# FEASIBILITY OF INTRODUCING LAB-GROWN MEAT IN MALAYSIA

BY

LIANG JIA YI

OOI BOON TAT

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DECLARATION

We hereby declare that:

(1) This undergraduate FYP is the end result of our own work and that due acknowledgement has been given in the references to ALL sources of information be they printed, electronic, or personal.

(2) No portion of this FYP has been submitted in support of any application for any other degree or qualification of this or any other university, or other institutes of learning.

(3) Equal contribution has been made by each group member in completing the FYP.

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Name of Student:          Student ID:          Signature:

1. _____Liang Jia Yi_____     ___15UKB01810___     _____

2. _____Ooi Boon Tat_____     ___15UKB02180___     _____

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LIST OF ABBREVIATIONS

AMSA                          American Meat Science Association

ASC                            Adult Stem Cell

CVD                            Cardiovascular Disease

ESC                            Embryonic Stem Cell

FBS                            Feotal Bovine Serum

FDA                            Food and Drug Administration

GHG                            Greenhouse Gas

GMO                            Genetically Modified Organism

HACCP                          Hazard Analysis and Critical Control Points

ICoMST                        International Congress of Meat Science and Technology

IIUM                          International Islamic University Malaysia

JAKIM                          Department of Islamic Development Malaysia

NCBA                          National Cattlemen's Beef Association

UKM                            University Kebangsaan Malaysia

UM                            University of Malaya

UTAR                          University Tunku Abdul Rahman

USCA                          United States Cattlemen's Association

USDA                          United States Department of Agriculture

# LIST OF APPENDICES

PREFACE

We are undergraduates pursuing Bachelor of International Business (HONS) at University Tunku Abdul Rahman. We are required to conduct a final year project in our last year of study; therefore, we have come out with this research titled "Feasibility of Introducing Lab-grown Meat in Malaysia". The reason for conducting this research was because it is a brand new concept to Malaysians whereby limited research was conducted in Malaysia to provide understanding about lab-grown meat. Also, currently, there is no research conducted to determine the perception of Malaysians towards lab-grown meat. In this research, a deep insight about lab-grown meat is discussed to provide a clearer picture of the concept of lab-grown meat as well as the potential impact that it could bring to the world.

Our research includes the following components:

- Chapter 1: Research Overview
- Chapter 2: Literature Review
- Chapter 3: Research Methodology
- Chapter 4: Qualitative Data Analysis
- Chapter 5: Discussion, Conclusion, and Recommendation

ABSTRACT

In the near future, the meat industry might not be able to respond to the increasing world meat demand which might cause conventional meat a luxury. Besides, the current meat production has raised some issues in terms of environmental sustainability, animal welfare, and human health. In response, several alternatives such as plant-based meat and genetically modified meat have been introduced to the market to satisfy the meat demand. The newest food technology, lab-grown meat is meat produced in laboratories without raising and slaughtering animals addressing the issues associated with conventional meat production. The production involves growing cells in the cell-culture using various tissue-engineering techniques. It is known to be potentially more environmentally friendly, animal-friendly, and healthier compared to conventional meat. Since lab-grown meat is still a relatively new concept to the world, more extensive research has to be done to determine the perceptions of potential consumers towards lab-grown meat. As most of the Malaysians are not yet exposed to this concept, qualitative research method is used to initiate this study to determine the feasibility of introducing lab-grown meat in Malaysia. Five experts were chosen to participate in the interview sessions. Plenty of challenges such as lack of awareness among Malaysians about lab-grown meat, the cost of production, the readiness of Malaysians to accept lab-grown meat, and religious issues have to be overcome before it becomes feasible to be introduced in Malaysia. The government agencies have to take proactive actions to create awareness among Malaysians about lab-grown meat when they are more ready to accept this concept in the near future. The findings of this research could serve as a foundation for future researchers to conduct further research on this topic and to further determine the perceptions of Malaysians towards lab-grown meat in the future.

# CHAPTER 1: RESEARCH OVERVIEW

## 1.0   Introduction

As the world's population is increasing rapidly, it is essential to ensure there is enough food to feed the global population. Recently, the advancement in food technology has generated the interest of the scientists, nutritionists, engineers and other stakeholders to innovate lab-grown meat which mimics the taste of real meat to satisfy the global meat consumption. This research aims to determine the feasibility of introducing lab-grown meat in Malaysia by investigating the concept of lab-grown food, the impacts as well as the challenges associated with lab-grown meat.

In this chapter, an introduction to this topic will be presented in the research background, followed by highlighted issues in the problem statement. Research questions that guide the research arguments and the research objectives will be stated. Then, the significance of this study will be discussed. This is then followed by the chapter layouts and a summary of this chapter.

## 1.1   Research Background

Agriculture has evolved dramatically over the past few decades. The advancement in technology has transformed the agriculture system to become more scientific, effective, and efficient. The rapid increase of global population has significantly increased the global meat production and consumption. According to Ritchie and Roser (2017), as a global average, a person can consume approximately 43 kilograms of meat in 2014, which is an increase of around 20 kilograms since 1961. The global meat production has been increasing fivefold since 1961. The increasing demand for meat may be due to global population growth, rising income level, economic growth,

and many other factors. To satisfy the global demand, animals are reared and produced at the optimum level without concerning the animals' welfare. Therefore, bioscience and agricultural innovation has created opportunities to overcome the enormous challenge to the sustainability of meat production.

Traditionally, human produces meat through growing animals, feeding, and slaughtering them for consumption to gain essential nutrients for human's health. Obviously, the traditional method of harvesting meat will not be able to feed the global population in the future. There are various meat substitutes available in the market, such as tofu and beans, which aim to reduce the meat supply. With new technological developments, lab-grown meat is now one of the innovations where meat is produced in laboratories without slaughtering animals while providing the same or additional nutrient benefits compared to conventional meat at the same time. The adoption of lab-grown meat has both its pros and cons. Therefore, it is important to look into the impacts before the innovation become locked in.

Currently, several companies are working on commercialising lab-grown meat. The major players are Mosa Meat and Meatable from the Netherlands, Memphis Meats and Just Inc from the United States (US), Higher Steaks from the United Kingdom (UK), SuperMeat and Aleph Farms from Israel, and Integriculture from Japan (Watson, 2018; Knowles, 2019). Shiok Meats was founded in 2018 and was the first player in Southeast Asia. The co-founder, Dr. Sriram stated that lab-grown meat companies in Asia do not have more capitals in terms of funding and infrastructure compared to the other countries (Lamb, 2019). Unlike Asia companies, Memphis Meats had received funding of $17 million from companies such as Cargill, Tyson Food, and billionaires such as Bill Gates. Besides, China announced that it would purchase lab-grown meat by signing a $300 million deal with the companies from Israel ("Meet 7 Startups Creating Lab-Grown Meat", 2017).

Indeed, many researchers and studies often show that lab-grown meat solves the crisis of satisfying global meat consumption, saves the environment and the well-

being of animals, and makes people healthier. However, it could have a great negative impact on the food industry in general. The production of lab-grown meat will cause significant changes in the national economies and employment patterns, affecting the markets of import and export and the need to redraw the policies of countries. The food security policies are critical as it directly shows whether the government agencies encourage or discourage the consumption of lab-grown food (Mattick and Allenby, 2012).

## 1.2    Problem Statement

Cellular agriculture is a technology mainly used for food applications. This technology has revolutionised the supply chain of agricultural products to continually provide sustainable food to the growing global population (Khanna, Pawan, Deshpande, Tiwary, and, Sharma, 2018).

There are still limitations in producing lab-grown meat. Growing lab-grown meat can be costly and timely. This can be seen from the project of Professor Mark Post, where it took years and a huge amount of money to create the first hamburger (Fountain, 2013). One of the factors that contribute to the high cost of lab-grown meat production is the pricey nutrient mix used in the growing process. The mix contains animal serum known as Foetal Bovine Serum (FBS), which is harvested from the blood of foetuses of cows. This causes the foetus to die during the extraction process (McCarthy, 2018). According to Reynolds (2018), it costs between \$400 and \$900 for one litre of FBS, and it is estimated that 50 litres of serum are needed to create a beef hamburger.

Besides, introducing and convincing people to turn away from consuming traditional meat from animals is another problem. As the concept is still new to the world, many people may not be aware of lab-grown meat. Though it is a "meat" produced from the cells, people may not be ready to accept the idea. Thus, it is

difficult for scientists and producers to predict the response of people towards lab-grown meat. Additionally, people could react differently to lab-grown meat due to their perspective, experiences, culture and values. For example, there will be debates on whether lab-grown meat is considered Halal and are Muslims allowed to consume it.

Lab-grown meat involves producing meat without killing animals. There are still a lot of unknowns that will affect various aspects around the world. The concerns of lab-grown food are in terms of environmental, regulatory, animal welfare, and human's health. According to Mattick, Landis, Allenby and Genovese (2015), lab-grown meat might help in saving the environment, but the energy input could be the same as the animal-based meat. Moreover, the health-consciousness of the public encourages them to understand how lab-grown meat is produced to ensure it is safe for consumption.

In short, this research seeks to discover what lab-grown meat is and to identify the possible impacts of lab-grown meat before it is realised. Some challenges associated with lab-grown meat will also be highlighted in this paper so that it can be effectively managed when it is commercially available.

## 1.3   Research Objectives

This research aims to investigate the feasibility of introducing lab-grown meat in Malaysia. Following this, the specific key objectives are derived:

RO 1:   To understand the concept of lab-grown meat.

RO 2:   To understand the perceptions of the global community towards lab-grown meat.

RO 3:   To determine the impact of lab-grown meat towards meat industry.

RO 4:   To determine the potential benefits of lab-grown meat.

RO 5:   To determine the potential challenges associated with lab-grown meat.

RO 6:   To recommend solutions to curb the negative perceptions of lab-grown meat.

## 1.4   Research Questions

Based on the research objectives, the research questions (RQ) to be addressed are as follows:

RQ 1:   What is lab-grown meat?

RQ 2:   How does the global community view lab-grown meat?

RQ 3:   How does lab-grown meat affect the meat industry?

RQ 4:   What are the potential benefits of lab-grown meat?

RQ 5:   What are the potential challenges associated with lab-grown meat?

RQ 6:   What are the recommendations to curb the negative perceptions of lab-grown meat?

# 1.5   Significance of Study

A variety of studies have been done to determine the adoption of global community towards lab-grown meat. These studies are mainly focused on explaining the concept of lab-grown meat and investigating the willingness of the people in certain countries such as the US and the UK to try lab-grown meat. However, studies to gauge the perception of people from Islamic countries such as Malaysia are limited. Taking into consideration that the Halal issue is significant in these countries; this study also aims to examine how Malaysians view lab-grown meat as our diet in the future.

The findings of this study provide substantial insight into the fields of food technology, environmental studies as well as business. The information enables food manufacturers and investors to have precise preparation for their activities and investments on lab-grown meat. Investors can grab opportunities to invest in lab-grown meat production to meet the demand for meat shortly. The investment could bring a considerable profit to the first movers as this innovation is relatively new to the market.

Moreover, this study would also benefit the government agencies and policymakers by suggesting them the explanatory variables in regulating lab-grown meat. The government should take proactive actions by imposing more regulations to ensure lab-grown meat will not negatively affect the economy of the country. Laws and regulations may be one of the ways to control the demand of lab-grown meat that may replace the traditional livestock industry. Besides, government agencies have to ensure the quality of lab-grown meat is safe enough to be accepted and consumed by the public.

This study also contributes to future researchers who are interested to further study this topic. The content presented may serve as a reference in conducting new research or testing the validity of introducing lab-grown meat in Malaysia in the future.

In summary, this research enables the community to have a better picture of how lab-grown meat is produced and the potential impacts of lab-grown meat if it is to be commercialised.

## 1.6  Chapter Layouts

This research will be outlined in five chapters:

**Chapter 1:**  This chapter provides an overview of the study by emphasising the relevance of the research topic, the relevant objectives and the questions to be addressed.

**Chapter 2:**  This chapter reviews the prior empirical studies on lab-grown meat. All the past researches from journals, articles, and information collected from websites are considered as secondary data.

**Chapter 3:**  This chapter describes the qualitative research methodology used to carry out this research. The respondents and the sources of data are presented.

**Chapter 4:**  This chapter presents the analysis of data collected from interviewing the professionals related to this topic.

**Chapter 5:**  This chapter concludes the topic and answers the research questions mentioned in this study. Also, recommendations for further studies are provided.

## 1.7   Conclusion

In view of the fact, global meat production may not be sufficient to feed the growing world's population. Therefore, lab-grown meat will be a substitute that may become one of human's diet. It is therefore important to understand the acceptance level of the global community, especially Malaysians towards lab-grown meat. Besides, concerns on the impacts of lab-grown meat have become increasingly significant whereby each party needs to know how lab-grown meat will affect the market and our lives. This chapter aims to provide a foundation for this topic so that readers have a better understanding of the following chapters.

# CHAPTER 2: LITERATURE REVIEW

## 2.0    Cellular Agriculture

Cellular agriculture is an emerging field that involves producing agricultural products from cell culture in laboratories. It poses opportunities to improve animal welfare, environment, and human health, provided if people understand the technology and guide its development (Mattick, 2018). Lab-grown meat is one of the applications of cellular agriculture.

It is firstly important to distinguish lab-grown meat from genetically modified organisms (GMOs) and plant-based meat. GMO is defined as alterations of DNA which do not naturally occur in an organism (Zhang, Wohlhueter, and Zhang, 2016). It involves combining and changing genes from different organisms by using DNA technology (Bawa and Anilakumar, 2013). According to Mosa Meat (2018) and Takhar (2018), the process of producing lab-grown meat does not involve genetic modification as the cells act normally as if they are still inside the animals; therefore it is unnecessary to re-program the cells.

On the other hand, plant-based meat, which aims to mimic the taste of real meat, is already commercially available in the market. Ingredients such as soy protein, mushroom, and wheat gluten are mainly used to produce the meat. It is believed that plant-based meat contains higher protein level compared to meat (Kumar, Chatli, Mehta, Singh, Malav, and Verma, 2017). Beyond Burger is one of the examples of plant-based meat wherein the burger is mainly made of ingredients like pea protein, oils, and potato starch. Beet juice extract is used in the beef patty to make the appearance "meat-like" ("The Beyond Burger", 2018).

## 2.1   Lab-grown Meat

According to Ireland (2017), lab-grown meat is also referred to as cultured meat, artificial meat, synthetic meat, *in-vitro* meat, or clean meat. The name of this meat remains contested, but the scientists preferred "*in vitro* meat" as it sounds more scientifically accurate (Stephens and Lewis, 2017). A survey by Consumer Reports reported that 35% of consumers chose the term "lab-grown meat" as it is clearly labelled and understandable (McCauley, 2018). The term "clean meat" is used because it was reportedly cleaner than conventional meat in terms of environmental friendliness and animal welfare (Cassiday, 2018).

Stephens (2010) argued that the definition of lab-grown meat remains unclear and has no ontological meaning. Lab-grown meat production involves growing tissues and cells in cell-culture through various tissue-engineering technologies in laboratories, instead of slaughtering live animals (Post, 2012). To manufacture lab-grown meat, animal cells are extracted from live animals and are raised in a culture medium to undergo proliferation. Then, the cells are induced to differentiate into myofibrils and muscles tissues, where the dominant constituent of the meat are formed (Schaefer, 2018).

A research program on lab-grown meat was initiated by Willem van Eelen who applied for a patent on the idea in the year 1999. In 2002, NASA funded a project led by Morris Benjaminson in experimenting lab-grown goldfish, which aimed to find an alternative way to provide food for the astronauts. In 2004, New Harvest, a non-profit organisation who concentrates on lab-grown meat as a future promise, carried out a four-year research project in the Netherlands led by Professor Mark Post in Eindhoven University in the year 2009 (Leersum, Luyt, Versluijs, and Vlachos, 2014).

In August 2013, the first lab-grown hamburger was served by Professor Post in a taste-test event held at University of Maastricht, London. The research was

supported by the Google co-founder, Sergey Brin's family foundation. The event was attended by 200 journalists worldwide. The first tasters, Professor Mark Post, a journalist Josh Schonwald, and a nutritional researcher Hanni Rützler (Datar, 2015) commented that the hamburger was similar to a real meat with a good bite and intense taste but not as juicy, probably due to the absence of fat. Professor Mark Post was satisfied with the hamburger as it met with his expectations. It had taken several years and $330,000 to create the small patty (141g) (Leersum et al., 2014).

The hamburger images together with decisive moments in the history of lab-grown meat have created a frame on what lab-grown meat is and what it can do. Through this, perhaps lab-grown meat is considered as an ontological object which serves as a referencing point to support the definition of lab-grown meat. However, a culturally accepted ontological definition of lab-grown meat is remaining unknown (Stephens and Ruivenkamp, 2016).

## 2.2 Techniques of Production

According to Arshad, Javed, Sohaib, Saeed, Imran, and Amjad (2017), lab-grown meat must have similar physical characteristics such as appearance and texture to conventional meat. Therefore, different techniques have been tested to develop meat-like products.

### 2.2.1 Scaffold-based Technique

In this technique, Embryonic Stem Cells (ESCs) or adult stem cells (ASCs) are extracted from the farm animals and are attached to a scaffold made of collagen meshwork. Then, it spreads over a culture medium in a rotating or stationary bioreactor, enabling the cells to grow inside. The culture medium

contains serum known as FBS which additionally provides 5-20% nutrients concentration in the medium (Arshad et al., 2017). Under various environmental cues, the cells fuse into myotubes and differentiate into myofibers that may be cooked and consumed as meat. However, this technique only works for growing processed meats with soft consistency like sausage but is unable to produce highly structured meat such as steaks (Bhat and Bhat, 2011). Figure 2.1 shows the scaffold-based technique.

Figure 2.1: Scaffold-based technique
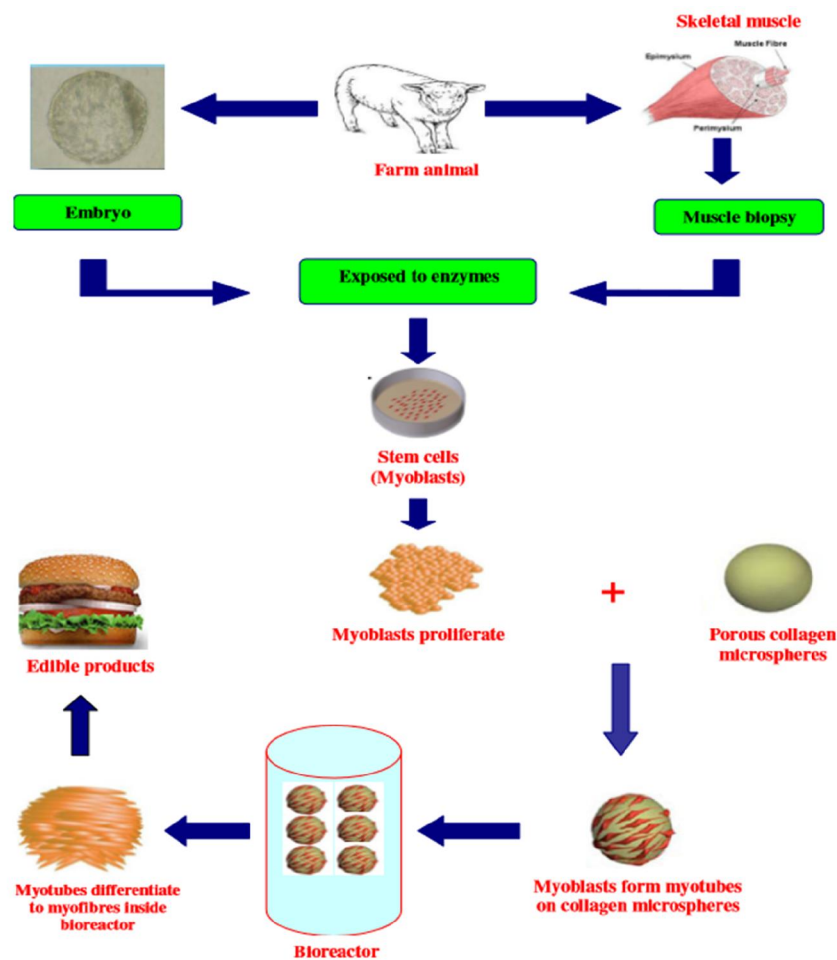


Source: Bhat, Z.F., & Fayaz, H. (2011). *Prospectus of cultured meat-advancing meat alternatives.* Journal of Food Science Technology, 48(2), 125-140.

### 2.2.2 Self-organizing Technique

In this technique, explanted animal tissues are proliferated hydroponically to produce highly structured meats (Kumar, Berwal, Pandey, Sharma, and Sharma, 2017). The explants contain closely resembled tissues that build up the muscle in the right proportions and provide a three-dimensional structure which makes the meat looks like the conventional meat (Suresh, 2018). However, lack of blood circulation in these explants prohibits the substantial growth of the cells. Therefore, it is impossible to produce large, highly structured meats without vascularization (Noor, Radhakrishnan, and Hussain, 2016).

## 2.3 Lab-grown meat – The Global and Malaysians' Perspectives

As lab-grown meat will soon be commercialised, it is important to understand the attitude of the global community and Malaysians towards lab-grown meat. Attitude is defined as a mental state, value, belief, or feeling, and an intention to act (Altmann, 2008).

### 2.3.1 The Global Perspective

A survey on the attitude of potential consumers towards lab-grown meat was conducted in the US. Based on the results, almost two-thirds of the participants would like to try lab-grown meat, but only one-third of them would be willing to consume it regularly. They viewed this production as ethical by agreeing that lab-grown meat possesses numerous positive impacts like improving animal welfare and reducing global warming associated with conventional meat production (Wilks and Phillips, 2017). However, over 800

online news comments were analysed and concluded that the Americans would not accept lab-grown meat, probably due to their perception of lab-grown meat as an unnatural product (Laestadius and Caldwell, 2015).

Besides, a quantitative study conducted in Flanders shown that 23.9% of participants wanted to try lab-grown meat before receiving additional information on its benefits, but it increased to 42.5% after additional information was given. They believed lab-grown meat would be ethical, safe, and nutritious to be consumed. Also, the participants viewed lab-grown meat as an alternative to replace conventional meat due to its sustainability and effectiveness. However, a small number of participants opposed lab-grown meat (Verbeke, Sans, and Loo, 2015).

Furthermore, a focus group study was conducted in Belgium, Portugal, and the UK. The participants initially felt disgusted towards lab-grown meat and expressed their reluctance to consume this product. However, after watching a video provided, some were curious about the taste of lab-grown meat and results have shown that two out of three participants would like to give it a try. From the study, the Belgium participants were most interested in trying lab-grown meat, while the UK participants shown the strongest objection to this product (Verbeke, Marcu, Rutsaert, Gaspar, Seibt, Fletcher, and Barnett, 2015).

## 2.3.2 The Malaysians' Perspective

Malaysia has yet to invest in this technology. Thus, the perception of Malaysians towards lab-grown meat remains unknown. Malaysia is a diverse country where the main ethnic groups consist of Malays, Chinese, and Indians. According to the Department of Statistics Malaysia (2018), 69.1% of the citizens are Malays. Therefore, it is important to consider whether lab-grown

meat is considered *halal*. The production of lab-grown meat involves the use of ESCs, ASCs, and serum as nutrients to grow the cells. According to Hamdan, Post, Ramli, and Mustafa (2017), lab-grown meat is considered clean and *halal* if ESCs and ASCs were harvested from the slaughtered animals but considered unclean otherwise. The mother must be slaughtered before the embryos can be slaughtered. However, collecting ASCs from marine animals when they are still alive is considered permissible.

FBS extracted from animal blood is considered unclean as blood is forbidden to be consumed in Islamic law. To make the meat clean and edible, serum has to undergo the *istihalah* process before it turns into meat. However, it is *halal* if the serum is replaced with the mushroom extract as mushrooms are considered as clean ingredients (Hamdan et al., 2017). In brief, lab-grown meat is considered *halal* as long as it was produced with the animal cells that are allowed to be eaten, and the cells and serum were processed according to Islamic law.

## 2.4 Potential Positive Impact of Lab-Grown Meat

### 2.4.1 Environmental Impact

The livestock sector has become the largest user of land and water in the world. Also, it is one of the major contributors to greenhouse gas (GHG) emission (FAO, 2018a). Thus, lab-grown meat is an alternative to overcome the problem of natural resource scarcity and to avoid the worst effects of climate change. Lab-grown meat production is more environmentally friendly than conventional meat production as it would lower the carbon footprint, probably methane emission (Alexander, 2011). Moreover, lab-grown meat production would reduce carbon dioxide emissions as it would be produced domestically whereby no transportation is needed to export the product (Ford, 2011).

A life cycle assessment was conducted to analyse energy use, GHG emission, and land use in lab-grown meat production. By using cyanobacteria as a source of nutrient, there were 7% to 45% less energy use, 78% to 96% lower GHG emission, 99% lower land use and 82% to 96% lower water use in lab-grown meat production compared to conventional meat production (Tuomisto and Teixeira de Mattos, 2011). Cyanobacteria contains up to 70% of dry weight protein which provides nutrients and energy to the cells (Ford, 2011). According to Tuomisto and Roy (2012), the GHG emission, land use, and water use would be lowered by 98.8%, 99.7%, and 94% respectively compared to current meat production if the European Union-27 replaces all meat produced with lab-grown meat. These figures show that there is a significant reduction in GHG emission. The decrease in land use may be used for other purposes such as reforestation.

A more recent study found that less land is required to produce lab-grown meat but at the expense of more energy. Lab-grown meat has a higher

global warming potential than conventional poultry but lower than beef. 35% higher energy is required for the production compared to traditional techniques used to produce the same quantity of meat. This is because bioreactors are used to regulate temperature as how the skin of animals does so. Also, to prevent the growth of pathogens, all the equipment must be sterilised as how the immune system of the animals destroys pathogens (Mattick et al., 2015). All these processes have contributed to the greater use of industrial energy for lab-grown meat production.

## 2.4.2 Animal welfare

As the global demand for meat increases, farmers strive to make meat production more efficient, at the expense of the well-being of animals. Animals are poorly treated in the factory farm without having enough space for movement, being handled roughly, and suffering from multiple forms of injuries (Sharma, Thind, and Kaur, 2015). Thus, people view animal welfare as a serious concern. A conviction to animal rights is a major reason why some people become vegetarians (Lund, McKeegan, Cribbin, and Sandøe, 2016). Lab-grown meat offers great hope to reduce animal suffering (Weele and Driessen, 2013). Perhaps it would be an alternative option for meat-lovers who are concerned about animal welfare.

The idea of lab-grown meat is generally favoured by the animal welfare group and animal organizations. They view lab-grown meat as "victimless meat" because the production does not involve animal suffering and animal death, but only removing cells from the donor painlessly and culturing it in mediums (Bhat, Kumar, and Fayaz, 2015). The process of harvesting cells from animals takes only a few minutes with minimal harm (Jochems, van der Valk, Stafleu, and Baumans, 2002). Theoretically, the world's meat demand can be satisfied with a single farm animal, therefore,

improving animal welfare by reducing the killing of animals (Bhat and Fayaz, 2010). According to Cassiday (2018), people who take vegetarian diet due to ethical reasons will be able to enjoy lab-grown meat without feeling guilty.

On the other hand, some argued that lab-grown meat production might threaten the relationship of human with nature. According to Schaefer and Savulescu (2014), some animals exist for human consumption. The production of lab-grown meat would destroy the natural food chain. This perception hinders the idea of improving animal welfare. In brief, human is meat eaters, lab-grown meat allows human to enjoy meat while reducing the suffering and killing of animals.

### 2.4.3 Health Impact and Food Safety

Human nowadays are getting more health-conscious. Diseases such as swine influenza raised from intensive farming and foodborne pathogens such as *Norovirus* and *Salmonella* found in meat have caused millions of infection in the US (Bonny, Gardner, Pethick, and Hocquette, 2015; Centers for Disease Control and Prevention, 2018). Besides, over-consumption of meat poses a higher risk of obesity, diabetes, cardiovascular disease (CVD) and other related health problems (Bellavia, Stilling, and Wolk, 2016). Today, antibiotics are widely used as growth promoters to stimulate animal tissue growth. This practice has become one of the most significant risks posed to human health (Rorheim, Mannino, Baumann, and Caviola, 2016). Lab-grown meat production is claimed to be safer and healthier for human consumption (Cassiday, 2018).

Lab-grown meat production allows better human control over the nutrient composition of meat (Bhat, Kumar, and Bhat, 2017). To compete in the meat industry, lab-grown meat has to meet or exceed the nutritional value

of conventional meat. Nutrients such as vitamins and minerals can be added in the culture medium to promote health benefit (Kadim, Mahgoub, Baqir, Faye, and Purchas, 2015). Besides, saturated fats can be removed from lab-grown meat and replaced with omega-3 fatty acids, for instance, to make the product more nutritious and healthier (Sivasudhan, 2016) which can then lower the risk of obesity.

Furthermore, lab-grown meat is produced in a sterile environment where human health and food safety could be guaranteed. The production process limits the interaction between human and animals, reducing the risks of diseases (Bonny et al., 2015). Through a strictly controlled environment, foodborne pathogens could be greatly removed from lab-grown meat. The sterile production process also prevents the exposure of meat to risky products such as pesticides, which prevent the meat from antibiotics and bacteria contamination (Kadim et al., 2015; Schwartz, 2016).

According to Post and Hocquette (2017), cancerous cells could be developed during the process. They are harmless to human health as they are dead after the meat is cooked or the human digestive system would kill them if they are still alive. Also, lab-grown meat does not require the use of antibiotics and hormones to promote growth as the cells could multiply themselves near-indefinitely (Takhar, 2018). Both Mosa Meat and Memphis Meats claimed that antibiotics and growth-promoting hormones are not required for the production due to the sterile lab process (Zaraska, 2016). In short, lab-grown meat production would help to overcome the impact of current livestock production in terms of human health and food safety.

## 2.5 Dark Sides of Lab-Grown Meat

### 2.5.1 Foetal Bovine Serum

The process of culturing cells always involves the use of FBS as nutrients to promote cell growth and transport protein. FBS is a universal growth medium which they effectively promote growth in both human and animal cells (Gstraunthaler, 2003; Thieme, 2017). There are around one million of foetuses being killed to harvest 500,000 litres of FBS (Ahmed, Rabie, Helmy, and Ibrahim, 2018). Thus, more foetuses will be killed if a large amount of FBS is required for lab-grown meat production.

According to Condon (2018), pregnant cows are killed and foetuses are being removed from the uterus to obtain foetal blood from the heart using cardiac puncture to prevent contaminations of serum. Ethical issues are raised as the foetuses are still alive and may suffer from pain during the blood collection process, leading to death due to lack of oxygen. FBS has to be replaced with serum-free formulation if the purpose of lab-grown meat is to reduce animal cruelty.

### 2.5.2 Cannibalism

The idea of lab-grown meat does not only alter the method of meat production but also broaden the type of meat that can be produced in laboratories. Cannibalism is defined as the practice of human consuming another human (Kale, 2015). The process involves producing human flesh through cell culture for consumption, which is deemed disrespectful to the value and dignity of humanity. According to Milburn (2016), this idea should be permitted as human flesh production will not involve any human suffering or death. Also, human should not view themselves as uniquely dignified. This

idea was supported by Mordanicus (2013) stated that cultured human flesh would not be wrong if there are people who voluntarily donate cells for the production without involving any death during the process. However, this idea is morally wrong. A disease called *kuru* caused by the consumption of human flesh would lead to degenerative nerve diseases and causing human death (Ellington, 2011).

### 2.5.3 Economics

According to FAO (2018b), there are at least 1.3 billion people engage in livestock sector globally. It is an indispensable income source for approximately 600 million poorest households in the world. The production of lab-grown meat would bring monumental changes in the livestock sector, perhaps replacing the traditional livestock production (Hultin, 2017). If lab-grown meat could be produced in bulk with lower costs than conventional meat, the public and the fast food outlets would choose lab-grown meat for their menu (Deavoll, 2017). This would cause the farmers to lose their jobs and eventually affects their livelihoods ("The pros and cons of lab-grown meat", 2018). However, Schaefer and Savulescu (2014) argued that lab-grown meat would not entirely replace traditional farming as there will always be niche markets for conventional meat.

Many farmers from poor countries are struggling to survive and trying to lift out of poverty. However, unfair trade causes the farmers to receive only a small proportion of revenues from the food that we pay for. People believe that this unfair system is manipulated by large companies. Therefore, if lab-grown meat is to be commercialised, it would be monopolised by powerful firms from the Western countries. This is similar to the case of GMO production whereby it was mainly in the hands of multinational food

companies, which after all further widen the gap between the rich and poor countries (Hocquette, 2016).

Today, the meat industry has become a complex international business which involves farming and feeding, as well as meat intermediaries such as production centres, slaughterhouses, warehouses, and logistics ("Our Meatless Future: How the $90B Global Meat Market Gets Disrupted", 2019). Lab-grown meat would threaten the value chain if meat could be produced domestically in the laboratory without exporting to the other countries. This would especially impact the major meat exporters such as Canada, New Zealand, and the US (Mattick and Allenby, 2012). Less or even no intermediaries and transportations would be involved in the supply chain, which will eventually affect the economics of the countries in general.

## 2.6    Challenges of Lab-grown meat

### 2.6.1  Regulation

Lab-grown meat is in the developmental phase where the regulatory framework and the labelling of lab-grown meat remain unclear. The public relies on the professionalism of the US Department of Agriculture (USDA) and Food and Drug Administration (FDA) to assure the food supply is clearly labelled, safe, and healthy (Green, 2018).

Penn (2018) stated that a generalised petition could be created and the day-to-day regulations could be left to USDA as it already has a system, i.e. Hazard Analysis and Critical Control Points (HACCP), for inspection of meat to ensure the safety of lab-grown meat. However, due to the expertise in regulating new food technologies, especially cell-culture technology and living bio-systems, some argued that FDA would be the best agency to regulate lab-grown meat (Greene and Angadjivand, 2018). In November 2018, both FDA and USDA held a public meeting to discuss lab-grown meat, whereby both agencies announced to jointly regulate lab-grown meat. FDA is responsible for the collection, banking, growth and differentiation of cells, while USDA is responsible for the production and labelling of lab-grown meat. However, there is still a lack of regulatory framework for the marketing of lab-grown meat (Osborne, 2018).

The stakeholders' question whether lab-grown meat should be labelled as "meat". According to Boler and Woerner (2017), American Meat Science Association (AMSA) views meat as the skeletal muscles and tissues originated from the animals for human consumption. Although lab-grown meat is an animal-based protein, it is not derived naturally from animals. Thus, it does not currently meet the definition of meat defined by AMSA. Besides, the US Cattlemen's Association (USCA) has filed a petition requesting that

lab-grown meat should not be labelled as "meat" as it is not traditionally harvested from animals. However, the National Cattlemen's Beef Association (NCBA) argued that lab-grown meat meets the definition of meat (Garfield, 2018).

The labelling of lab-grown meat is contentious. Consumers want the regulations of lab-grown meat labelling, marketing, and information to be transparent so that they will not consume lab-grown meat without their knowledge and also to ensure lab-grown meat is safe to be consumed (Bryant and Barnett, 2018). Thus, the FDA and USDA have to ensure the labelling is truthful and not misleading (Greene and Angadjivand, 2018). Regulation is a tool to build public trust and acceptance towards lab-grown meat (Laestadius and Caldwell, 2015).

## 2.6.2 Public Acceptance

Public acceptance is a critical determinant of successful new technology commercialisation. The public might not accept lab-grown meat as they perceive it as an "unnatural" product, and therefore is unhealthy and dangerous. The concept of unnaturalness has become a large resistant for European to accept new food technologies (Welin, 2013). According to Marcu et al. (2015), "natural vs artificial" is one of the considerations for the participants to take lab-grown meat relative to conventional meat. However, debates arise concerning this perception is dubious: something natural could be bad, or something unnatural could be good (Rorheim et al., 2016).

According to Hopkins and Dacey (2008), nature is indefinable. Something natural does not mean good for the human. Although lab-grown meat is human-made, it could be healthier than conventional meat, depending on the substance of meat. The brief discussion was ended by stating that it is

the alleged "unnaturalness" that makes lab-grown meat attractive as it might be superior to what nature gives to human. However, the argument on the naturalness of lab-grown meat does not solve the issue on the value of lab-grown meat (Welin, 2013).

The perceived naturalness and evoked disgust may, directly and indirectly, influence the public acceptance on lab-grown meat (Siegrist, Sütterlin, and Hartmann, 2018). The "yuck factor" is described as the feeling of people towards the idea of lab-grown meat. People do not like the idea of associating technology with food (Goodwin and Shoulders, 2013). Upon learning about lab-grown meat, the initial reactions of people were disgust and fear as they are concerned about the safety of meat and healthiness (Cassiday, 2018). Besides, people do not see personal benefits but global society benefits that lab-grown meat could bring (Post and Hocquette, 2017). According to Hopkins and Dacey (2008), such reaction does not pose as much on people who have experience in and knowledge of the production of conventional meat. Furthermore, the "yuck factor" might diminish after people were exposed to the culturing process.

### 2.6.3 Cost

The relatively high cost of lab-grown meat production is one of the main potential challenges in marketing lab-grown meat. When the consumption rate is proportional to the production rate, this challenge could be resolved due to the economies of scale (Gaydhane et al., 2018). However, a lack of investigation into large-scale lab-grown meat production has hindered the capability to produce lab-grown meat at a rate comparable to the conventional meat (Datar and Betti, 2010). One should be noted that the current average price of meat is artificially low as the government has provides subsidies for the agribusinesses (Rorheim et al., 2016). Therefore, the production of lab-

grown meat on an industrial scale could be feasible if it is supported by the governmental subsidisation (Bhat, Kumar, and Fayaz, 2014).

## 2.7    Conclusion

In short, lab-grown meat could bring both potential positive and negative impacts on mankind. If lab-grown meat is being successfully commercialised, the people, animals, and the environment will be benefited from this food technology. However, more realistic and reliable impacts have to be investigated after lab-grown meat is commercialised and is produced on a larger scale (Welin, 2013). Moreover, the challenges associated with lab-grown meat have to be overcome before it can be introduced into the market.

# CHAPTER 3: METHODOLOGY

## 3.0   Introduction

Lab-grown meat is still new to the world that there is limited knowledge about this food among the public. To initiate this research, a qualitative research method is used to discover the feasibility of introducing lab-grown meat in Malaysia. Interviews were conducted to several professionals and lecturers in this field to have a better understanding of this research topic. The face-to-face interview provides an opportunity for both the interviewer and interviewee to interact verbally and at the same time to observe the non-verbal cues which also illustrate meanings (Hofisi, Hofisi, and Mago, 2014).

The data collection process involved two interviewees from University Kebangsaan Malaysia (UKM), one interviewee from University of Malaya (UM), International Islamic University Malaysia (IIUM), and University Tunku Abdul Rahman (UTAR) respectively. As face-to-face interview is costly and time-consuming (Adhabi and Anozie, 2017), only a total of five knowledgeable interviewees were invited to obtain valuable input for this research. It took one month for the researchers to complete the data collecting process.

## 3.1   Research Design

According to Bhat (n.d.), exploratory design is referred to a form of research used to examine a problem which is not specifically defined. The intention of exploratory research design is not to solve the research problems or to derive any conclusion. Exploratory design was applied in this research to clarify the nature of problem and to generate better understanding towards lab-grown meat through gaining initial insights.

Exploratory research can be conducted through various forms including literature research, case studies, focus groups, and interviews. In this research, exploratory research was performed by interviewing professionals and lecturers. The flexibility design of exploratory research provides the researchers with an opportunity to clarify the existing concepts of lab-grown meat and to gain professional opinions on the feasibility of introducing lab-grown meat in Malaysia.

## 3.2　Data Collection Method

### 3.2.1　Primary Data

Primary data can be obtained through observation, experiment, email, face-to-face interview, online interview, and focus group (Bhasin, 2018). The data of this research were primarily obtained from the experts and lecturers in this field. The method used was through semi-structured interview where the interviewees were given open-ended questions to respond. To ensure the data collected were captured effectively, the data were recorded through note taking and audiotape recording, provided if the interviewee allowed doing so. This ensures no key points were missed during the interview process, hence, enhance the quality of research.

### 3.2.2　Secondary Data

Secondary data of this research were obtained through previously published and unpublished research such as journals, magazines, books, and other reliable online sources. The relevant and significant points of reasoning were extracted to enhance the discussion of this topic further. Mainly, most of the journal articles were accessed through Google Scholars, ResearchGate and

ScienceDirect. Secondary data can be obtained more easily and inexpensively compared to primary data.

## 3.3    Sampling Design

### 3.3.1  Research Population

The research population for this research is the professionals and lecturers in Malaysia who have adequate knowledge of lab-grown meat. The reason being they possess the related knowledge, and so able to provide relevant and appropriate information and opinions for this research. Therefore, it increases the validity and quality of this research.

### 3.3.2  Sampling Frame and Sampling Location

As mentioned, professionals and lecturers who are equipped with sufficient knowledge regarding this topic were selected as the source of content. This research took place at four universities, i.e. UKM, UM, IIUM, and UTAR Sungai Long Campus.

### 3.3.3  Sampling Element

In this research, five interviewees from different universities werechosen for the interview. The interviewees are from different areas of expertise which may provide different perspectives to this topic. Prof. Dr. Abdul Salam Babji is one of the respondents from UKM who has knowledge of food technology and meat science. Also, Dr. Salawati Mat Basir from UKM is knowledgeable in the current trends of the industrial revolution. The other three respondents

are lecturers who have qualifications in the related field. Their identities are confidential as they prefer to provide their opinions anonymously.

## 3.3.4 Sampling Method

In general, sampling techniques can be classified into two categories which are probability sampling and non-probability sampling (Taherdoost, 2016). Purposive sampling, one of the techniques of non-probability sampling, is used to conduct this research. It requires the availability and willingness of individuals who are knowledgeable about the topic to participate in the research (Palinkas et al., 2016). The participants were sought based on their expertise to provide quality information for this topic. A pre-selected criterion of respondents was strictly designed to find the right interviewees for this research.

After an initial discussion, individuals having an understanding of lab-grown meat were the primary candidates. The criteria for sample selection are experts that have experience in the field of food science and technology, food law, and Islamic studies. Islamic studies are particularly important as it determines whether lab-grown meat can be consumed by Muslims in Malaysia. Only five respondents were chosen out of nine potential candidates to save time and costs. According to Taherdoost (2016), purposive sampling is subjective. The information provided by each interviewee was unique, meaningful and will serve as an invaluable input to this research.

### 3.3.5  Sampling Size

In Malaysia, there are a limited number of qualified experts in this field. Thus, only a total of five participants were selected to participate in the data collection process.

# 3.4  Research Instrument

The interviews were conducted using a semi-structured method. The purpose of using this method is because little is known about this research topic (Adams, 2016). It consists of several predetermined questions where the wording and the sequence of the questions can be modified during the data collection process (Abawi, 2014). Besides, this method allows both the interviewers and interviewees to discuss the topic in greater detail. The flexibility of this method allows the interviewees to have a great deal of ways in replying the interview questions (Hofisi, Hofisi, and Mago, 2014). Thus, the interviewees are encouraged to freely share their knowledge, experiences, and feelings regarding the study.

After forming the interview question, it was sent to the participants three days before the interview session. This enables the participants to prepare the information needed for the interview, which further enhances the quality of the data collected. The information collected were summarised and repeated to the interviewees to ensure the validity and reliability of data. The interview questionnaire is attached in Appendix 3.1.

# 3.5   Data Processing

Thematic analysis is a widely used data analysis strategy across qualitative research (Castleberry and Nolen, 2018). It involves identifying, analysing and reporting themes that help in organising the dataset in detail (Braun and Clarke, 2006). To generate an accurate thematic analysis, the data of this research were processed according to the following five steps.

**Step 1: Data familiarization**

During the interviews, raw data were written down, and voice recordings were done after the interviewees granted permission to record the conversation. The data collected were translated into words. After reading and familiarising with the data, the general ideas were noted down for further evaluation.

**Step 2: Coding**

Codes were assigned to the data collected. A code is referred to as a brief description of the data collected (Mortensen, 2019). Useful data were coded, and relevant data were segmented accordingly to each code. This helps to organise the data in a systemic way that makes the data interpreting process easier. Besides, the inappropriate and incomplete data collected from the interview were being filtered out in this phase.

**Step 3: Theme generating**

The codes were examined to identify potential themes. After several candidate themes were generated, the grouped data were collated to each candidate theme, enabling the researcher to review the viability of the themes. At the end of this phase, the themes will represent something specific about the research questions (Maguire and Delahunt, 2017).

## Step 4: Themes reviewing and themes naming

The themes were reviewed if they worked in relation to the codes. They will be modified if they are against the entire dataset or do not answer to the research question. After refining the theme, the informative name will be decided for each theme.

## Step 5: Generating report

The final step is to produce a written report on the data collected. After the final analysis was completed and themes were established, a report aimed to discuss the findings, evaluation, and interpretation of data was generated. In this phase, literature review was used to confirm the findings. The report helps the researchers to have a better understanding of this research topic.

# 3.6   Data Analysis

Thematic data analysis is applied as it is a useful approach to study different points of views of research participants, emphasising similarities and differences, and providing initial insights toward the research topic (Braun and Clarke, 2006). In this research, several themes were chosen to analyse the data collected from the interview and were recorded in the written report. The themes are as follow:

1. *Potential impact of lab-grown meat towards livestock or meat industry*
2. *Potential benefit of lab-grown meat*
3. *Potential risk of lab-grown meat*
4. *Potential challenges of lab-grown meat*
5. *Malaysians' readiness to accept lab-grown meat*
6. *Religion as a barrier to accept lab-grown meat*
7. *Knowledge equipped by and resources available for Malaysia to produce lab-grown meat*
8. *Law enforcement of lab-grown meat in Malaysia*
9. *Recommendation to curb Negative Perceptions*

These established themes enable the information collected to be organised accordingly. A written report was generated in the final step of data analysis through analysing and summarising the data collected. The report mainly focuses on presenting the information and opinions provided by the interviewees.

## 3.7   Conclusion

In short, this chapter focuses on the methodology used while conducting this study. Semi-structured interview was used to collect data. A total of five experts were involved in the interview and thematic data analysis method was applied to analyse the data collected. Furthermore, this chapter includes a detailed structure of research and sampling design, sampling technique, and research instrument.

# CHAPTER 4: QUALITATIVE DATA ANALYSIS

## 4.0    Introduction

In this chapter, the data collected from the five interviewees were analysed, interpreted and restructured according to the themes generated to provide a better presentation and understanding of the findings.

The points of views from different perspectives towards lab-grown meat were addressed. The identity of the interviewees will only be disclosed with the prior consent obtained from them. They are required to sign a consent letter provided (refer to appendix 4.1 and 4.2) if they agreed to reveal their identity in our project. Interviewees who do not wish to disclose their identity will be cited anonymously in the following section with appellation (Respondent A, Respondent B, and Respondent C).

## 4.1    Biography Data

Prof. Dr. Abdul Salam Babji is an experienced senior lecturer from the Faculty of Science and Technology of UKM. He is an expert in the field of food science and technology, especially in animal and meat science. He was one of the attendees of the International Congress of Meat Science and Technology (ICoMST) which gathers over 500 pure meat scientists from around the world. Lab-grown meat is one of the topics that have been discussed in the ICoMST.

Assoc. Prof. Dr. Salawati Mat Basir is a senior lecturer from the Faculty of Law of UKM. She has been attending interviews and giving talks on the fourth industrial revolution.

The other three interviewees who preferred to participate in the interview sessions will be anonymously addressed as Respondent A, Respondent B, and Respondent C.

## 4.2   Findings

The data collected were summarised and categorised into nine themes, with the original interview transcripts attached in the appendix (refer to appendix 4.3- 4.7).

**<u>Theme 1: Potential Impact of Lab-grown Meat towards Livestock or Meat Industry</u>**

Prof. Babji mentioned that lab-grown meat would further prosper the meat industry by supplying sufficient meat to satisfy the increasing world meat demand. According to Prof. Babji, Indonesians consume 3kg to 10kg of meat protein per person per year; Malaysians consume 50kg to 60kg of meat protein per person per year while the Americans consume 60kg to 70kg of meat protein per person per year. Therefore, lab-grown meat is an added value to the meat industry.

Dr. Salawati stated that it would have an impact on both industries by encouraging competition in the industry. To compete effectively, lab-grown meat must possess the competitive advantage over traditional meat for the well-being of people. Thus, research and development (R&D) has to be done by considering various factors such as social and economics.

Respondent A explained that the meat industry depends on the livestock industry, and hence would affect both industries. However, it still depends on the choice and demand of people.

Respondent B mentioned that the "yuck factor" in people towards lab-grown meat contributes to their decision of consuming conventional meat. There is still demand for conventional meat, and hence it would not affect both industries.

Respondent C believed that lab-grown meat is not going to impact the meat industry drastically as it is not a replacement but an alternative to conventional meat. He elaborated that every product has its own market which would not be greatly affected by its competitors or substitutions. He further explained that the production of lab-grown meat is not easy because it requires stringent nurturing conditions that might be very costly to implement or maintain.

## **Theme 2: Potential Benefit of Lab-grown Meat**

Prof. Babji believed that lab-grown meat would surely benefit the manufacturers or investors, especially scientists who have been experimenting lab-grown meat since 20 years ago. They are trying to market lab-grown meat mainly for business purposes but not to help people. According to Prof. Babji, the Americans will not eat lab-grown meat, but they will export it to countries like China and the Middle East for profit. He stated that the benefit of lab-grown meat towards human health in the long run still remains unknown as all the vitamins are synthetically produced.

Dr. Salawati explained that lab-grown meat would benefit the world in terms of economics. She described that anything that comes from the industry or innovation in the industry would improve the economics of the country. R&D is crucial for manufacturers to produce better products. Therefore, R&D has to be done to produce lab-grown meat to receive a higher return to prosper the nation.

Respondent A believed that lab-grown meat would help to satisfy the excessive world meat demand as it could be produced in bulk in a shorter period of time, leading to economies of scale.

According to Respondent B, lab-grown meat would help to overcome the shortage of world meat supply. The world meat demand is increasing due to the rising income level of the world population. Besides, comparing to traditional meat, a large

quantity of lab-grown meat could be produced with a shorter period. He also stated that lab-grown meat production requires less land and water consumption. Hence, it is more environmentally friendly. Moreover, the nutrient compositions of lab-grown meat could be controlled by adding more beneficial nutrients to the meat; thus improving human health.

Respondent C reckoned the on-going research on lab-grown meat would benefit the world in the long run. He explained that the increasing world population would lead to a shortage in meat supply, rendering conventional meat a luxury. He further stated that lab-grown meat would help in reducing the animal agricultural activities on a global scale, eventually reducing pollution. He also mentioned that lab-grown meat could reduce the risk of infectious diseases and thus improving human health.

## Theme 3: Potential Risk of Lab-grown Meat

Prof. Babji claimed that lab-grown meat could pose a health risk. The health impact of consuming lab-grown meat over a long period is yet to be proven. Although the beneficial nutrients can be added into lab-grown meat, there is still no human experiment conducted to compare the health effect of consuming lab-grown meat with the health effect of consuming normal meat over the years.

Dr. Salawati stated that the potential risk is that people may overeat lab-grown meat. If the price of lab-grown meat declines, people tend to purchase more, resulting in over-consumption. Therefore, the players in the industry should cooperate in minimising the risk. Although there is competition among the players, they can set an average market price for lab-grown meat to ensure no issues of over-consumption would arise.

Respondent A mentioned that health risk is a potential risk of lab-grown meat. She explained that the method of production is crucial to ensure that it is safe for consumption. Consumers would not know if lab-grown meat is exposed to bacteria during the production. She said that the production process has to be proven clean and safe for human consumption.

Respondent B mentioned that there would be food safety and food poisoning issues. There is a possibility for food contamination if lab-grown meat is not being produced under a sterile environment. Also, he stated that ethics is another risk where manufacturers would mix the meat with other protein sources such as insects. According to him, there are certain animals that Muslims are not allowed to consume. Hence, ethical issues arise as manufacturers may mix some non-Halal food with lab-grown meat to create something new.

Respondent C stated that lab-grown meat poses a health risk. Unlike conventional meat where livestock animals have their immune system to prevent the growth of pathogens, there is no immune system within lab-grown meat. Hence, lab-grown meat might be susceptible to pathogens which might harm human health.

## Theme 4: Potential Challenges of Introducing Lab-grown Meat

Prof. Babji mentioned that there would be no challenge to introduce lab-grown meat to the market once the texture and cost of producing lab-grown meat are fine-tuned and is approved by the FDA. He stated that strong marketing used to promote lab-grown meat could increase public awareness and acceptance. Thus, there will be no issue to introduce this product in the market, provided that the public has accepted lab-grown meat.

Dr. Salawati stated that consumer would have more varieties of meat to choose from if lab-grown meat is commercialised. The challenge is the players have

to work more to enhance their products, either by creating or modifying their product characteristics. She explained that consumers would only choose the best meat and only the best will win the competition and get the highest return.

Respondent A claimed that the biggest challenge is to educate people about lab-grown meat and to convince that it is safe for consumption. Nowadays, consumers are aware of the food they consumed. To successfully market lab-grown meat, the perception of the society is important. The marketers have to ensure the society is well-educated by delivering information about lab-grown meat.

Respondent B mentioned that the main challenge to introduce lab-grown meat is consumer acceptance. He stated that Malaysians like to try things that are new but not totally different from the present ones. Lab-grown meat is a totally new idea, so the perception of Malaysians remains unknown. He said that it would not be a challenge for Muslims to consume lab-grown meat as long as the entire process meets the requirements stated: prayers have to be done before the slaughtering process, animals are slaughtered by Muslims, and all the raw materials are *halal*. He believed that consumers would take years to accept lab-grown meat.

Respondent C agreed that the obvious challenge would be public acceptance. He believed that a vast majority of people would think that lab-grown meat is unnatural, or disgusting to be consumed. He explained that this reason is similar to why people consume a certain type of meat at one corner of the world and not at the other.

## Theme 5: Malaysians Readiness to Accept Lab-grown Meat

Prof. Babji believed that Malaysians are not ready to accept lab-grown meat generally. Only a minority of Malaysians would consume lab-grown meat because it poses a certain health risk and most of the people would be unable to afford it. He mentioned

that ASEAN people would only eat lab-grown meat only if they want to be fashionable or there is no other choice. Thus, there will always be a market for lab-grown meat.

Dr. Salawati stated that the acceptance of Malaysians towards lab-grown meat depends on the culture and education level of people. She elaborated that people from urban areas would like to know more and to try lab-grown meat as they are open to accepting new things. In contrast, people from rural areas are unwilling to accept new things due to various reasons such as culture and education. Therefore, the acceptance of lab-grown meat strongly depends on the understanding, habits, culture, and education of the society.

In contrast, Respondent A believed that Malaysians are ready to accept lab-grown meat. She explained that there are various meats in the supermarket which Malaysians are already familiar with. Thus, the important thing is to ensure the societies are well-educated about lab-grown meat.

Respondent B is unable to respond to this question as no prior data is provided to show Malaysians acceptance of lab-grown meat.

Respondent C believed that generally, Malaysians are not ready to consume lab-grown meat due to various reasons such as religion. He mentioned that this concept is still relatively new even to the world. Thus, he said that Malaysians would not accept lab-grown meat in the near future until it has become a norm globally.

## Theme 6: Religion as a Barrier to Accept Lab-grown Meat

Prof. Babji mentioned that it would be a barrier for Muslims to consume lab-grown meat as they believe in wholesomeness. He explained that wholesomeness is the gift of God with which the food is clean, complete, and is not added with anything

doubtful. Also, Halal is defined as food that is natural with the blessing of God. Thus, Muslims would think that lab-grown meat is unnatural.

Dr. Salawati stated that religion could be a barrier for Muslims to accept lab-grown meat unless it can be proven that it does not contradict the religion. She mentioned that the slaughtering process has to be conducted according to the Islamic way, or it is said to be unsafe for consumption. Dr. Salawati told that it would not be a barrier for Hindus as long as it is not beef.

Respondent A believed that religion would not be a problem for Malaysians to accept lab-grown meat. She said that the biggest concern lies within the Hindus and the Muslims. If cows are slaughtered properly and the production process meets the Halal requirements, it would not be a barrier for Muslims to eat lab-grown meat.

Respondent B stated that there is no barrier for Malaysians to eat lab-grown meat from the religious perspective. Once the government authorities proved that lab-grown meat is *halal*, Muslims are then allowed to consume lab-grown meat. It would not be a barrier for Hindus and some Buddhists to eat lab-grown meat as long as it is not beef.

Respondent C believed that religion might be one of the barriers for Malaysians to consume lab-grown meat, but he reckoned the most critical barrier is still the psychological barrier of the people.

## Theme 7: Knowledge Equipped by Malaysians and Resources Availability for Malaysia To Produce Lab-grown Meat

Prof. Babji stated that Malaysia has the capabilities to produce lab-grown meat if the government decides to invest in this technology. However, he mentioned that there is

no manpower and laboratory in Malaysia to produce this. Besides, the government does not encourage this investment due to the large capital needed for production.

Dr. Salawati mentioned that there is not much knowledge in this field and thus, the resources could not be utilised. As indicated by her, the lack of knowledge in this field is because there is no motivation and awareness among Malaysians toward lab-grown meat. She said that it is difficult to introduce new things in Malaysia unless someone virals it.

Respondent A said that Malaysia does not have sufficient knowledge and resources to produce lab-grown meat. She explained that 80% of the meat, including Halal meat, in the market is imported from other countries. She claimed that Malaysia can always be ready if the meat is no longer imported from other countries, and when there are sufficient raw materials to produce lab-grown meat. She also mentioned that the ministry is now trying to expand both the livestock and agriculture sectors.

Respondent B mentioned that Malaysia has the capabilities to produce lab-grown meat, but the cost of production is too high. He said that the base of lab-grown meat is stem cells research which is only widely used in the cosmetic industry in Malaysia. He mentioned that University Putra Malaysia had conducted some lab-grown meat research.

Respondent C stated that Malaysia does not have sufficient knowledge and resources to produce lab-grown meat at the moment. He mentioned that knowledge sharing among nations is always possible. For example, Malaysia could hire or invite meat scientists or other specialists from other countries to share their knowledge of lab-grown meat production. Also, he stated that funding would be a major stumbling block.

**Theme 8: Law Enforcement of Lab-grown Meat in Malaysia**

Prof. Babji claimed that it is unnecessary to amend the laws in Malaysia to commercialise lab-grown meat. He explained that the laws regard to anything new, including food that are controlled by the Ministry of Health. He then mentioned that lab-grown meat has to undergo all the procedures like microbiology, *halal*, and wholesomeness to prove that it is safe to be consumed.

Dr. Salawati said that the policymakers have to discuss and predict the impact of commercialising lab-grown meat. She said that if there is a need to amend the law, the policymakers have to carefully analyse which parts of laws to amend to commercialise this food successfully.

Respondent A mentioned that it is unnecessary to change or modify the current laws as it is sufficient in commercialising lab-grown meat. She said that the production process would need to meet all the current requirements stated.

Respondent B stated that he has no idea as he does not have any background in law. He mentioned that lab-grown meat involves many areas such as food, biology, research. It is unclear that lab-grown meat will fall under which category of laws.

Respondent C mentioned that it is unnecessary to change the laws as lab-grown meat could be produced or marketed like conventional meat. He stated that the policymakers have to ensure the production meets all the current standards, laws, and regulations in Malaysia. He emphasised that lab-grown meat has to comply with the Islamic laws as it will be marketed to Muslims.

**Theme 9: Recommendations to Curb Negative Perceptions among Malaysians**

Prof. Babji mentioned that it is important for new meat products to follow all regulations to ensure the safety of meat. Once the government authorities have proved that lab-grown meat is safe, people will change their negative perceptions and start to accept lab-grown meat. Lab-grown meat has to be certified by the Ministry of Health to prove that it is perfect for health.

Dr. Salawati believed that parties such as manufacturers and government have to convince the public that lab-grown meat could benefit the environment and human in the long run. She explained that negative perceptions could be countered when people start to understand what lab-grown meat is. Malaysians have to be open-minded to accept lab-grown meat if it is being commercialised.

Respondent A stated that it is important to ensure the societies are well-educated about the benefits of lab-grown meat. She explained that surveys have to be conducted to gauge Malaysians perceptions towards lab-grown meat. Also, people may think that lab-grown meat is unsafe to be consumed. If lab-grown meat is commercialised, tasters can be provided in supermarkets to the public.

Respondent B mentioned that lab-grown meat must be approved by the Department of Islamic Development Malaysia (JAKIM) to prove that it is *halal*. Also, promotional videos with complete and truthful information about lab-grown meat production can be published by the government to raise awareness among Malaysians.

Respondent C stated that Malaysians often rely on the government to prove that new food is safe for consumption. The role of government in shaping the perceptions of Malaysians towards lab-grown meat is crucial. The idea of lab-grown meat must be supported by the government, in terms of the provision of technology and funding. He further stated that the government could promote lab-grown meat

through social media platforms as it is a strong medium to disseminate information about new things to the public.

## 4.3   Conclusion

The interviewees had provided different viewpoints on potential benefits of lab-grown meat, potential impact, risks, and challenges associated with lab-grown meat, the Malaysians' acceptability towards lab-grown meat as well as the legal issues related to the introduction of lab-grown meat in Malaysia. The information has served as a valuable input to this research.

# CHAPTER 5: DISCUSSION, CONCLUSION AND RECOMMENDATION

## 5.0    Introduction

A summary of the major findings is presented to show that the research objectives mentioned in Chapter 1 are achieved. Also, the implications and limitations of this research will be discussed. Finally, recommendations for future research to conduct similar topic in Malaysia, as well as the conclusion will be presented in this chapter.

## 5.1    Discussion of Major Findings

The findings for RQ 1 and RQ 2 were presented in Chapter 2. The findings for RQ 3, RQ 4, RQ 5 and RQ 6 are addressed by Theme 1, Theme 2, Themes 3 to 8 and Theme 9 respectively:

*Theme 1:* In general, lab-grown meat is a potential asset to the meat industry as it serves as an alternative to conventional meat which may be deemed a luxury in the future if the current meat supply fails to satisfy the demand due to the continuous rise of global population. The meat and livestock industries will not be greatly affected, mainly due to human perceptions that hinder them from consuming lab-grown meat. Therefore, there will still be a continuous demand of conventional meat in the market. Nevertheless, the introduction of lab-grown meat creates competition in the market whereby the conventional meat industry will have to compete with lab-grown meat industry to retain its market position.

*Theme 2:* The potential benefits of lab-grown meat can be subjective. To summarise, the successful introduction of lab-grown meat to the market will certainly prevent the shortage of world meat demand in the future, improve human health and reduce

environmental pollution. Besides, the pioneers of the technology may export lab-grown meat to rich countries to generate profit.

*Theme 3*: All the interviewees agreed that lab-grown meat poses a health risk. The health impacts of lab-grown meat consumption remain unknown as studies that compare the health impacts of lab-grown meat and conventional meat to human remain scarce. Furthermore, the production process relies on the presence of a sterile environment. A breach on this condition will certainly increase its susceptibility to pathogens. Ethics could also be one of major concerns of lab-grown meat production.

*Theme 4*: The biggest hurdle to overcome in introducing lab-grown meat to the market would be public perception and acceptance towards lab-grown meat. People tend to perceive that lab-grown meat is unnatural and is unsafe for consumption as their knowledge on this technology is limited. This further emphasises the importance of public awareness and responsible promotion if it is to be marketed to the public. Furthermore, more intensive R&D has to be done to improve the quality of meat to survive in the competition within and between the industries.

*Theme 5*: There were two standpoints on the readiness of Malaysians to accept lab-grown meat. Some interviewees believed that Malaysians who are well educated and willing to accept would always be prepared to consume lab-grown meat. On the other hand, some interviewees believed that Malaysians are not ready to accept lab-grown meat until it has become a norm globally due to a lack of exposure to this relatively new food technology.

*Theme 6*: A majority of the interviewees believed that religion could be a barrier for Malaysians to accept lab-grown meat, especially the Muslims. This is because they believed in wholesomeness. However, they believed that this barrier could be overcome once the authorities proved that the production process meets all the standards and requirements of the Islamic laws.

***Theme 7:*** At present, Malaysia does not have sufficient knowledge and resources to produce lab-grown meat. Even if it has the capability to invest in this technology, a large capital is needed to build laboratories and bioreactors for the implementation of this production. Furthermore, in Malaysia, there is a limited expert to maintain these assets and to inspect the production process. However, knowledge sharing among nations is always possible. Experts from the other countries can be hired to provide technical trainings in Malaysia.

***Theme 8:*** Based on the findings, it is unnecessary to amend the laws and regulations in Malaysia to commercialise lab-grown meat as long as the production and marketing process comply with all the standards and requirements that are already stated in the Laws of Malaysia. Government agencies such as the Ministry of Health play an important role in ensuring all the production process satisfies the requirements to convince the public that lab-grown meat is safe for consumption.

***Theme 9:*** To curb the negative perceptions of the public has towards lab-grown meat; it is recommended that the authorities have to create awareness and to prove that lab-grown meat is safe for consumption. Relevant information, including the production process, safety assurance and the potential health and environmental benefits can be disseminated to Malaysians through social media platforms.

To conclude, the idea of lab-grown meat as an alternative to conventional meat is going to benefit the world in the long run. However, further research such as experiment on human has to be done to prove its health impacts before it is considered safe to be consumed by people. The scarcity in knowledge and awareness, coupled with cultural, religious and ethical concerns inhibit the acceptance of lab-grown meat among Malaysians. The shortage of competent experts and capital in investments further hinder the feasibility of its introduction.

## 5.2   Implications of Study

This research study focuses on determining the feasibility of introducing lab-grown meat in Malaysia. The findings of this study yield some implications that could help the policymakers in real life. From the overall findings, at the moment, it is not feasible to introduce lab-grown meat in Malaysia due to a lack of awareness among the people, high cost of production and cultural issues. Based on the research, all interviewees agreed that lab-grown meat is beneficial to the world. Therefore, Malaysia is encouraged to introduce lab-grown meat when more extensive research has been conducted and when Malaysians are aware and well-educated about lab-grown meat.

When the introduction of lab-grown meat in Malaysia has become feasible in the future, this research helps to identify the potential challenges and risks. It could serve as a reference for policymakers to draft strategies on how to effectively promote lab-grown meat in Malaysia.

Based on the findings, it is undeniable that creating awareness among the Malaysians is crucial. The government agencies have to take proactive actions in introducing lab-grown meat through various social media platforms such as Facebook, Instagram, and Twitter where large audiences could be reached within a short period. It is important to know how social media would influence the consumer perceptions. Therefore, the relevant information to be published includes the current meat production problems and the potential benefits of lab-grown meat.

To reduce the "yuck factor" among Malaysians, the authorities such as the Ministry of Health have the responsibility to prove that lab-grown meat is safe for consumption if it is introduced. Lab-grown meat production has to undergo stringent food fraud checks where it has to be further tested. Screening for potential bacteria and monitoring of the nutrient compositions of lab-grown meat have to be done to ensure the highest standard of lab-grown meat is being produced to address the

concerns on health issues. The introduction of lab-grown meat must undergo the regulatory considerations where a highly complex and lengthy procedure is needed to get approval from the government authorities.

Last but not least, large capital investment needed for lab-grown meat production is hindering Malaysia from investing in this food technology. The government is suggested to provide subsidies to the manufacturers to promote this investment in the near future. This does not only encourage the manufacturers to produce lab-grown meat but also encourages the consumption of lab-grown meat among Malaysians by lowering the price. Tax incentives such as tax exemptions and tax refunds given by the government can increase the profitability of the manufacturers by reducing their tax burden.

# 5.3    Limitations of Study

Several limitations are acknowledged throughout the process of completing this research project.

As required, this research project has to be completed within 21 weeks, which is insufficient to be completed effectively. The use of semi-structured interviews in this research means that each interview has to be conducted individually and the data collected has to be transcribed and analysed. The data collection process was time consuming. Thus, limited time was used to analyse the data collected, resulting in a potential reduce in the reliability of the results of this research.

Besides, this topic is still new to Malaysia and even to the developed countries. Currently, no research has been conducted to determine the perception of Malaysians towards this technology. Thus, there is no statistics to support this research project. The researchers have to depend on foreign journals and articles while conducting this research. There are differences in culture, attitude, values, and beliefs between other countries and Malaysia, so the foreign research studies may not fully reflect the case in Malaysia. Also, some of the journals and articles published online may be outdated, so the data and information might be inaccurate or inconsistent with the current situation.

Moreover, the sample size for this research project is considered small. This is because, in Malaysia, there are only a few experts who have sufficient experience and knowledge specifically on lab-grown meat. The researchers were unable to obtain the most specific and accurate information about lab-grown meat due to the limited number of experts available in this field. Time constraint is also one of the reasons for selecting a small sample size. Therefore, only five interviewees were included in this study due to the limited time frame provided to complete the whole research.

Despite the limitations mentioned here, they do not affect the overall findings of this research topic.

## 5.4    Recommendations for Future Research

Based on the limitations addressed in the previous section, the following recommendations are suggested to further improve the reliability and accuracy of results for future research.

Firstly, future researchers will need to have sufficient time to search for the research participants, to communicate with them, to collect and analyse the data, and to generate a written report. Future researchers may make use of technology such as e-mail, online survey or online interview to approach the research participants who are from the other cities in Malaysia instead of reaching out to them in person. This helps to shorten the time for meeting and collecting data from the participants. In addition, the post-processing of data is time-consuming. Therefore, future research should be conducted over a longer time frame to provide time flexibility for future researchers to complete their research ethically, hence enhancing the quality of the research.

Besides, future researchers may use a quantitative research method to study this research topic. As mentioned, no research regarding this topic has been conducted in Malaysia. Therefore, to validate the feasibility of introducing lab-grown meat in Malaysia, field data collected from the public is crucial. The researchers may be able to understand and determine the perceptions and attitudes of the people towards lab-grown meat by distributing survey questionnaires among Malaysians. The data collected through this method may generate a more accurate and significant result on the feasibility to introduce this new food to Malaysians.

The sample size used in this research is considered too small to be representative of the overall results. It is highly recommended that future researchers increase the sample size to improve the quality of the research outcomes. Focus groups can be done to collect more information from a larger group of participants. Each respondent from the focus group may provide different viewpoints towards the research topic, which can then generate more reliable results.

## 5.5   Conclusion

In conclusion, this report has achieved the research objectives where the concept of lab-grown meat and the perception of the global community towards lab-grown meat were identified. The potential benefits, challenges, and risks associated with lab-grown meat were determined and discussed in the findings. Besides, as lab-grown meat is gaining more attention around the world and is getting closer to entering the market, this report helps to create awareness among Malaysians on lab-grown meat. Although it is believed that lab-grown meat is currently not feasible to be introduced in Malaysia, hopefully the Malaysians will be able to accept it in the near future as lab-grown meat is beneficial to the environment, animals, and people. However, the challenges and risks associated with lab-grown meat have to be overcome before it can be introduced in Malaysia. Future research has to be done to gauge the perception of Malaysians towards lab-grown meat to further determine if Malaysians are ready to accept lab-grown meat.

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APPENDICES

## Appendix 2.1: Scaffold-based Technique
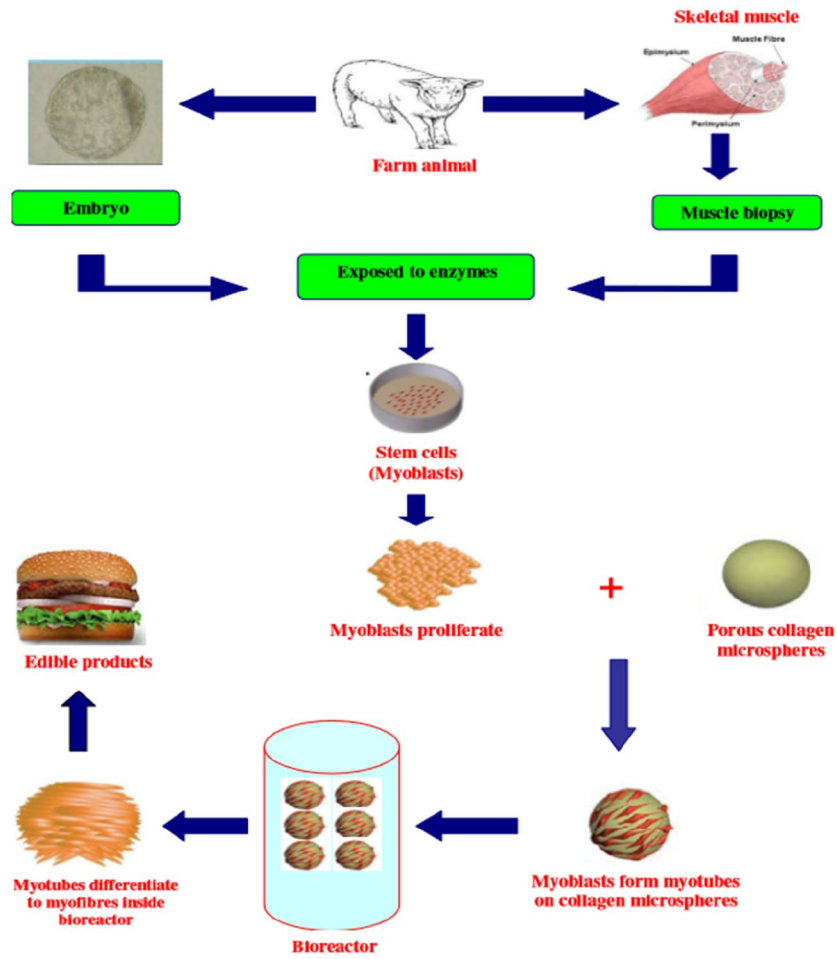
**Appendix 3.1: Interview Questionnaires**

1. Have you heard about lab-grown meat? From your understanding, what is lab-grown meat?

2. Do you think lab-grown meat is going to benefit the world? Why?

3. Do you think lab-grown meat is going to impact the livestock or meat industry? How?

4. What will be the potential risks associated with lab-grown meat?

5. What will be the potential challenges face when introducing lab-grown meat to the market?

6. Are Malaysians ready to accept lab-grown meat as their diet? Why?

7. Do you think religion will be one of the barriers for Malaysian to accept lab-grown meat?

8. Do you think Malaysia has sufficient knowledge and resources to produce lab-grown meat?

9. Do the laws in Malaysia need to be amended in commercialising lab-grown meat?

10. In your opinion, what can be done to curb the negative perceptions of Malaysians toward lab-grown meat?

**Appendix 4.1: Consent Letter: Prof. Dr. Abdul Salam Babji**

Prof. Dr. Abdul Salam Babji
Universiti Kebangsaan Malaysia,
43600 UKM,
Bangi Selangor, Malaysia.

**CONSENT TO USE ALL THE INFORMATION COLLECTED FROM INTERVIEW**

My name is Liang Jia Yi. My group mate, Ooi Boon Tat and I are pursuing Bachelor of International Business at Universiti Tunku Abdul Rahman (UTAR) Sungai Long Campus. We had conducted a Final Year Project titled "Feasibility of Introducing Lab-grown meat in Malaysia". An interview session was conducted with Prof. Dr. Abdul Salam Babji to obtain valuable information and opinions regarding the research topic.

The interview session was conducted on February 12, 2019 at Universiti Kebangsaan Malaysia, which is located at UKM Bangi Selangor. The interview took about one hour to complete. The information provided by Prof. Dr. Abdual Salam Babji was used in our research project.

Hereby, we would like to request for approval in using the informationcollected from the interview in our Final Year Project Research. This research may be used as teaching materials in the classroom environment in UTAR, and the copyright of this research will be held by UTAR.

Authority to execute this agreement:

| | |
|---|---|
| Name: | ABDUL SALAM BABJI |
| Position: | TECNOLOGIST in RESIDENCE |
| Organization: | U. K. M. |
| Address: | BANGI. |
| Date: | February 12 2019 |
| Signature: | |

**PROF. DR. ABDUL SALAM BABJI**
School of Chemical Sciences and Food Technology,
Faculty of Science and Technology,
UKM, Bangi, 43600 Selangor.
Email: daging@ukm.my
Tel: 89215988 / 3382

**Appendix 4.2: Consent Letter: Assoc. Prof. Dr. Salawati Mat Basir**

Dr. Salawati Mat Basir
Universiti Kebangsaan Malaysia,
43600 UKM,
Bangi Selangor, Malaysia.

## CONSENT TO USE ALL THE INFORMATION COLLECTED FROM INTERVIEW

My name is Liang Jia Yi. My group mate, Ooi Boon Tat and I are pursuing Bachelor of International Business at Universiti Tunku Abdul Rahman (UTAR) Sungai Long Campus. We had conducted a Final Year Project titled "Feasibility of Introducing Lab-grown meat in Malaysia". An interview session was conducted with Dr. Salawati to obtain valuable information and opinions regarding the research topic.

The interview session was conducted on February 27, 2019 at Universiti Kebangsaan Malaysia, which is located at UKM Bangi Selangor. The interview took about one hour to complete. The information provided by Dr. Salawati were used in our research project.

Hereby, we would like to request for approval in using the information collected from the interview in our Final Year Project Research. This research may be used as teaching materials in the classroom environment in UTAR, and the copyright of this research will be held by UTAR.

Authority to execute this agreement:

Name: *Assoc Prof Dr. Salawati Mat Basir*

Position: *Legal Advisor*

Organization: *UKM*

Address: *Bangi 43600 Selangor.*

Date: *27. 2. 2019*

Signature:

**Appendix 4.3: Interview Response: Prof. Dr. Abdul Salam Babji**

1. Have you heard about lab-grown meat? From your understanding, what is lab-grown meat?

   <u>Yes. Lab-grown meat is a biotechnology produced outside animals. It is human creation and is anything that is not originally from animals. The production involves getting stem cells from the animals and allowing it to undergo mitosis. The nutrients of lab-grown meat are just same as the conventional animals while the different is it is synthetically produced.</u>

2. Do you think lab-grown meat is going to benefit the world? Why?

   <u>Yes. It will surely benefit to the manufacturers or investors whose intention is just to make money but not to help people. It is especially benefits to those who are trying to make lab-grown meat 20 years ago. The national people of America will not take this meat but they will pass it to the other countries who want to buy it such as China, for business purposes. They will also be selling to countries which are rich, for example, Middle East countries where most of their citizens' desire ease and convenience. Also, the long term benefit of lab-grown meat in terms of health still remains unknown.</u>

3. Do you think lab-grown meat is going to impact the livestock or meat industry?

   <u>Lab-grown meat is an added value to the meat industry. It will prosper the meat industry by providing over and above meat supply which is not sufficient for the consumption of the whole world. For example, Malaysia is the No. 4 country with richest meat consumption where each person consumes around 50kg to 60kg meat protein per year. Yet, only 20% of meat is produced domestically for Malaysians' consumption while 80% of meat is imported from the other countries.</u>

4. What will be the potential risks associated with lab-grown meat?

   No one knows if lab-grown meat is healthier than the conventional meat. Taking GMO food as an example, we do not know whether it is harmful to human being. Currently, there is no human experiment to compare a group of people eating lab-grown meat with a group of people eating conventional meat over years. There is no health impact shown; thus, it poses health risk.

5. What will be the potential challenges face when introducing lab-grown meat to the market?

   There is no challenge once it is approved by FDA. Nowadays, the marketing is too strong where advertising plays an important role in introducing lab-grown meat. Slogans such as "Meat from sterile room with no diseases" can be used in advertising lab-grown meat. It is important to educate the people on lab-grown meat. Also, the manufacturers have to get the meat right in terms of cost of production and fine-tune the taste before it is commercialised. It may be cheap at first but the manufacturers will surely bring up the price.

6. Are Malaysians ready to accept lab-grown meat as their diet? Why?

   There will always have market for lab-grown meat. In my opinion, there would be a very low percentage of Malaysian willing to accept lab-grown meat. This is because some of them could not afford to buy it. Also, the health risk associated with lab-grown meat would be one of the reasons Malaysian are not ready to eat lab-grown meat as we do not know about the whole science and biology. People from ASEAN countries would only eat lab-grown meat unless there is no other choice or they just want to be fashionable.

7. Do you think religion will be one of the barriers for Malaysian to accept lab-grown meat?

   It will be a barrier for Muslims to eat lab-grown meat. Halal is about eating of food which is natural with the blessing of God. They believe in "wholesomeness" as the gift of God. Wholesomeness is food that is clean,

complete, and not added with anything that is doubtful. Besides, organic food eaters or those who are close to nature will not accept lab-grown meat as their diet.

8. Do you think Malaysia has sufficient knowledge and resources to produce lab-grown meat?

Malaysia has the capabilities if they want to invest in this technology. However, there is no man power, scientist, and lab to produce lab-grown meat. Also, the government does not encourage Malaysia to invest in this technology due to the large capital needed for the production.

9. Do the laws in Malaysia need to be amended in commercialising lab-grown meat?

There is no need to amend the laws in Malaysia to commercialise this meat. The laws will regard to anything new, including food as controlled by the Ministry of Health. Lab-grown meat has to go through all the procedures such as microbiology, Halal, and wholesomeness, to prove that it is safe to be consumed. No meat can be imported to Malaysia if it is not Halal.

10. In your opinion, what can be done to curb the negative perceptions of Malaysians toward lab-grown meat?

The government plays an important role to ensure all the products follow the regulations stated to ensure the safety of meat. People will change their perceptions and accept lab-grown meat when it is proven safe to be consumed by the Ministry of Health.

**Appendix 4.4: Interview Response: Assoc. Prof. Dr. Salawati Mat Basir**

1. Have you heard about lab-grown meat? From your understanding, what is lab-grown meat?

   Yes. We have to look lab-grown meat from different perspective such as economic perspective, food, and health. The people from less developing countries are eating healthy food while the people from first world countries are either eating fast foods or something very health. From my understanding, lab-grown meat is important to educate people from these various perspectives.

2. Do you think lab-grown meat is going to benefit the world? Why?

   Yes, it is because anything that comes from the industries or whatever we put in the industries, it would give more than the economic impact. Research and development (R&D) is important to ensure the final product will be better than the current product.

3. Do you think lab-grown meat is going to impact the livestock or meat industry?

   There will be competitions in many industries. Thus, lab-grown meat has to go better in order to compete in the meat industry. New food technology helps us to have better life and better choice. R&D is normally done according to the social and economic factors of the people in order to create more choices and to get more return. There is an impact but it is more on competition.

4. What will be the potential risks associated with lab-grown meat?

   There will be a risk associated with over-consumption or under-consumption of lab-grown meat. In order to minimize the risk, the industries have to work together to control it so that no problem would arise when commercialising lab-grown meat.

5. What will be the potential challenges face when introducing lab-grown meat to the market?

   People have more varieties to choose. Therefore, the challenge is that the companies have to work more to enhance their product. This is because people are creating the best and only the best will win the competition.

6. Are Malaysians ready to accept lab-grown meat as their diet? Why?

   It depends on the cultural and education of people. If you are introducing lab-grown meat to the urban people which they are open to accept new things, they will be willing to know more about and to try lab-grown meat. Yet, it will be hard to introduce lab-grown meat to rural people. So, it depends on the understanding, habits, cultural, and education of the societies of certain areas.

7. Do you think religion will be one of the barriers for Malaysian to accept lab-grown meat?

   There is an effect as Hindus do not eat meat. On the other hand, for Muslims, the slaughtered way has to be conducted according to the Muslims way. Otherwise, it is considered as not safe to be consumed. Thus, religion can be a barrier unless it can be proven that the lab-grown meat production process is not contradicting with the religion issues.

8. Do you think Malaysia has sufficient knowledge and resources to produce lab-grown meat?

   There is not much knowledge in this field. When there is not much knowledge, even Malaysia has the resources also it could not be utilized. This is because there is no awareness and motivation among Malaysian towards lab-grown meat. People do not know the good things about lab-grown meat and thus they will not accept lab-grown meat. However, people with open-minded would accept it if the benefits were stated to them. In Malaysia, introducing new thing is not easy unless someone viral it.

9.  Do the laws in Malaysia need to be amended in commercialising lab-grown meat?

    It depends. We have to do it if there is a need to amend the law to commercialise lab-grown meat. The policy makers have to sit down and analyze how far the impact of commercialising lab-grown meat is. They have to be very careful on which parts of the laws need to be amended.

10. In your opinion, what can be done to curb the negative perceptions of Malaysians toward lab-grown meat?

    It is important that the manufacturers and the government have to convince the people that lab-grown meat brings benefit to the world in terms of environment and human health in the long run. When people start to understand what lab-grown meat is, they will change their negative perceptions. Also, Malaysians themselves have to be open-minded to accept lab-grown meat.

**Appendix 4.5: Interview Response: Respondent A**

1. Have you heard about lab-grown meat? From your understanding, what is lab-grown meat?

   Yes. Lab-grown meat is produced outside of an animal. It involves harvesting stem cells from the animals and growing it inside the laboratory. Yet, I think it will take 5 to 10 years before it can be successfully marketed to the people.

2. Do you think lab-grown meat is going to benefit the world? Why?

   Yes, of course it will benefit to the world. As we know, the world meat demand is higher than the meat supply. Lab-grown meat can be produced in the lab with a very large quantity which helps to overcome this problem. Also, it takes shorter time to produce meat in lab instead of growing up animals in order to get their meat.

3. Do you think lab-grown meat is going to impact the livestock or meat industry?

   Lab-grown meat will affect both the industries as meat industry is dependent on livestock industry. It depends on the demand of the market. If people choose to eat lab-grown meat, it will definitely affect the meat industry. If lab-grown meat is sold at a cheaper price than the normal meat, people will choose it instead of normal meat. So, if meat industry gets affected, the livestock industry will also be negatively affected.

4. What will be the potential risks associated with lab-grown meat?

   The method of producing lab-grown meat would be one of the risks as it would expose to certain types of bacteria. We would not know whether lab-grown meat is clean or safe enough for human consumption unless it is proven to be safe. This is related to the risk of human health.

5. What will be the potential challenges face when introducing lab-grown meat to the market?

   The biggest challenge to introduce lab-grown meat to the market is to make people understand that it is safe for consumption. People, especially those who are living a healthy lifestyle, are very aware of food that they eat. The marketers have to make sure that the societies are well-educated. They have to deliver the knowledge about lab-grown meat process to make the societies know that it is actually safe for consumption. The perception of society towards lab-grown meat is pretty much important to introduce it to the market successfully.

6. Are Malaysians ready to accept lab-grown meat as their diet? Why?

   Yes, I think we are ready to accept this. As we can see in the supermarket, there are various canned meats which Malaysian is already familiar with. It is just that we have to make sure people are well-educated on what actually lab-grown meat is.

7. Do you think religion will be one of the barriers for Malaysian to accept lab-grown meat?

   In terms of religions, it would not be a big problem. When it comes to meat, the biggest concern will be the Hindus and Muslims communities. I am not sure with the Hindus community but for Muslims, if the cow is properly slaughtered and the process meets the Halal conditions, then it would be fine.

8. Do you think Malaysia has sufficient knowledge and resources to produce lab-grown meat?

   To be honest, we do not have the sufficient knowledge and resources. From what I know, it is about 80% of the meat, including Halal meat, in the market are actually imported from the Australia. Malaysia can always be ready if we do not have to import the meat from the other countries anymore and when we

have enough raw materials to produce lab-grown meat. The ministry is now putting more effort to expand the livestock and agriculture sector.

9. Do the laws in Malaysia need to be amended in commercialising lab-grown meat?

   It does not need to be amended as the laws that we have right now are sufficient for commercialising lab-grown meat. The production of lab-grown meat just needs to meet all the requirements stated.

10. In your opinion, what can be done to curb the negative perceptions of Malaysians toward lab-grown meat?

    We have to ensure that the societies are well-educated about the benefits of lab-grown meat. Surveys can also be done to determine the perceptions of Malaysians towards lab-grown meat. Also, if lab-grown meat is commercialised, tasters can be provided in the supermarkets to the people to try lab-grown meat.

## Appendix 4.6: Interview Response: Respondent B

1. Have you heard about lab-grown meat? From your understanding, what is lab-grown meat?

   I have heard about lab-grown meat in the year 2013. From my understanding, lab-grown meat is different from the conventional meat in way such that conventional meat is obtained through livestock but lab-grown meat is produced in the laboratory which is outside of the animal body. Lab-grown meat is still in the experiment level and the cost is extremely high. Once it is produced at an industrial scale, it will be very cheap.

2. Do you think lab-grown meat is going to benefit the world? Why?

   It will sure benefit to the world. Firstly, the world population is increasing and the demand for meat is high, especially in countries such as China and India. In the past, meat was only consumed by people with high income level, but nowadays, the medium income level societies are also able to afford to consume meat. Therefore, lab-grown meat helps to support the demand of meat. Besides, it takes shorter time to produce a large quantity of meat. As for livestock, it would take up to 5 years to grow a cow but only about 80 to 100kg of meat is obtained. Compared to conventional meat, theoretically, lab-grown meat can be produced within 3 months. Thus, lab-grown meat is benefit in terms of time of production. Moreover, 30% of land is used to grow livestock. Also, a minimum of 50 to 100k litter of water is drinks by a cow in order to obtain only 1kg of meat. Therefore, lab-grown meat is also benefit in terms of environment as it does not require a large piece of land and a huge amount of water consumption for the production. Next, a mass amount of meat can be produced through slaughtering one cow. Furthermore, healthier meat can be produced through laboratory as the nutrients can be organized by human.

3. Do you think lab-grown meat is going to impact the livestock or meat industry?

   There is still demand for conventional meat, thus, it will not affect the livestock and meat industry. This is because there is a "yuck factor" where some people may accept lab-grown meat while some may not.

4. What will be the potential risks associated with lab-grown meat?

   There will be risk in terms of food safety and poison during the production process. Contamination of virus may happen. Ethical issues will also be one of the risks associated with lab-grown meat where the manufacturers would just simply mix the meat with other proteins such as insects. For Muslims, there are certain animals which Muslims are not allowed to eat. Manufacturers will always try to produce something new which is demanded by the societies. Yet, the production may involve ethical issues.

5. What will be the potential challenges face when introducing lab-grown meat to the market?

   There are lots of challenges. The main challenge will be the acceptance of consumer to eat lab-grown meat. In Malaysia, people like to try new things but not on something which is totally different from the current ones. Yet, lab-grown meat is considered a totally new thing to people where the perception of Malaysian towards lab-grown meat is still unknown. Other than this, from Islamic perspectives, prayer has to be done before the slaughtering process. A cow must be slaughtered by Muslims before it can be produced in the laboratory. Also, the sources used in the lab-grown meat production must be Halal. As long as it meets all the requirements, it will not be a challenge for Muslims to accept lab-grown meat. By the way, it will take a long period of time for people to accept lab-grown meat.

6.  Are Malaysians ready to accept lab-grown meat as their diet? Why?

    Further research has to be done on Malaysian acceptance towards lab-grown meat. Currently, there is no data on this, thus, I am not sure if Malaysian is ready to accept lab-grown meat.

7.  Do you think religion will be one of the barriers for Malaysian to accept lab-grown meat?

    I think it will not be a barrier for Muslims to accept lab-grown meat once the authorities proved that it is Halal. For Hindus and some Buddhists, they are not allowed to eat beef, but other animals such as chicken would be fine. Therefore, I do not see any barriers to consume lab-grown meat from the religion perspectives.

8.  Do you think Malaysia has sufficient knowledge and resources to produce lab-grown meat?

    Malaysia has the capability to produce lab-grown meat. However, the cost of production is too high. As I know, University Putra Malaysia (UPM) has planned to do some research on this meat but I am not sure about the progress. The base of lab-grown meat is stem cell research. In Malaysia, stem cell research is widely used in cosmetic industry but no other fields because of the high cost.

9.  Do the laws in Malaysia need to be amended in commercialising lab-grown meat?

    Sorry to say that I have no ideas on the laws needed to be amended to successfully commercialised lab-grown meat in Malaysia. We do not know if lab-grown meat will fall under which law as it involves a large area.

10. In your opinion, what can be done to curb the negative perceptions of Malaysians toward lab-grown meat?

   Firstly, JAKIM has to prove that lab-grown meat is *halal* where Muslims are allowed to consume lab-grown meat. Also, the government can create and publish promotional videos with complete and truthful information about lab-grown meat production to raise awareness among Malaysians.

**Appendix 4.7: Interview Response: Respondent C**

1. Have you heard about lab-grown meat? From your understanding, what is lab-grown meat?

   From my understanding, it is a form of cellular agriculture whereby stem cells painlessly extracted from live stocks are fed and nurtured so that it multiplies and forms new muscle tissues, which is equivalent to what we are consuming.

2. Do you think lab-grown meat is going to benefit the world? Why?

   I reckon the on-going research and improvements on lab-grown meat are going to benefit the world in the long run. The reasons are threefold. Firstly, the world population is forecasted to rise in the current century, meaning that there will probably be a shortage in meat supply at some point in the future, rendering agricultural meat a luxury. Therefore, the introduction of lab-grown meat to the market would certainly solve the problem if it is well publicised and accepted by people. Secondly, environmental pollution is alarming. The reduction in animal agricultural activities in a global scale would certainly help in reducing pollution. Thirdly, since lab-grown meat is nurtured in the lab, we have control over the nutrient content in the meat, hence reducing the risk of infectious diseases and improving the health of people.

3. Do you think cultured meat is going to impact the livestock or meat industries?

   I don't think lab-grown meat is going to impact the meat industry drastically as lab-grown meat is not a replacement of agricultural meat, but just a substitute. Furthermore, the production of lab-grown meat is not easy as it requires stringent nurturing conditions that might be very costly to implement or maintain.

4. What will be the potential risks associated with cultured meat?

   The only risk I can think of is that there is no immune system within lab-grown meat; hence it may be susceptible to pathogens which may destroy the entire production of lab-grown meat.

5. What will be the potential challenges face when introducing cultured meat to the market?

   The obvious challenge would be public acceptance. I believe a vast majority of the people would think that lab-grown meat is not natural, or just disgusting to consume. This reason is similar to why people consume a certain type of meat at one corner of the world and people do not at the other.

6. Are Malaysians ready to accept cultured meat as their diet? Why?

   I think generally Malaysians are not ready to accept even the concept of lab-grown meat. This might be due to religion and other issues. The idea of lab-grown meat is still relatively new even to the giants of the world. Therefore, I don't see the acceptance of lab-grown meat among the people here in Malaysia in the near future, until it has become a norm globally.

7. Do you think religion will be one of the barriers for Malaysians to accept cultured meat?

   Yes. Religion might be one of the factors as Malaysia is a multi-racial country. But, I reckon the most critical barrier is still the psychological barrier of people.

8. Do you think Malaysia has sufficient knowledge and resources to produce cultured meat?

   Not at the moment. Knowledge sharing among nations is always possible, but funding will be a major stumbling block.

9. Do the laws in Malaysia need to be amended in commercialising cultured meat?

    I think we do not have to amend the laws. As I mentioned, it is a substitute for the agricultural meat, therefore it can be marketed just like the way how agricultural meat is marketed. The government must make sure the production meets with all the standards and laws in Malaysia. Most importantly, as lab-grown meat will be marketed to Muslims, the government has to make sure it complies with the Islamic Laws.

10. In your opinion, what can be done to curb the negative perceptions of Malaysians toward lab-grown meat?

    The role of government in shaping the perceptions of Malaysians towards lab-grown meat is crucial as people often rely on the government to prove that new food is safe for consumption. The idea of lab-grown meat has to be supported and approved by the government. Government agencies could also promote lab-grown meat through various social media platforms.