



Introduction

Today, prostate cancer (PCa) is a major and challenging global health concern and is recognized as the second most common solid malignancy among men and the fifth leading cause of cancer death worldwide. Each year, about 1.3 million men have this type of cancer, and almost 400,000 die from metastatic disease. Fortunately, survival rates have improved in many areas, but unfortunately, a significant number of patients survive more than a decade after diagnosis and often struggle with complications from treatment. Risk factors include age, genetic background, and family history, and it seems that heredity accounts for more than half of the total risk. It should be noted that racial differences continue to play an important role; black men face much higher incidence and mortality rates than white men. Previous studies have reported significant differences in the incidence and long-term mortality of prostate cancer in different countries. Despite advances, many basic questions about the cellular origin of prostate tumors remain unanswered. Experimental efforts have been made using human tissues and genetically engineered mouse (GEM) models to identify the population of cells that initiate this type of cancer. Some findings have shown that basal epithelial cells have the ability to have a tumor origin and can be the initiator of the disease.

Methods

This narrative review was conducted through a comprehensive search of PubMed, Scopus, Web of Science, and Google Scholar for studies published between 2010 and 2025 using the keywords "Prostate Cancer," "3D Printing," "3D Scaffold," "Tissue Engineering," and "Tumor Models." English-language articles that directly addressed the use of 3D-printed scaffolds in prostate cancer modeling were included, while irrelevant studies or those lacking sufficient data were excluded.

Results

The Additive Manufacturing technique, known today as 3D printing, is a set of technologies that produce physical objects using digital maps and by placing successive layers of materials. Using advanced imaging methods such as CT scan (CT) and magnetic resonance imaging (MRI), doctors can convert tumor data for each patient into accurate and reliable 3D digital models; after this step, the models are physically printed to obtain real and accurate copies of the tumor and organs involved, making it easier for the specialist to make decisions, and also allowing surgeons to check the exact size, shape and position of the tumor well before the operation this dramatically reduces the risks of surgery and improves the results of treatment. In addition, printed tumor models allow researchers to test various drugs and treatments in a controlled environment, which speeds up the process of discovering effective cancer treatments and reduces dependence on animal testing. To close the gap between the two domains in vitro and in vivo, the use of three-dimensional cell culture is considered the best solution. These systems regenerate more realistic conditions of the body's small tumor environment than two-dimensional images. In this article, we classify the materials used by popularity and their consumption in laboratories, from the most popular materials to those that are not very popular and are used. In recent years, the use of 3D models to simulate the behavior of prostate tumors has increased dramatically, especially in the in vitro environment, and most activists in this field have pushed their studies in this direction. These scaffolds also led to increased expression of cancer stem cell markers (CSCs) such as CD44 and ALDH1, highlighting the importance of using three-dimensional models in the study of drug resistance and cell plasticity. [58]. In more advanced models, endothelial cells such as HUVECs and prostate fibroblast cells (PrSCs) are also used alongside tumor cells to add vascular and stromal components to the model.

LABORATORY MODELING AND CLINICAL APPLICATIONS OF 3D PRINTING IN PROSTATE CANCER

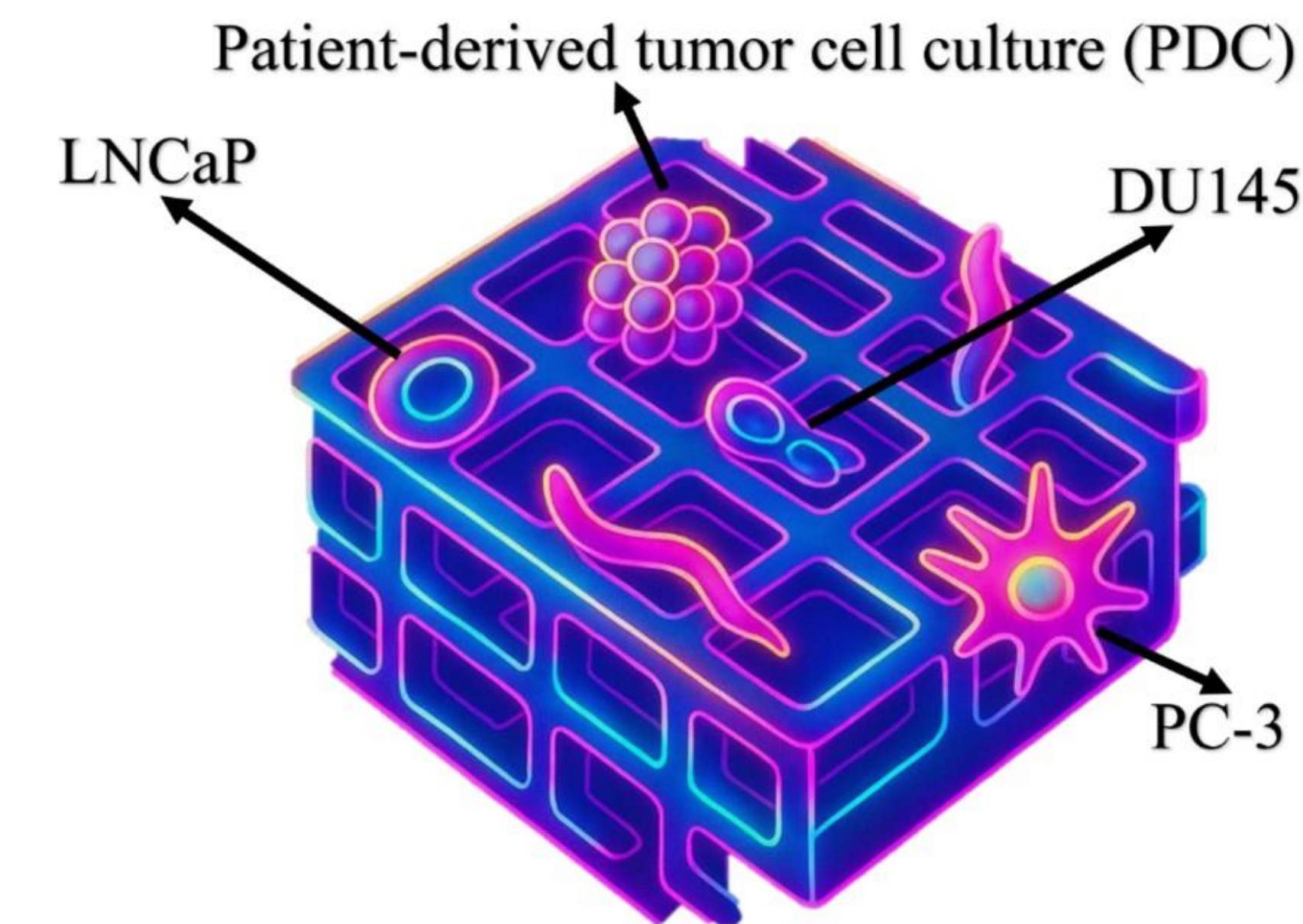
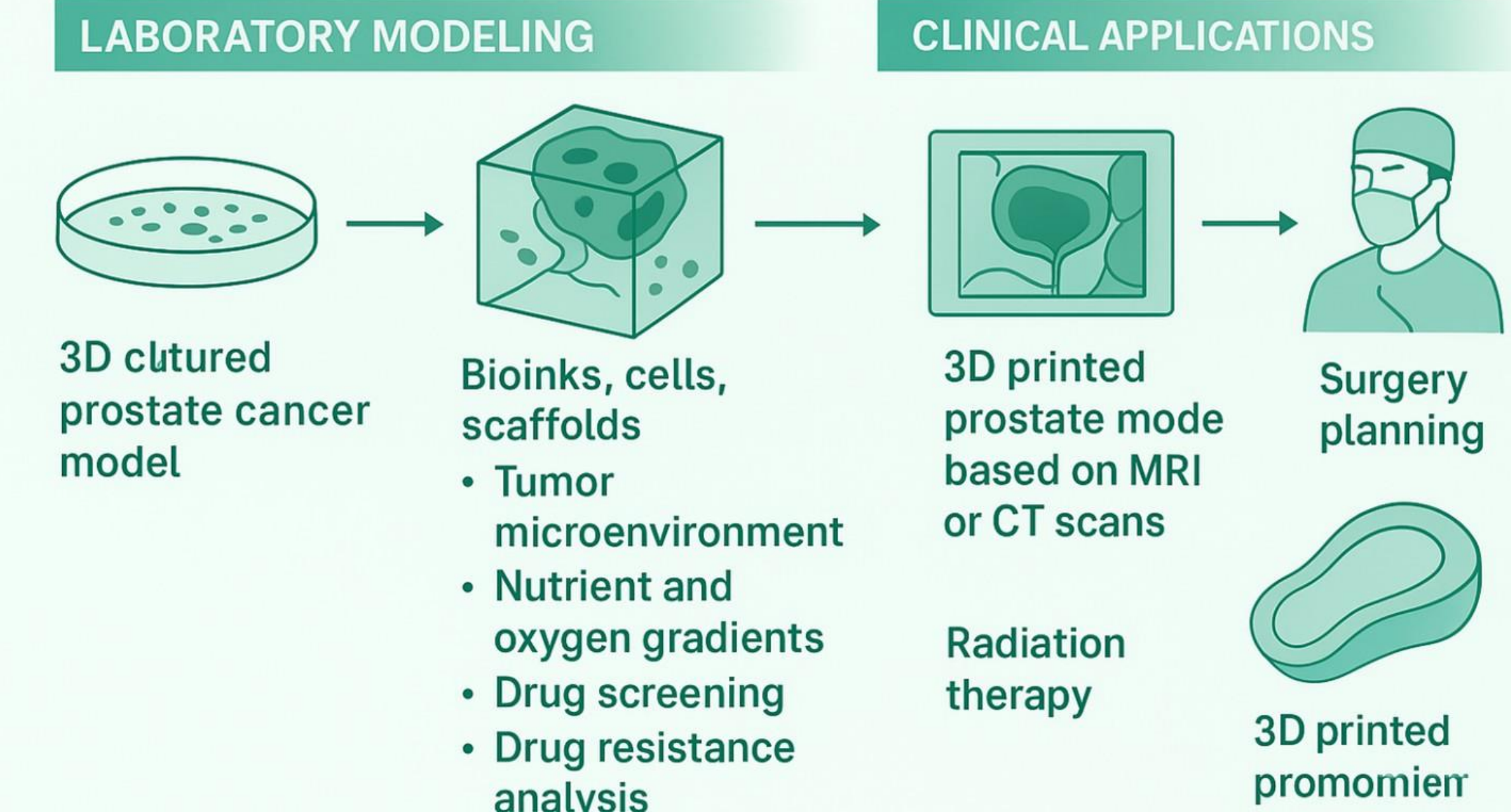


Fig. 1. Schematic of Cell types in prostate cancer 3D printer scaffolds

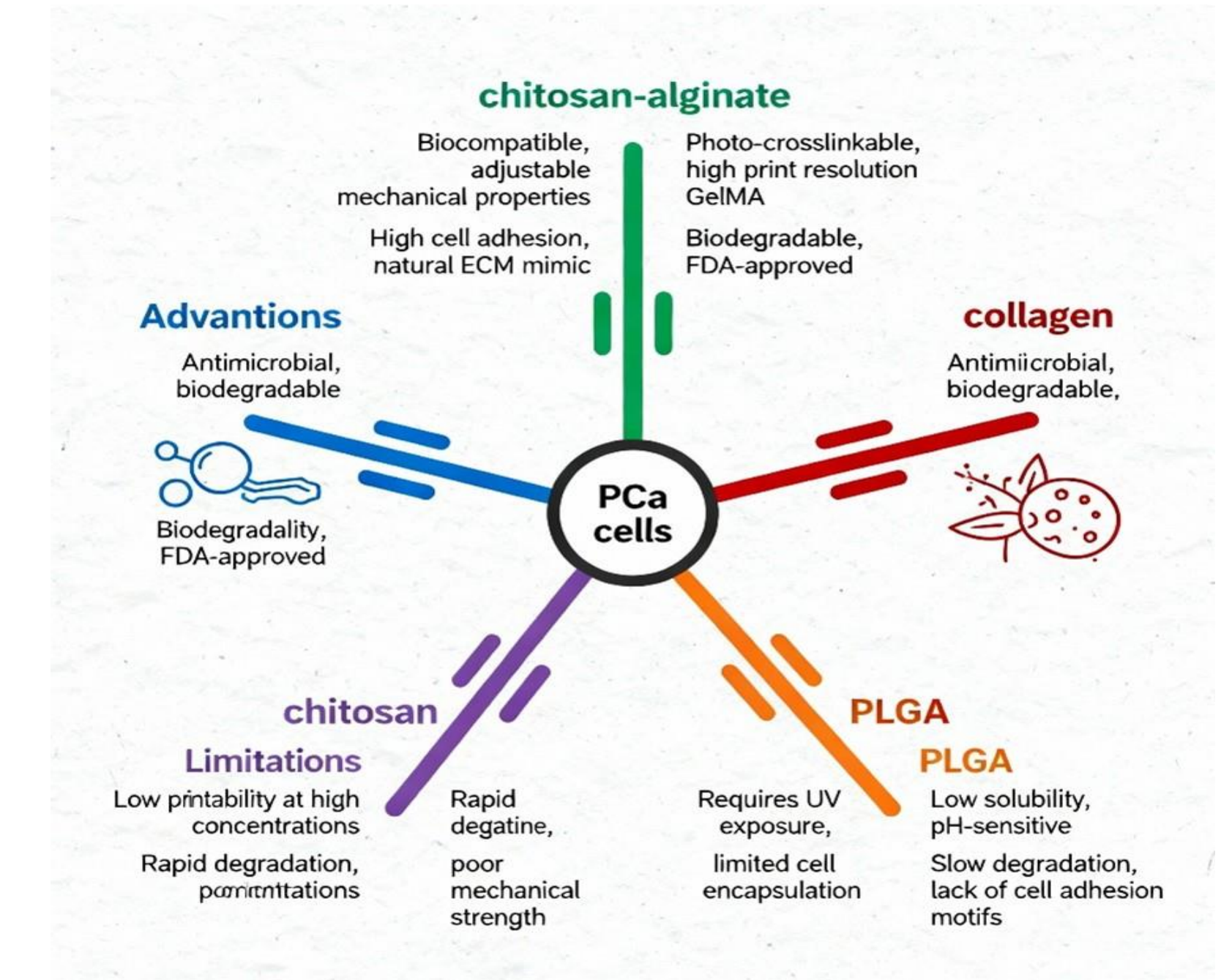


Fig. 2. Types of biomaterials in 3D printed scaffolds

Conclusions

Prostate cancer remains a major global health burden, with survival strongly dependent on disease stage at diagnosis. Three-dimensional (3D) printing has rapidly evolved from a prototyping tool into a versatile platform bridging basic prostate cancer biology and personalized medicine. Recent advances enable reconstruction of the tumor microenvironment with high fidelity, supporting more accurate modeling of epithelial-mesenchymal transition, cytokine signaling, and drug resistance. Compared to traditional 2D cultures, bio-printed multicellular hydrogels and bone-mimicking scaffolds provide reliable platforms for drug screening and mechanistic studies, while microtomographic systems now permit investigation of oxygen gradients and patient-derived disease models, thereby accelerating preclinical research and reducing reliance on animal studies.