**Reflective Statement describing your effective and innovative research process and use of resource material (750-1000 words)**

My assignment involved writing a research grant proposal to use 3D printers to fabricate hydrogel-based liver tissue for pharmaceutical applications. My research question was: can 3D printers and hydrogel vascular channels extend the in vitro life of liver cells (hepatocytes). This was a particularly challenging project as I had to formulate a research plan in a field where practically no research existed. Everything from the 3D printing technology (as it pertained to liver cells) to the nature of hepatic (liver) cells in the hydrogel to the maturity of the cells in vitro was something that had never been investigated properly. The resources of the University of Toronto Libraries shortly proved indispensable to me and I effectively used several of these resources to write an effective grant proposal. Particularly, unique search strategies, library databases, and a variety of library media like textbooks and journals were used.

One of the most useful resource was the University of Toronto Library database for journals and textbooks. Databases, especially on the Gerstein Library website, like Medline, PubMed, and even BIOSIS and Web of Science, were not only easy-to-use but also provided relevant and up-to-date research papers. This allowed me to use a variety of papers from each database. This way, I maximized how much information I gathered, from an already limited research field. For instance, when I was researching “3D printable liver cells”, I used the same search query in each of the four aforementioned databases. Although key papers appeared consistently in all four databases, each database also returned exclusive manuscripts of up-coming papers that contained very useful bits of information that was most helpful in my assignment. Additionally, I consulted several online textbooks as well. For instance, I used several textbooks on cell culture methods like “Hepatocytes - Methods and Protocols” by Maurel, “Human Cell Culture Protocols” by Mitry, and even a couple on 3D bio-printing like “3D Bioprinting and Nanotechnology in Tissue Engineering and Regenerative Medicine” by Zhang. Also, because these texts were available online, that made it much more convenient for me to use. However, because research in the biomedical field changes so rapidly, I merely used these texts as guide and chose not to cite them (as some information was outdated).

Similarly, distinctive queries greatly narrowed down specific research papers. I not only used single key words, but multiple combinations using logical operators like “AND” or “OR” to limit not only the literature but the type as well (i.e. primary review, primary research article). In my case, queries like “hepatocytes AND 3D printing AND hydrogel OR alginate” and parameters like “limit to review” effectively narrowed down results from thousands of papers to a manageable few dozen. However, very specific queries, like “hepatocytes AND Three-dimensional printing AND Alginate limit to review”, resulted in a “dead end” (0 results) as there were gaps in the existing research. Generally, to address these shortcomings, I tried multiple strategies: in most cases, I used similar keywords, for instance, using “liver cells” instead of “hepatocytes” or “scaffold” instead of “alginate” (alginate serves as a scaffold). But occasionally, I had to sift through dozens of papers and use the ones most relevant to my project.

Similarly, filtering results using authors and key papers was another effective strategy I used. For instance, in my research involving 3D printers and hepatocytes (liver cells), I broke up the research into “modules” and examined key papers in each module. In my case, for the 3D printing aspect, one of the
most prominent papers was “3D bioprinting of tissues and organs” by Dr. Anthony Atala who essentially revolutionized the field. Similarly, regarding the hepatocytes “module”, I used papers by Kareem Si-Tayeb who has created several effective protocols for culturing hepatocytes in vitro. Basically, I used the research papers of such pioneering scientists as a starting point in my research. In doing so, I also started critiquing the methodology and experimental design used in each paper and evaluated factors like statistical analysis, presentation of raw data, and interpretation and incorporated possible improvements in my grant proposal.

Finally, I consulted with a variety of professors and upper-year students to gain an insider perspective of the existing research. For instance, my supervisor, Dr. Michael Sefton, provided me with much valuable insight as well as the shortcomings of the existing research in the field of 3D printer organ fabrication. He provided me with key papers about 3D printing technologies as well as novel cell culturing methods in hydrogel channels. His insight proved very useful especially when used with university library’s database. Similarly, I referred to Dr. Andrew Baines (my course instructor) regarding statistical analysis and experimental design. Finally, I asked upper-year students on how best to use online journals and good strategies for evaluating such papers. By consulting with multiple sources, I found it much easier to navigate and efficiently research my grant proposal using the advanced U of T library databases.

Essentially, all of the aforementioned strategies and techniques allowed me to effectively analyze my research topic. By using precise methods I easily found relevant papers using multiple databases (PubMed, Medline, BIOSIS to name a few) and this allowed me to pinpoint my research question which in my case was: Can 3D printers be used to embed liver cells in hydrogel channels to make long-lasting cell culture. In short, the effective research strategies shaped my knowledge of the subject and ultimately helped form my thesis.