

**NANYANG**  
research programme



*Junior*



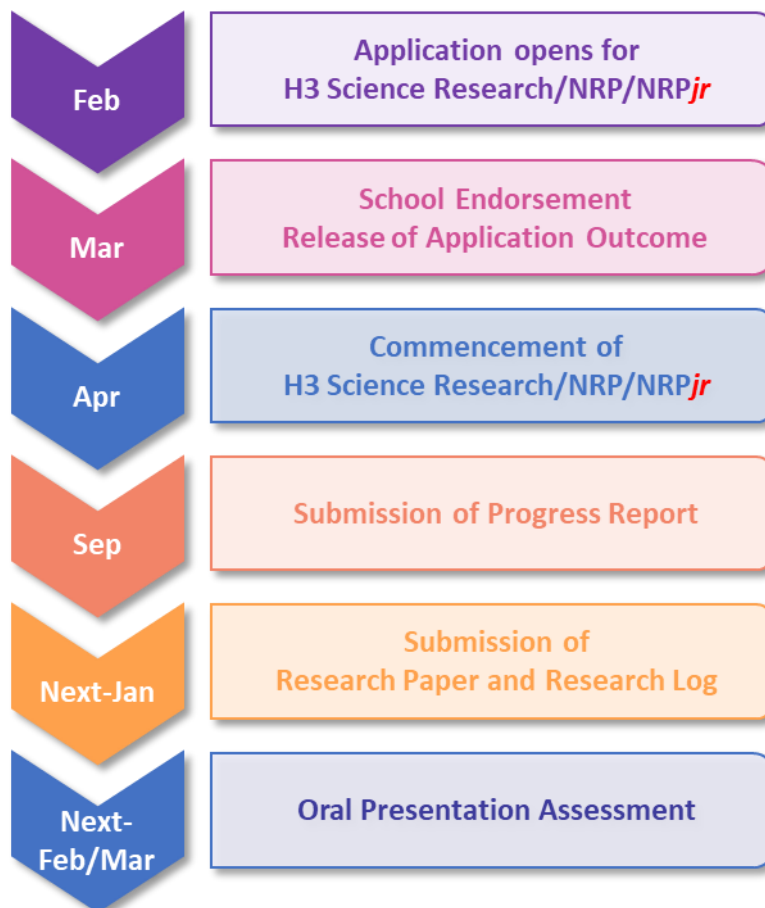
# **NRP<sub>jr</sub> 2024**

## **Project Synopses**

Nanyang Research Programme Junior Researcher (NRPjr) is a sister programme to the Nanyang Research Programme (NRP). It is an enrichment programme targeted at Secondary 3 students and Year 3 and 4 students in Integrated Programme (IP) Schools.

NRPjr seeks to offer students with a keen interest in and aptitude for research the opportunity to engage in the process of intellectual inquiry by undertaking projects in a real research environment under the supervision of NTU faculty and researchers.

Students from the same school will work in pairs and undertake eight months of research activities from April to December, culminating in the submission of a Research Paper in January of the following year and an Oral Presentation Assessment in late February/early March.



Category	Project Code	Project Title
Engineering	<u>CCEB</u> <i>jr</i> 01	Environmental Sustainability of Antimicrobial Peptides versus Small-Molecule Antibiotics Productions
	<u>CCEB</u> <i>jr</i> 02	Evaluating Environmental Sustainability of Bioactive Peptides Production from Life Cycle Assessment Perspectives
	<u>CCEB</u> <i>jr</i> 03	Process Simulation
	<u>EEE</u> <i>jr</i> 01	Wireless Power Transfer to aid Energy Harvesting
	<u>EEE</u> <i>jr</i> 02	Research and development of spectrum-adaptive light
	<u>EEE</u> <i>jr</i> 03	Application of deep learning algorithm for orthogonal frequency-division multiplexing systems
	<u>EEE</u> <i>jr</i> 04	Deep learning based algorithm for frequency estimation from noisy signals
	<u>EEE</u> <i>jr</i> 05	Performance study of DVB-T2 system using common simulation platform (CSP)
	<u>EEE</u> <i>jr</i> 06	Performance study of rotated quadrature amplitude modulation (QAM) signals over fading channels
	<u>EEE</u> <i>jr</i> 07	Artificial Intelligence-based power demand forecasting
	<u>MAE</u> <i>jr</i> 01	Simulation of vortex rings colliding with cylinders
	<u>NIE</u> <i>jr</i> 04	Exploring Local Micro-Climates With Open-Source Sensors

Category	Project Code	Project Title
Sciences	<u>NIE</u> <i>jr</i> 02	Physiological Changes During Aerobic Exercise With Cloth Mask

Category	Project Code	Project Title
Business, Humanities, Arts & Social Sciences	<u>NIE</u> <i>jr</i> 01	Topics in Singapore English
	<u>NIE</u> <i>jr</i> 03	Exploring Digital Tools and Methods for Investigations within the field of Humanities
	<u>NIE</u> <i>jr</i> 05	Cultural Evolution in Singaporean Chinese Textbooks: A Corpus Based Analysis of Primary School Materials

**ENGINEERING**

**School of Chemistry, Chemical Engineering and Biotechnology**

**Project Code** CCEBjr01

**Project Title** Environmental Sustainability of Antimicrobial Peptides versus Small-Molecule Antibiotics Productions

**Description** Antimicrobial peptides represent a powerful class of medicines with unique capability to address the emergence of antibiotic-resistant pathogens. Compared to small-molecule antibiotics, bioactive peptides exhibit superior targeting capability and higher biocompatibility as they're made up of amino acids, which are the building blocks for proteins in the body. Production of antimicrobial peptides, however, is expensive due to the purification steps involving multicycle chromatography steps that require heavy use of organic solvent and low mass yield. Contamination of water systems by antimicrobial peptides after ingestion and excretion from the human body has not been quantified yet. Will this be an issue for the environment?

In this project, the students will be tasked to evaluate the environmental sustainability of antimicrobial peptide production in terms of its global warming potential, human toxicity, and ecosystem toxicity. The goal is to identify the production step that incurs the largest negative environmental impacts. The ultimate goal is to propose an alternative production method to reduce the environmental footprint of antimicrobial peptide production.

The students will be using life cycle assessment (LCA) open-source software. The project involves literature search and data mining to determine the mass/energy input/output of antimicrobial peptide production and how it is compared to small-molecule antibiotics (e.g., penicillin, quinolones, tetracycline). This project doesn't involve any wet laboratory experiments.

**Group Size** Pair

**Specific Knowledge** Keen interest in chemistry and pharmaceutical research  
Ability to carry out literature review and data mining  
Keen interest in computer simulation project

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**ENGINEERING**

**School of Chemistry, Chemical Engineering and Biotechnology**

**Project Code** CCEBjr02

**Project Title** Evaluating Environmental Sustainability of Bioactive Peptides Production from Life Cycle Assessment Perspectives

**Description** Bioactive peptides represent a powerful class of medicines with unique capability to treat complex diseases that are not yet effectively treatable by small-molecule pharmaceuticals or protein biologics. Examples of such diseases include cancer and autoimmune diseases. Compared to small-molecule pharmaceuticals, bioactive peptides exhibit superior targeting capability and higher biocompatibility as they're made up of amino acids, which are the building blocks for proteins in the body. Compared to protein biologics, the smaller molecular weight of peptides opens up avenues to synthesise peptides in the laboratory, unlike protein biologics which must rely on cell culture production. Production of bioactive peptides, however, is expensive due to the purification steps involving multicycle chromatography steps that require heavy use of organic solvent and low mass yield.

In this project, the students will be tasked to evaluate the environmental sustainability of bioactive peptide production in terms of its global warming potential, human toxicity, and ecosystem toxicity. The goal is to identify the production step that incurs the largest negative environmental impacts. The ultimate goal is to propose an alternative production method to reduce the environmental footprint of bioactive peptide production.

The students will be using life cycle assessment (LCA) open-source software. The project involves literature search and data mining to determine the mass/energy input/output of bioactive peptide production. This project doesn't involve any wet laboratory experiments.

**Group Size** Pair

**Specific Knowledge** Keen interest in chemistry and pharmaceutical research  
Keen in computer simulation project  
Ability to carry out literature search on specific topics

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**ENGINEERING**

**School of Chemistry, Chemical Engineering and Biotechnology**

**Project Code** CCEBjr03

**Project Title** Process Simulation

**Description** Chemical engineering is not just about experiments, but also about playing with simulation software.

In this project, we shall look into various parts of the chemical plant. We shall employ a modelling platform - a user-friendly and exciting tool - to simulate and understand the operation of different operations of chemical plants.

The aim of this project is to give students a light appreciation of some core chemical engineering fundamentals with the aid of typically used simulation tools.

**Group Size** Pair

**Specific Knowledge** Students will be doing modelling

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**ENGINEERING**

**School of Electrical and Electronic Engineering**

**Project Code** EEEjr01

**Project Title** Wireless Power Transfer to aid Energy Harvesting

**Description** Smart buildings and smart cities require the seamless integration of wireless sensor networks. The maintenance and replacement of batteries of wireless sensors installed in remote areas inside a building becomes a hassle. Developing low-power wireless sensor sensors and harvesting electromagnetic (EM) energy and other types of energy such as solar, thermal energy, vibration, etc around the wireless sensor as a viable option for achieving self-sufficiency.

In this project, you will be doing a survey on various energy harvesting techniques, and how EM harvesting is done.

**Group Size** Pair

**Specific Knowledge** Interest in Electromagnetics

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**ENGINEERING**

**School of Electrical and Electronic Engineering**

**Project Code** EEEjr02

**Project Title** Research and development of spectrum-adaptive light

**Description** Table lamps currently in the market could have warm or cold white light. Users will choose the one which is suitable for them. However, users typically do not know the scientific reasons for their choice. In fact, our eyes have evolved to adapt to sunlight, which changes from dawn to dusk with various light spectrums from warm to cool white light.

The project will do research on the sunlight spectrum throughout the day and build the table lamp with a tunable spectrum that can change the spectrum according to the user's need or following the sunlight so that users have a feeling of outdoor light.

Students will not only learn about the sunlight spectrum but also control the light with a simple microcontroller (Arduino) and coding.

**Group Size** Pair

**Specific Knowledge** NIL

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**ENGINEERING**

**School of Electrical and Electronic Engineering**

**Project Code** EEEjr03

**Project Title** Application of deep learning algorithm for orthogonal frequency-division multiplexing systems

**Description** Recently, orthogonal frequency-division multiplexing (OFDM) techniques have been widely used for wireless communication systems, including the fifth generation (5G) cellular system. To further improve the performance and robustness of the OFDM systems, deep learning based algorithms have been introduced.

In this project, the student will study and design a deep learning based receiver for OFDM system in an end-to-end approach. We will explore the advantage of the deep learning model to recover the distorted signal. Moreover, the channel state information will not be required as compared with the traditional method. Matlab and Python simulations will be conducted to study the performance of the proposed system.

**Group Size** Pair

**Specific Knowledge** Preferably to have basic programming skills in Matlab and Python, though it is not compulsory, as students should be able to pick up the skills during the execution of the project.

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**ENGINEERING**

**School of Electrical and Electronic Engineering**

**Project Code** EEEjr04

**Project Title** Deep learning based algorithm for frequency estimation from noisy signals

**Description** Estimation of the frequency of a noisy modulated signal has been one of the main challenges in the field of signal processing and communications.

The objective of this project is to investigate the existing techniques for frequency estimation. Following that, a deep learning algorithm will be proposed to estimate the frequency of the modulated signal that is corrupted by Gaussian noise with the advantages of having higher accuracy and faster estimation time. Comparisons between existing frequency estimation methods and the proposed deep learning-based method will be carried out.

Matlab or Python programming will be used to study the performance of the proposed scheme.

**Group Size** Pair

**Specific Knowledge** Preferably to have basic programming skills in Matlab and Python, though it is not compulsory, as students should be able to pick up the skills during the execution of the project.

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**ENGINEERING**

**School of Electrical and Electronic Engineering**

**Project Code** EEEjr05

**Project Title** Performance study of DVB-T2 system using common simulation platform (CSP)

**Description** Recently, the Terrestrial Digital Video Broadcast (DVB-T2) system has widely been deployed worldwide. It has been officially adopted as well in Singapore. The DVB-T2 system can provide much better signal quality.

The main focus of this project is on the decoding of the DVB-T2 signals under various channel conditions such as additive white Gaussian noise (AWGN) and fading channels. The performance of the algorithms will be studied and verified through the readily available common simulation platform (CSP).

Matlab simulation will be conducted to study its performance under different scenarios of channel conditions.

**Group Size** Pair

**Specific Knowledge** Preferably to have basic programming skills in Matlab, though it is not compulsory, as students should be able to pick up the skills during the execution of the project.

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**ENGINEERING**

**School of Electrical and Electronic Engineering**

**Project Code** EEEjr06

**Project Title** Performance study of rotated quadrature amplitude modulation (QAM) signals over fading channels

**Description** Recently, rotated quadrature amplitude modulation (QAM) has been widely used in practical wireless systems. One of the important applications is the digital video broadcasting system in Singapore.

In this project, the objective is to study rotated QAM signals and simulate their bit-error rate (BER) performance over various fading channels. The performance of the algorithms will be analyzed and verified through the commonly available simulation programs from the common simulation platform (CSP). Matlab programming will be used for BER simulation.

**Group Size** Pair

**Specific Knowledge** Preferably to have basic programming skills in Matlab, though it is not compulsory, as students should be able to pick up the skills during the execution of the project.

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**ENGINEERING**

**School of Electrical and Electronic Engineering**

**Project Code** EEEjr07

**Project Title** Artificial Intelligence-based power demand forecasting

**Description** This project aims to develop an artificial intelligence (AI)-based method for power load demand forecasting.

The students are expected to do computer programming for an AI model, and then use the historical electricity load data to train and test the model.

**Group Size** Pair

**Specific Knowledge** Matlab programming, preliminaries of artificial intelligence.

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**ENGINEERING**

**School of Mechanical and Aerospace Engineering**

**Project Code** MAEjr01

**Project Title** Simulation of vortex rings colliding with cylinders

**Description** Jet impingement based problems are central towards many engineering problems, such as cold-spraying based additive manufacturing, heat transfer, textile industries, cooling/heating of components, among others.

For this project, the students will conduct flow simulations on vortex rings colliding on cylinders which are either offset from the collision axis to investigate the asymmetry of the resulting flow, or what happens if multiple vortex rings were to collide with the cylinder simultaneously. ANSYS Fluent software will be used and the students will have a PhD student to consult with during the project.

**Group Size** Pair

**Specific Knowledge**

1. ANSYS Fluent from MAE computer labs
2. Paraview (open-source)

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**ENGINEERING**

National Institute of Education

**Project Code** NIEjr04

**Project Title** Exploring Local Micro-Climates With Open-Source Sensors

**Description** You will be using open-source environmental sensors (based on Arduinos) to build a dataset of the microclimate around your home, over a period of time spanning the duration of the project.

You and your team-mate will use the datasets to compare the microclimate from your two respective sites, and make reasoned inferences and analyses regarding the variation in the patterns of the data observed. The sensors can be configured to measure variables such as light, temperature, and humidity. They can be self powered and can be configured to run-off regular handphone battery-pack chargers.

For extension activities, you and your team-mate could explore modifying and customising the sensors, and/or modifying the source code, and/or thinking about different ways of housing the sensors and weatherproofing them, possibly using fabricated parts that you yourselves design.

You will come away with a more informed understanding of how and why microclimate varies over time, using empirical data gathered from your respective local (home) environments.

Your study can contribute to wider datasets that the research team is already building in Singapore as well as in other countries in ASEAN.

**Group Size** Pair

**Specific Knowledge** NIL

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SCIENCES

National Institute of Education

**Project Code** NIEjr02

**Project Title** Physiological Changes During Aerobic Exercise With Cloth Mask

**Description** As Coronavirus Disease 2019 evolves to become an epidemic and the future of mask wearing activities is unknown, understanding the physiological effect and exercise performance with reusable cloth mask (RCM) is essential. It is hypothesized that RCM impedes airflow transmission between environment and user, hence a negative impact on the ventilatory breakpoint (V<sub>pt</sub>) and physiological variables (i.e. blood lactate, heart rate and oxygen consumption). However, the understanding is not concrete and many other studies conducted on surgical mask shows conflicting results.

There are three objectives to the study:

- 1) To investigate the physiological effects of reusable cloth mask (RCM) worn during exercise,
- 2) To investigate the perceived exertion level and perceptual discomfort of RCM during aerobic exercise, and
- 3) to determine the appropriate exercise intensity level while wearing a RCM during exercise for healthy adults.

The study will look into the physiological makers, perceptual mask discomfort, and rate of perceived exertion during aerobic exercise. The study adopts a randomized crossover counterbalanced experimental design. All participants will be randomly assigned into the experimental (with RCM) or control group (without RCM) and the changeover will take place in the following week. A submaximal graded exercise treadmill protocol will be used to conduct the experiment where the ventilatory breakpoint will be identified. The protocol requires participants to run and rest for four minutes each, on an alternate basis until volitional exhaustion is achieved.

**Group Size** Pair

**Specific Knowledge**

- 1) Communication skills
- 2) Attention to details
- 3) Adhere to protocols and guidelines for safe procedures in laboratory
- 4) Positive learning attitude and open mind
- 5) Basic understanding of human anatomy, circulatory and respiratory systems, effect of exercise and training

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**BUSINESS, HUMANITIES, ARTS & SOCIAL SCIENCES****National Institute of Education****Project Code** NIEjr01**Project Title** Topics in Singapore English

**Description** For this project, we will work on natural language data from Colloquial Singapore English (otherwise known as Singlish). Data will either be collected through elicitation/production tasks, designed experiments, or from existing corpora/data sets. Singapore English is a contact variety of English with several unique features. The specific aspect of Singapore English, as well as how the data is analysed will depend on the linguistic subfield of your choice: syntax (structure), semantics/pragmatics (meaning), or phonology/phonetics (sound). I am fine with adopting whatever linguistic framework you prefer to use.

**Group Size** Pair

**Specific Knowledge**

- Native speaker of Singapore English, or have easy access to one.
- Good intuition, interest and curiosity in the way language is produced and processed.

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**BUSINESS, HUMANITIES, ARTS & SOCIAL SCIENCES**

**National Institute of Education**

**Project Code** NIEjr03

**Project Title** Exploring Digital Tools and Methods for Investigations within the field of Humanities

**Description** In this project, you will learn how to use digital tools and methodologies to investigate a Humanities-related topic of your choice. The field of Digital Humanities is broad, so potential projects might involve (though not limited to) using text mining tools to analyse historical texts, using Geographical Information Systems (GIS) to analyse maps, or using network analysis to analyse relationships between characters in a work of literature.

You will be guided through the design of a project, which will be crafted to align with your own interests as feasibly possible. As such, you will come away with a deeper understanding of how digital tools can be used to analyse and interpret data within your chosen Humanities topic.

**Group Size** Pair

**Specific Knowledge** NIL

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**BUSINESS, HUMANITIES, ARTS & SOCIAL SCIENCES**

**National Institute of Education**

**Project Code** NIEjr05

**Project Title** Cultural Evolution in Singaporean Chinese Textbooks: A Corpus Based Analysis of Primary School Materials

**Description** Chinese textbooks play a pivotal role in language education, serving as a reflection of cultural connotations inherent in Chinese teaching. Singapore, influenced by unique geographical, historical, political, and racial factors, exhibits a multicultural essence within its Chinese teaching materials. However, the cultural orientation of Singaporean Chinese textbooks manifests distinct characteristics over time, shaped by internal and external environmental dynamics.

This study examines five sets of primary school Chinese textbooks under Singapore's new education system, employing corpus linguistics to systematically analyze the cultural vocabulary. The analysis focuses on cultural attributes, era characteristics, and regional distinctions within the vocabulary. By delving into the cultural context, this research aims to illuminate the historical teaching objectives, scope, and value orientation. Furthermore, it provides a macroscopic view of the development trajectory of Chinese teaching in Singapore, offering insights into its future direction.

The study attempts to explain the significance of cultural content existence, and internal motivations driving choices and suggests implications for the ongoing evolution of Chinese teaching in Singapore.

**Group Size** Pair

**Specific Knowledge** NIL

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