EasyChair Preprint

№ 8378

Quantum Generators: an Automated & Digitized Platform for Multi-Layer and Multi-Scale Cell Synthesis in Crop Grain Generation.

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July 3, 2022

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ABSTRACT

Quantum Generators is a means of achieving mass food production with short production cycles and when and where required by means of machines rather than land based farming which has serious limitations. The process for agricultural practices for plant growth in different stages is simulated in a machine with a capacity to produce multiple seeds from one seed input using computational models of multiplication (generating multiple copies of kernel in repetition). In this paper, we present a platform development of automated synthesizer where cell synthesis can be synergistically combined with multi-layer and multistep synthesis for crop generation. We show a modular platform for automating cell synthesis, which embodies synthesis framework along with synthesis abstraction in the platform. And abstraction of cell synthesis contains the key four stages of synthesis protocols: recognition, gene expression, transcription, and protein builder that can be linked to the physical operations of a digitized & automated synthesizer platform. Software control over hardware allows combination of individual unit operations into multistep cell synthesis in a framework incorporated in multiple synthesis units where the unit level computer creates low-level instructions for the hardware taking interface representation of the platform and abstraction representing cell synthesis. In this way, it is possible to script and run desired synthesis in a framework for assessing outcome without reconfiguration of the platform for multiple crop tissues simultaneously. Although the platform model given us a method of automating cellular assemblies in a mechanism of framework in different units of identical CellSynputer however, this need to be tested using natural crop cells and it could be promising for us in achieving quantum generation.

INTRODUCTION

A **Quantum** (plural quanta) is the minimum amount of any physical entity (physical property) involved in an interaction. On the other hand, **Generators** don't actually create anything instead, they generate quantity prescribed by physical property through multiplication to produce high quality products on a mass scale. The aim of Quantum Generators is to produce multiple seeds from one seed at high seed rate to produce a particular class of food grains from specific class of **seed** on mass scale by means of machine rather than land farming.

The process for agricultural practices include preparation of soil, seed sowing, watering, adding manure and fertilizers, irrigation and harvesting. However, if we create same conditions as soil germination, special watering, fertilizers addition and plant growth in different stages in a machine with a capacity to produce multiple seeds from one seed input using computational models of multiplication(generating multiple copies of kernel in repetition) then we will be closure to achieving mass food production by means of quantum generators(machine generated) rather than traditional land based farming which has very serious limitations such as large space requirements, uncontrolled contaminants, etc. The development of Quantum Generators requires specialized knowledge in many fields including Cell Biology, Nanotechnology, 3D Cellprinting, Computing, Soil germination and initially they may be big occupying significantly large space and subsequently small enough to be placed on roof-tops.

The Quantum Generators help world meet the food needs of a growing population while simultaneously providing opportunities and revenue streams for farmers. This is crucial in order to grow enough food for growing populations without needing to expand farmland into wetlands, forests, or other important natural ecosystems. The Quantum Generators use significantly less space compared to farmland and also results in increased yield per square foot with short production cycles, reduced cost of cultivation besides easing storage and transportation requirements.

In addition, Quantum Generators Could Eliminate Agricultural Losses arising out of Cyclones, Floods, Insects, Pests, Droughts, Poor Harvest, Soil Contamination, Land Degradation, Wild Animals, Hailstorms, etc.

Quantum generators could be used to produce most important *food* crop *like* rice, wheat and maize on a mass scale and on-demand when and where required.

Computers and Smartphones have become part of our lives and Quantum Generators could also become very much part of our routine due to its potential benefits in enhancing food production and generating food on-demand wherever required by bringing critical advanced technologies into the farmland practices.

3D Bioprinting

3D Bioprinting is a form of additive manufacturing that uses cells and other biocompatible materials known as bioinks, to print living structures layer-by-layer which mimic the behavior of natural living systems. Three dimensional bioprinting is the utilization of 3D printing–like techniques to combine cells, growth factors, and biomaterials to fabricate biomedical parts that maximally imitate natural tissue characteristics. In this paper, we are looking at natural tissues related to food crops like rice, wheat or maize.

METHODOLOGY

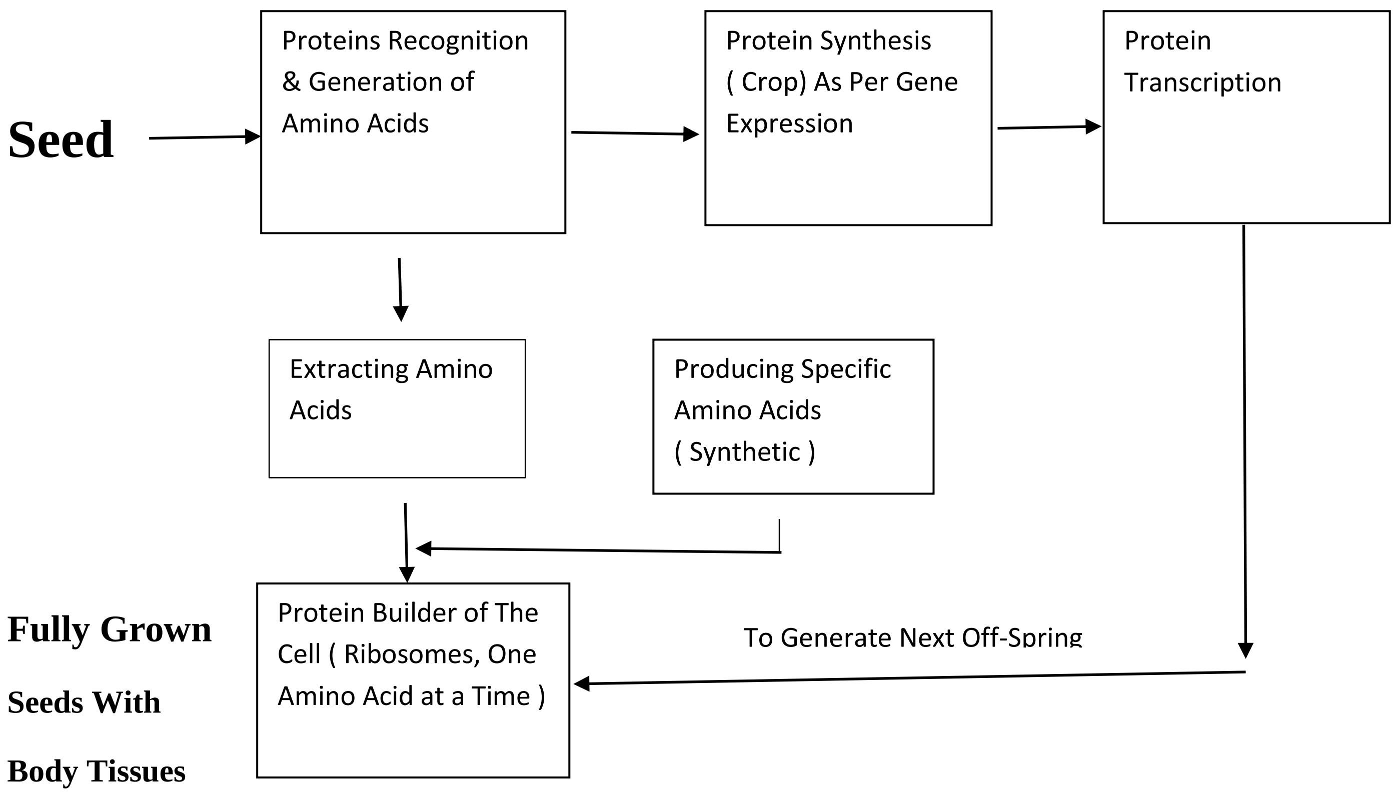


Fig 1. **Process Flow Diagram of Seed Builder**

Protein from input seeds is broken down into individual amino acids which are reassembled by Quantum Generating ribosomes into proteins that Crop cells need to be generated. The information to produce a protein is encoded in the **cell's** DNA. When a protein is produced, a copy of the DNA is made (called mRNA) and this copy is transported to a ribosome.

Protein **synthesis** is the process used by the QG(Quantum Generator) to make proteins. The first step of protein **synthesis** is called Transcription. It occurs in the nucleus. During transcription, mRNA transcribes (copies) DNA.

Body tissues **grow** by increasing the number of cells that make them up. Every **cell** in the crop body contains protein. The basic structure of protein is a chain of amino acids. We need protein in our diet to help human body repair cells and make new ones. Protein is also important for growth and development in children, teens, and pregnant women. The major steps in protein synthesis are:

- DNA unzips in the nucleus.
- mRNA nucleotides transcribe the complementary DNA message.
- mRNA leaves nucleus and goes to ribosome.
- mRNA attaches to ribosome and first codon is read.
- tRNA brings in proper amino acid from cytoplasm.
- a second tRNA brings in new amino acid.

The journey from gene to **protein** is complex and tightly controlled within each cell. It consists of two major **steps**: transcription and translation. Together, transcription and translation are known as gene expression.

Protein synthesis is the process in which **cells make proteins**. It occurs in two stages: transcription and translation. Transcription is the transfer of genetic instructions in DNA to mRNA in the nucleus. Translation occurs at the ribosome, which consists of rRNA and proteins**.**

Ribosomes are the protein builders or the protein synthesizers of the cell. They are like construction guys who connect one amino acid at a time and build long chains. Ribosomes are special because they are found in both prokaryotes and eukaryotes.

Ribosomes, large complexes of **protein** and ribonucleic acid (RNA), are the cellular organelles responsible for protein synthesis. They receive their “orders” for protein synthesis from the nucleus where the DNA is transcribed into messenger RNA (mRNA).

During the **process** of transcription, the information stored in a gene's DNA is passed to a similar molecule called RNA (ribonucleic acid) in the cell nucleus. A type of RNA called transfer RNA (tRNA) assembles the protein, one amino acid at a time.

Ribosomes are the sites in a **cell** in which **protein** synthesis takes place. Cells have many ribosomes, and the exact number depends on how active a particular cell is in synthesizing proteins. For example, rapidly growing cells usually have a large number of ribosomes.

Amino acids can be produced by breaking down proteins, known as the extraction method. However, the amount of amino acids in the source protein limits the amount of amino acids made. Extraction is not good for making mass quantities of specific amino acids**.** So Synthetic Methods of making amino acids is necessary in protein synthesis.

The Quantum Generator contains pre-programmed Protein Synthesizer relevant to specific Crop/Tissue which essentially reassembles ribosomes (Sites in a Cell) into proteins that your crop cells need. The sequence and information to produce a protein is encoded in the synthesizer of Quantum Generator.

Robotics & Machine Learning towards Biological Space Exploration

Machine learning approaches are fundamental to scientific investigation in many disciplines. In biological studies, many of these methods are widely applicable and robotics/automation is helping to progress cell synthesis through biological space exploration and beyond. Scientists have begun to embrace the power of machine learning coupled with statistically driven design in their research to predict the performance of synthetic reactions. For our study, the yield of a synthetic reaction can be predicted using **random forest (machine learning algorithm)** in the multidimensional space obtained from robotic automation to map the yield landscape of intricate synthesis following synthesis code allowing improved prediction of high-yielding conditions and replication mechanisms. Meanwhile, our emphasis is on automation of synthesis, which is controlled by robots/computers rather than by humans. Synthesis through automation offers far better efficiency and accuracy. In addition, the machine learning algorithm explored a wider range of biological space that would need to be performed purely automated random search and it is observed that self-driven laboratories/robots lead the way forward to fast-track synthesis, and collaboration between smart robotics and humans may be sometimes even more efficient than either alone. This brings the development of automation, optimization, and molecular synthesis very close.

In general, this approach allows for faster and more efficient retrosynthetic analysis than any other well-known method. Figure 2 shows a graphical representation of workflow for joining automated retrosynthesis with a synthesis robot and reaction optimization. The retrosynthetic module will generate a valid synthesis of the target that can then be transferred into synthesis code that can be executed in a robotic platform. The optimization module can optimize the whole sequence, getting the feedback from the robot.

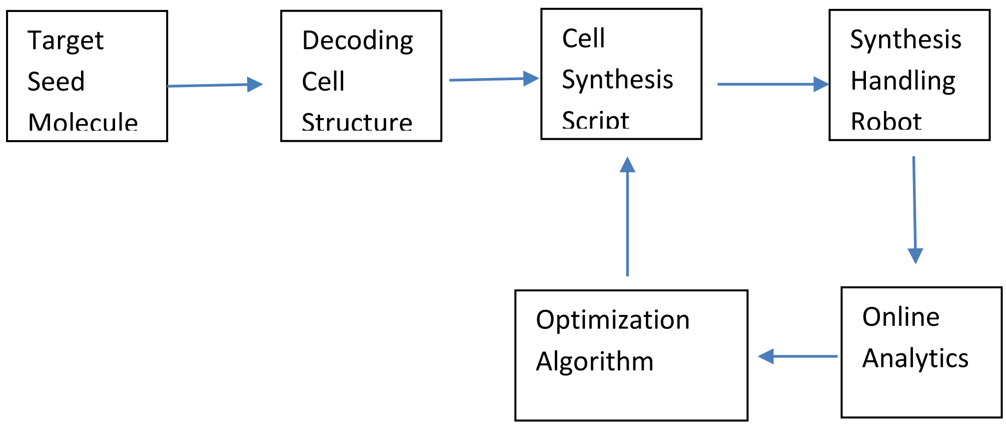


Fig. 2 Architecture of Robotic Synthesis of Crop Cells in a Quantum Generator

The Random Forest is a machine learning algorithm and as the name suggests, "**Random Forest** is a classifier that contains a number of **decision** trees on various subsets of the given dataset and takes the average to improve the predictive accuracy of that dataset. Instead of relying on one **decision tree**, the **random forest** takes the prediction from each decision **tree** and merges them together to get a more accurate and stable prediction.

ARCHITECTURE

Platform Design in Cell Synthesis

Methodologies for the automation of cell synthesis, optimization, and crop yields have not generally been designed for the realities of crop-based yields, instead focussed on engineering solutions to practical problems. We argue that the potential of rapidly developing technologies (e.g., machine learning and robotics) are more fully realized by operating seamlessly with the way that synthetic biologists currently work. This is because the researchers often work by thinking backwards as much as they do forwards when planning a synthetic procedure. To reproduce this fundamental mode of operation, a new universal approach to the automated exploration of cell synthesis space is needed that combines an abstraction of cell synthesis with robotic hardware and closed-loop programming. However, this leads biochemists to constantly test the reactions with different synthetic parameters and conditions. Therefore, the solution to this problem, is the development of an approach to universal synthesis using a programming language with automation in combination with machine learning and artificial intelligence (AI).

Automation Approach

There are different automation approaches for cell synthesis these include block based, iterative, multistep however, we considered CellSynputer which is integration of abstraction, programming and hardware interface, which is given below depicted as in Fig 3.

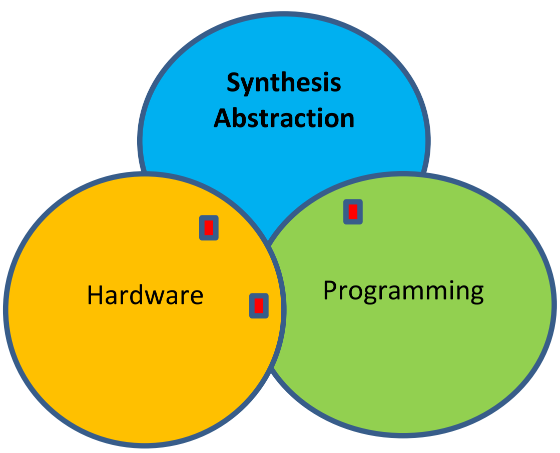


Fig. 3 Approach – Cell Synthesis Automation

Synthetic biologists already benefit from algorithms in the field of cell synthesis and, therefore, automation is one step forward that might help biologists and chemists to plan and develop biological space more quickly, efficiently, and importantly, CellSynputer is a platform that employs a broad range of algorithms interfacing hardware and abstraction to solve synthesis-related problems and surely can very well be established for quantum generation.

Synthesis via Programmable Modular System: 'The CellSynputer'

We presented a modular platform for automating cell synthesis, which embodies our synthesis abstraction in 'the CellSynputer'. Our abstraction of cell synthesis contains the key four stages of synthetic protocols: recognition, gene expression, transcription, and protein builder that can be linked to the physical operations of an automated robotic platform. Software control over hardware allowed combination of individual unit operations into multistep cell synthesis. A CellSynputer was created to program the platform; the system creates low-level instructions for the hardware taking graph representation of the platform and abstraction representing cell synthesis. In this way, it is possible to script and run published syntheses without reconfiguration of the platform, providing that necessary modules are present in the system. The synthesis of different small crop molecules on the system can be successfully scripted and performed automatically with yields comparable to traditional methods.

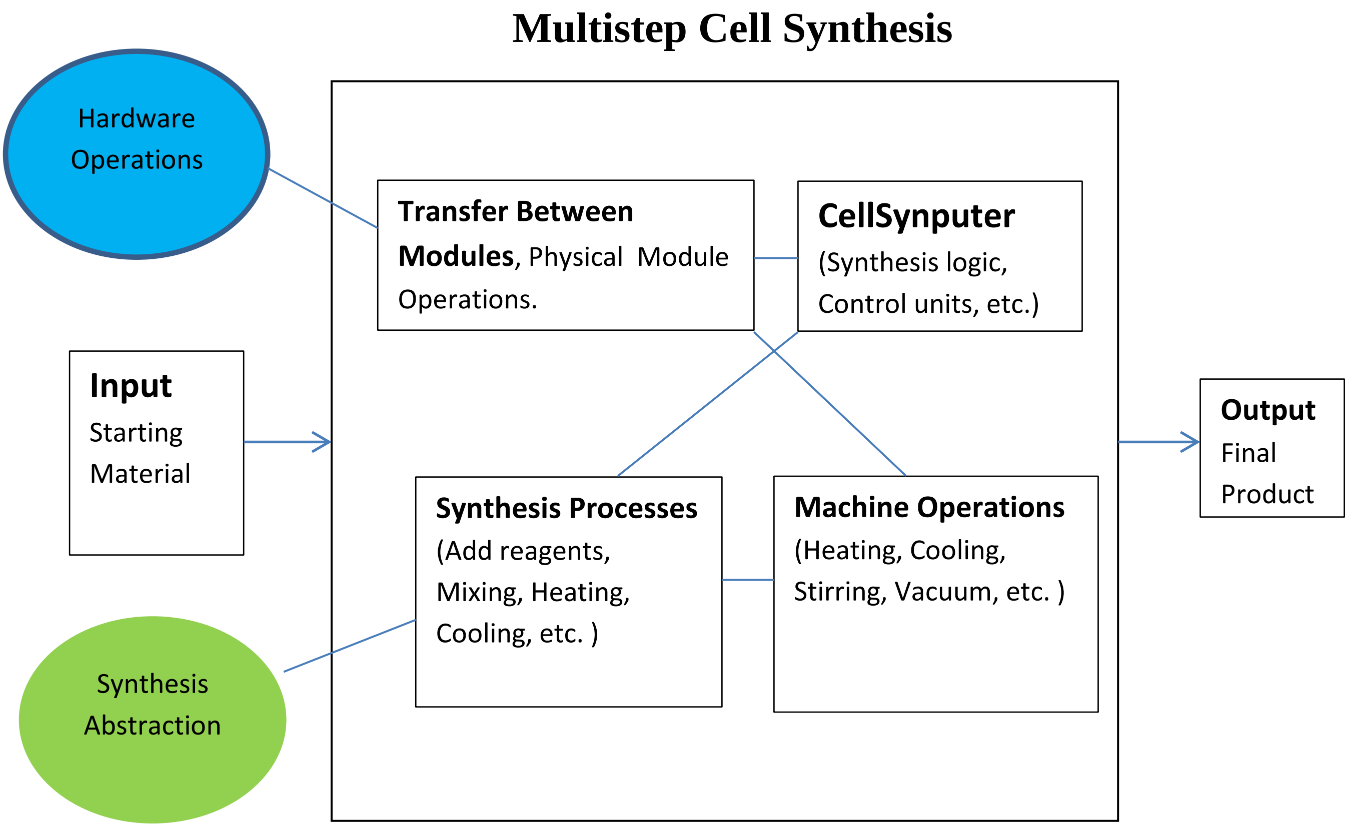


Figure 4. CellSynputer Operational Architecture

Finally, by combining CellSynputer platform and robotic systems with AI, it is possible to build autonomous systems working in closed loop, making decisions based on prior experiments and reactive conditions. We already presented a flow system for navigating a network of synthesis reactions utilizing an infrared spectrometer for on-line analysis and as the sensor for data feedback. The system will be able to select the most reactive or suitable starting materials autonomously on the basis of change in the infrared spectra between starting materials and end products

Parallel Synthesizers

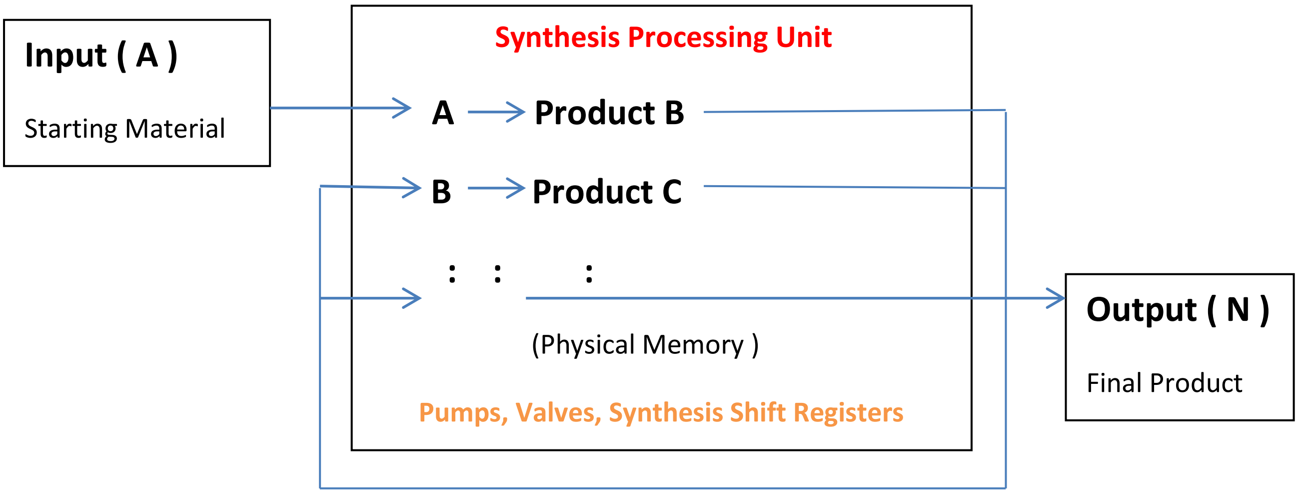
Parallel Synthesizer is a high yielding multiple synthesis systems consisting of parallel processing units & multiple synthesizers, in parallel. These automated multistep units are used as parallel synthesizers for high yield applications for high throughput screening or synthesis. Parallel synthesis with cell synthesis processes is a way to use the advantages of combinatorial synthesis in a manner that provides a more focused approach to the target molecules. This results in a smaller, more concentrated set of molecules, making the process of unit level synthesis easier.

The following are the attributes of parallel synthesizer:

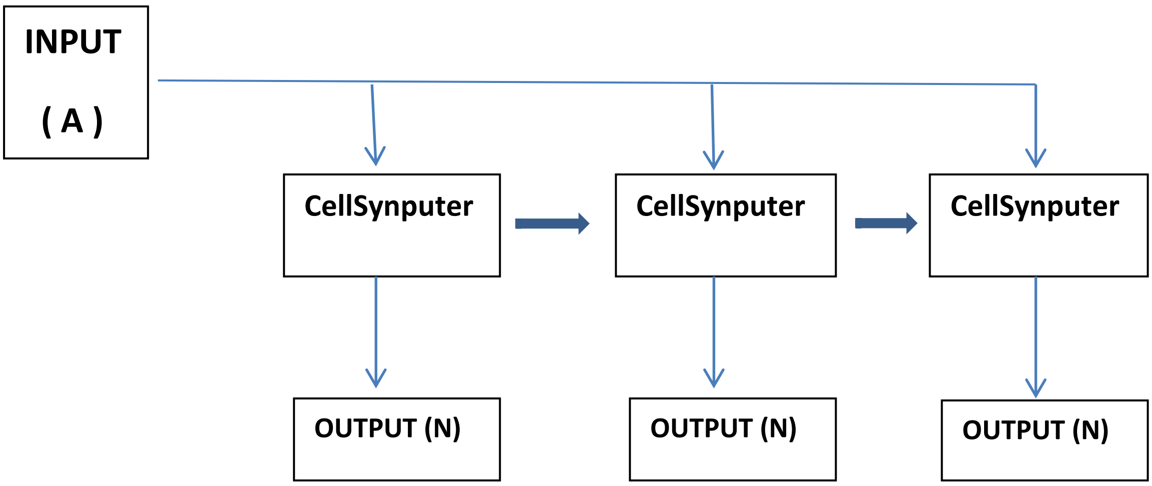
- **Based on multi-unit concept**
- **Configurable at unit level**
- **More versatile**
- **High throughput**
- **Small scale at unit level**
- **Limited to individual synthesis scope**
- **Embodies multistep procedure**

We give below automated cell synthesis using parallel synthesizer in pictorial format:

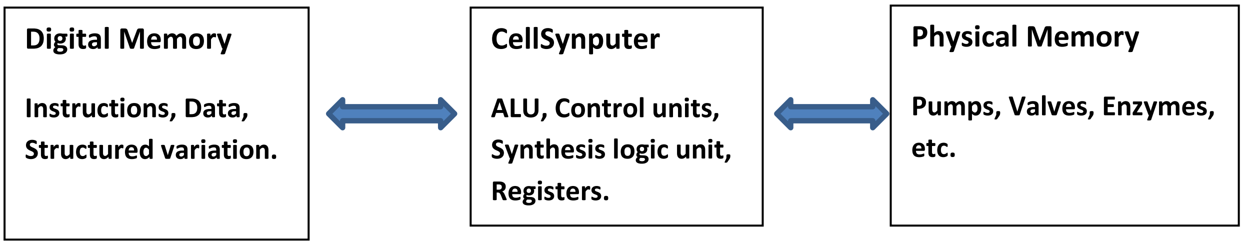
A) N-Step Cell Synthesis



B) Multi-unit Synthesis



C) CellSynputer Architecture



Synthesis Framework

The exploration of biological space by autonomous platform requires it to assess the difference or change of the obtained results in cell space. To achieve this, we proposed a framework for assessing the difference in originality and change of the synthesis results as shown in Figure 5. First, the synthesis process must be repeatable to be valid and exclude any unobserved values in measurement and by the system. Following confirmation of result repeatability, the next step is to check if this result has a precedent. This can be achieved simply by querying a given database containing knowledge of a given subject in a platform memory. If the search confirms that similar observation has been reported, the synthesis can be classified as not new, not contributing added information to our knowledge base. However, if the result has not been observed previously, we need to consider if it could be predicted using all the current knowledge. The predictability implies that this result is not unusual but new to some extent. Unpredictability implies that result obtained is offbeat, for example, a synthesis mechanism that cannot be predicted can be classified as unusual, opening a new set of flow parameters to execute for the platform. Therefore, this framework will enable automatic assessment of the synthesis results by autonomous and digitised robotic platform.

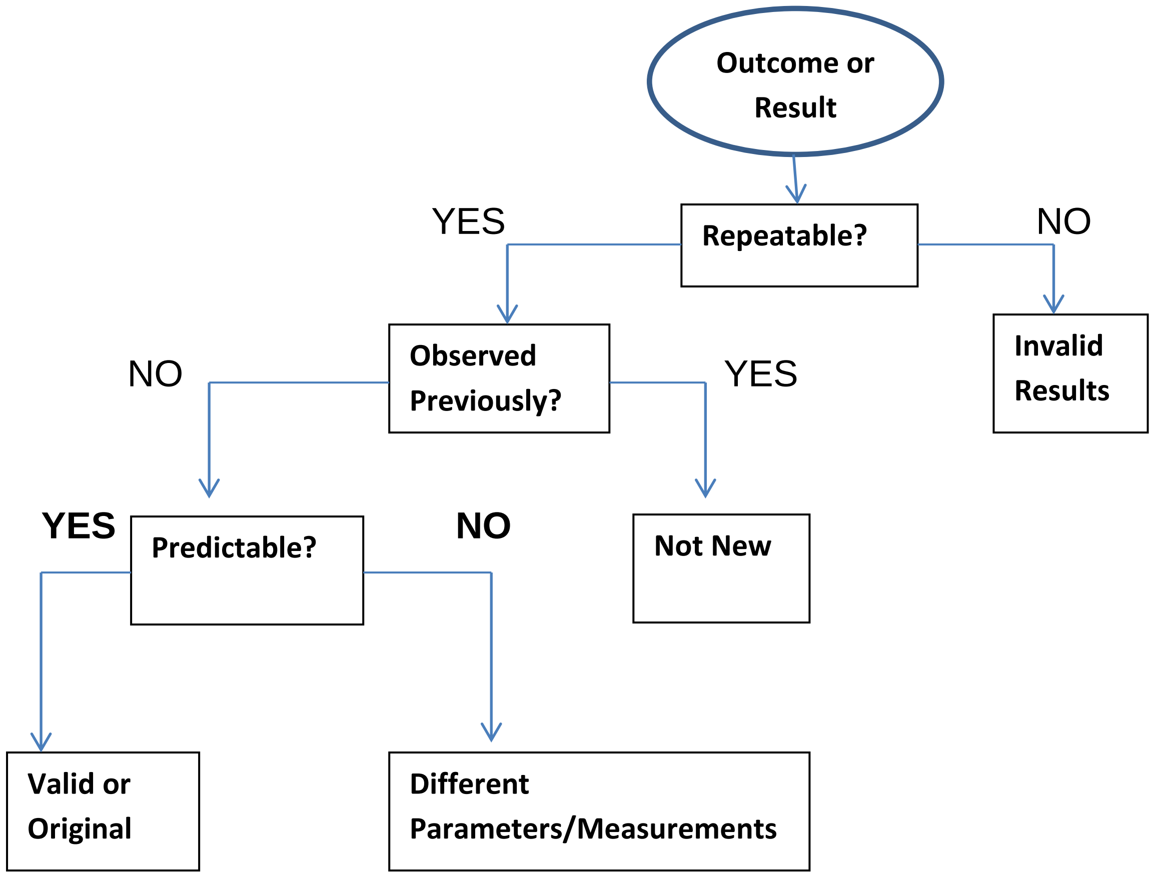


Figure 5. Synthesis Validity Diagram.

CONCLUSION

Quantum Generators (QG) creates new seeds iteratively using the single input seed and the process leads to a phenomenon of generating multiple copies of kernels in repetition. We presented a modular platform development of parallel synthesizers comprising of multistep cell synthesis, which embodies synthesis framework, synthesis abstraction, software control over hardware operations and automation assisted synthesizer in the platform. In this way, it is possible to script and run desired syntheses in parallel mode where the computer creates low-level instructions for the hardware taking interface representation of the platform, framework mechanism for assessing outcome and abstraction representing cell synthesis. Although the platform model given us a method of automating cellular assemblies in a framework embodied multi-unit system however, this need to be tested using natural crop cells and it could be promising for us in achieving quantum generation.

REFERENCE

1. Poondru Prithvinath Reddy: "**Quantum Generators: A Platform for Automated Synthesis in a Modular Robotic System Driven by Cell Programming**", Google Scholar.