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# Development of Nano Route Based Synthetic RBC

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**Abstract**
This paper gives the details about the development of Nano Route Based Synthetic RBCs. Blood plays an important role in the survival and functioning of Human body. Blood is required in various treatments during surgeries and loss of blood can cause several problems. World is facing problems due to shortage of blood. Synthetic RBC (Artificial blood) is a safe alternative for Human RBC using nano-technology. It can used instead of human blood during the blood transfusions to overcome the shortage of human blood. The main function of Synthetic RBC is to transport oxygen. Synthetic RBC mimics the actions of human RBC like ability to clot and react to pathogens. The work given here is a mini-project that is taken up as a part of the curriculum completed by electronics and communication engineering students in the second year of the electronics & communication engineering department at Dayananda Sagar College of Engineering in Bangalore.
**Keywords:** Artificial blood, Perfluorocarbons, RBC, Arduino uno.

## 1. Introduction
Human blood's RBC, WBC, platelets, and plasma make up its composition. Blood classes A, B, AB, O, and E. coli-based haemoglobin synthesis by fermentation and purification replacement are classified historically in blood transfusion [1]. There was a need for a more effective method of oxygen transfer because the current ways were only theoretical. It was quite challenging to put the oxygen carrying function into practise. Utilizing perfluorocarbons, particularly perfluorodecalin, it was discovered that Pfcs were required to be employed in emulsion form since they could not readily interact with blood [2]. When human blood was not available, the use of fulosol DA in a 65-year-old haemorrhage patient led to a significant improvement in blood pressure. This PFC had a shelf life of nine days and a washout time of about three months; this was an extremely early implementation that improved research on PFCs as oxygen carriers [3].

## 2. Patient testing with medicines
Fluosol DA-20% (FDA), a concoction of perfluorodecalin and perfluorotripropylamine emulsified with Pluronic F68, was first used in clinical trials in the 1980s. It was tested on 55 patients, but it had drawbacks because it only worked for around 12 hours and had a short shelf life. However, it stressed the use of an improved emulsion design to address these issues in the future [4]. PFCs have a lifespan of about 48 hours in the circulatory system. One of the disadvantages mentioned was that certain

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studies suggested that PFC particles may have adverse effects similar to the flu in some people when they breathe out these combinations.
Since PFC products can't be used by humans and must be destroyed, these particles are capable of dissolving numerous gases, including oxygen. This cycle takes 18 to 24 months. The reticulo-endothelial system is overworked and less effective during their removal process [5]. Because of the injury, there may be less blood flow, which would result in less oxygen being delivered to the tissues, and this could result in irreversible tissue damage. Recent studies have demonstrated the effectiveness of fluorocarbon (Oxycyte) in treating stroke and head injuries by increasing parenchymal tissue oxygen levels during the initial postinjury hypoxic period.

**3. Recovering stages**

According to rat studies, neuronal cells recover and improve more quickly from severe brain injuries. Additionally, in an experiment done on numerous injured animals with brains, the oxygen concentration increased by up to 6 times, and the animals displayed excellent improvement. The study also shows that, in comparison to saline, a PFC emulsion can dramatically improve mitochondrial function at 4 hours after injury and brain oxygenation following TBI. [6]. While PFCs and Normal Saline Solution (NSS) had comparable results when compared, there was a clear distinction between men and women who received PFC treatment. The survival of men was around 30% higher than that of women [7].
Studies revealed that PFCs diverged from the oxygen binding curve, making them ineffective for delivering oxygen at pO2 of 100mmHg (normal air). Therefore, to efficiently use PFCs, the partial pressure of oxygen in the environment should be increased, either in vivo by oxygenating the patient's ventilation system or in vitro by oxygenating perfusion solutions and cell culture medium [8]. PFCs gases are helpful for treating conditions like flue-gas poisonings or gas embolism/decompression illness since they can dissolve C0 and N2. However, PFCs had negative side effects such as a drop in mean arterial pressure, lung damage, thrombocytopenia, and flu-like symptoms. Its other drawbacks were poor emulsion stability and a propensity to accumulate in organs over time [9].

**4. PFC utilizations**

With the exception of one PFC utilised in the production of the emulsion, perfluorooctylbromide, cytotoxicity testing demonstrated that components were only minimally hazardous (PFOB). According to their research, oxygen mass transfer is determined by particle size, since larger micelles resulted in less oxygen diffusion. In order to create stable, repeatable emulsions with the appropriate bio-delivery qualities, which will guarantee the proper operation of PFC and boost reliability, it is crucial to concentrate on emulsification parameter characterisation.
According to research, oxygen mass transfer was not efficient in emulsions generated with either lipid- or pluronic-based surfactants with particle sizes less than 0.5 m at typical oxygen partial pressures. This is because the perfluorocarbon component's intrinsic higher oxygen solubility is counteracted by the relatively large particle sizes, which result in effective oxygen diffusivities [10]. The inability to improve oxygen delivery does not appear to be the cause of perfluorocarbon emulsions' failure to adversely improve blood management and safely reduce the percentage of patients having allogeneic blood transfusions after traumatic surgical procedures. Perfluorocarbon-based emulsions will probably be used to prevent organ dysfunction and tissue damage during a reversible time of tissue hypoxia when their higher impact on oxygen delivery in the medical area is identified [11].
Perftoran has been used the most in the study of different perfluorocarbons, with more than 35,000 users, and seems to have the fewest negative effects, presumably because of its small size and special surfactant, Proxanol 268. Based on data from Russian studies, adverse effects were reported by 912 individuals taking Perftoran at a rate of 6.9% overall, ranging from 0% to 25%. In America, Perftoran was renamed Vidaphor in 2017 and has been in use ever since [12]. Finding an appropriate blood

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substitute has proven to be challenging, and many studies have produced contradictory findings. The efficiency of transporting oxygen was significantly impacted by the usage of PFC emulsion and particle size. The usage of fulosol-DA and PFOB in particular caused several adverse effects in the beginning, which prompted improvements as well as the use of alternative PFCs, which produced less and milder side effects, such as dodecafluoropentane (DDFP) C5F12 [13]. PFC nano-emulsions with a long organ retention period have been developed as a result of extensive research[13].

**5. Scopes and goals**

There are still many improvements to be made in the study of artificial blood until the ideal artificial blood substitute is found. This research article aims to evaluate the existing literature on artificial blood with a primary focus on knowledge gaps for successful testing. The file compares and contrasts numerous PFC compounds and combinations, as well as their effects and side effects, leaving room for future study that could increase PFCs' effectiveness and utility in additional medical applications. The study acknowledges diverse contributions and contrasts the many substances employed in the search for a synthetically produced substitute for human blood. However, the sheer volume of patents granted by research institutions, pharmaceutical companies, medical supply chains, and educational institutions makes it hard to conduct an exhaustive analysis of all patented works. This organised overview, which highlights recent developments in PFC-based artificial blood as well as the obstacles that still need to be overcome in the near future in order to create the synthetic blood, is likely to be helpful to researchers working in this subject. The format of this review paper's outline is as follows. The method used to review the literature is surveyed in the second stage. The study of the literature is followed by a thorough discussion of the various PFCs and a review of the most recent research on various oxygen carriers. The conclusions of the fifth segment are presented after the discussions of the fourth phase.

**6. Suggestive Methodology**

The literatures gathered from online databases. "International Research Journal of Pharmacy," "Elsevier," "IEEE Xplore," and "Google Scholar," "PubMed" were all protected by the databases. The search was done using one or more of the following keywords: "Artificial Blood," "PFC," "Synthetic Blood," "Perflourocarbons," "Blood Substitutes," "Artificial Oxygen Carriers," or a combination of those words. Additionally, we searched for patentable works. Using the terms "artificial blood," "perfluorocarbons," and "blood substitute," patents published between the early 1980s and 2021 were also looked up using PubMed and Google Scholar. As previously mentioned, the purpose of a patent search is to identify potential commercialization endeavours in this field of study rather than to conduct an in-depth analysis of the patent works. ‘The terms "artificial blood," "artificial oxygen carriers," and "perfluorocarbons" were also used to search patents published between 2000 and 2021 using PubMed and Google Scholar.

As said in segment 1.1, the objective of the patents probe is to well known developing commercialization pursuits in this field of study rather than a comprehensive analysis of the copyright works. As a result, the discussion was limited to a single example of copyrighted works from pharmaceutical corporations. The literature has been examined for more than 40 years since artificial blood synthesis is a growing field in which work is being done to develop the ideal product. The review only took into account English language publications because they are widely available to readers globally. Relevant articles helped to advance the search strategy in the amassed literature's reference lists. The procedures that have often been mentioned in the literature use three perfluorocarbons. The oxygen carrying capacity, shelf life, composition, and side effects of perfluorocarbons that have been studied in the literature are also examined, starting with the 1980s' usage of perfluorodecalin in surgical procedures.

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## 7. Conclusive remarks, Recommendations and Next Steps

Since many years ago, research and trials have been conducted to develop a replacement to human blood. Following trials on rats, the use of PFCs in the 1980s sparked a number of studies that utilised perfluorocarbons as oxygen carriers in an emulsion to simulate artificial blood. Much more effective PFCs, such as DDFPe, were employed in the previous decade, and research is still being done to identify the best, side-effect-free replacement. As this field continues to develop, better options will be discovered that can be employed to supply the demand for blood and end the blood shortage. It is necessary to adjust the study and review of the work. How can we fix this? a quick summary of the different perfluorocarbons utilised to create synthetic blood. The report also discusses a variety of perfluocarbons that have been utilised by researchers to examine the effectiveness and negative effects of their ability to deliver oxygen.

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