-based Model for Tumour Proto-cognition

Discrete models can be used to understand cancer progression and cell movements in the TME [3]. In this research work, a two-dimensional spatial stochastic model for cell invasion is developed considering cell-cell stickiness, differential motility, cell crowding and availability of natural resources in the TME.

Initially, assume there is one normal cell in the domain. Since normal cells can control their cell growth, the domain has a cell equilibrium. With mutations of cells, abnormal cells start to grow and they have higher proliferation rate and low apoptosis rate. Hence cell equilibrium is lost and the TME becomes crowded.

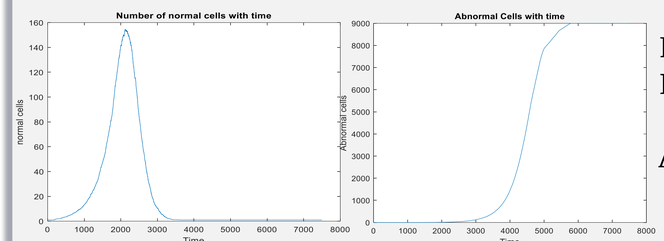

Figure 3: Left hand side: Normal cells with time, Right hand side: Abnormal cells with time

Cell crowding effects cellular stress and highly mobile cells with low cell-cell stickiness invade to outside of the TME.

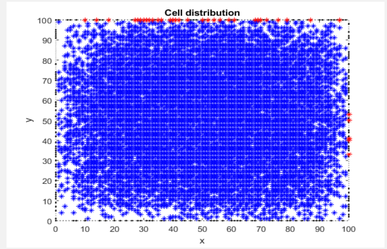

Figure 4: Tumour cell invasion

According to the results, over several generations, loss of cell-cell stickiness has occurred and cell motility is increasing.

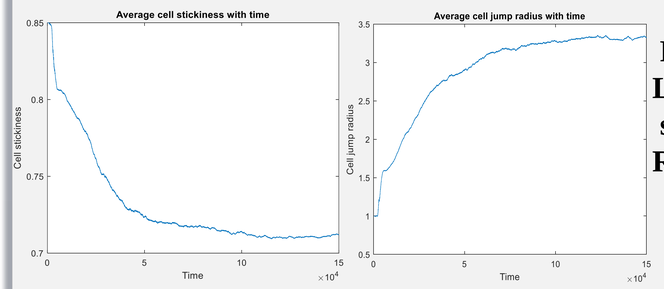

Figure 5: Left hand side- cell stickiness with time Right hand side- cell jump radius with time

Conclusion

From this model, cell-cell communication in the TME under cellular stress can be observed. Tumour cells have the ability to obtain information from the environment. According to that information they make better decisions such as surviving in the TME, plasticity, invasion and metastasis. Hence this model is a mathematical basis to study the protocognitive abilities of the tumour cells.

References

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