

# APPLIED SCIENCES GROUP

## WHERE INNOVATION LIVES

We leverage innovation to achieve greater efficiency in testing and analysis for our nation's health and safety.

# KNOWLEDGE AND INNOVATION

We constantly innovate to create new testing capabilities, methods, and products to meet stakeholder needs.



## NEW TESTING CAPABILITIES THROUGH OUR NEW BIOLOGICS LABORATORY

In May 2023, we began operations of our new Biologics Laboratory to safeguard public health by providing the following testing services:

-  Lot release for locally manufactured vaccines
-  Post-market surveillance testing of biologics in the local market
-  Investigation of substandard and unsafe biological products

## FIRST SET OF SIGNATURE HEXAPEPTIDE CRMS WITH METROLOGICAL TRACEABILITY LAUNCHED

We unveiled two first-in-the-world Certified Reference Materials (CRMs) designed for calibrating HbA1c measurement using the isotope dilution mass spectrometric (IDMS) method. The glycated VHLTPE Peptide Solution (HRM-3010A) and VHLTPE Peptide Solution (HRM-3011A) assigned by higher order IDMS method provide reference laboratories with an unbroken chain of traceability to the International System of Units (SI) from HSA.



## EVALUATING ALTERNATIVE LDL-CHOLESTEROL EQUATIONS




We successfully used External Quality Assessment (EQA) programme data to evaluate alternative published equations for calculated LDL-cholesterol, including the Friedewald equation. We found an alternative equation that gave the least difference against HSA's traceable LDL-C reference values and fewer misclassifications, especially in samples with higher triglycerides and LDL-cholesterol levels associated with higher risk patients.

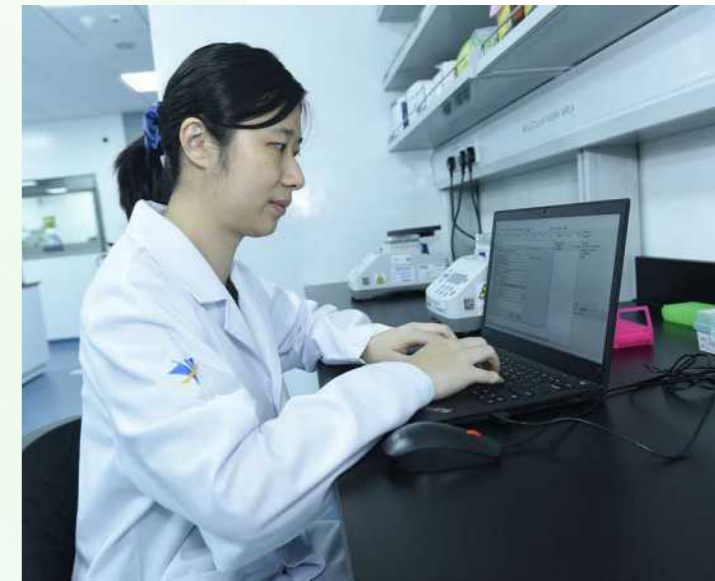
# ENHANCING OUR EFFICIENCY

We embrace digitalisation, striving for greater efficiency and ways to enhance our workflow.

## INTRODUCING DIGITALISED AND AUTOMATED LOT RELEASE PROCESSES FOR LOCALLY MANUFACTURED VACCINES



We developed a Lot Release App to streamline workflow and enhance efficiency, productivity and data management. Key features include:

-  Automatic retrieval and population of lot release request data submitted by manufacturers via FormSG
-  Real-time tracking of lot release status with a built-in alert system to trigger different roles for actions to ensure timely lot release
-  Centralised sample information, test and evaluation results, and communication to facilitate seamless information exchange within HSA



## DIGITALISATION OF DNA DATABASING TO ACHIEVE EFFICIENT, PAPERLESS WORKFLOW

By leveraging the new Laboratory Information Management System to digitise case data, our DNA Database Laboratory has reviewed and revised work processes to simplify report retrieval and reduce physical storage space required for hardcopy reports.

-  60% less time required for preparation of reports
-  80% reduction in paper usage

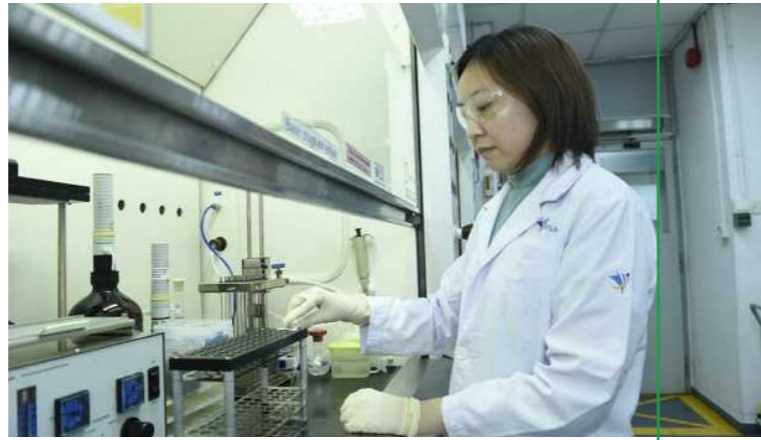
### TOXICOLOGY AND DRUG TESTING INNOVATIONS



#### New workflow for acidic and neutral drugs

Our newly created workflow:

- Requires **5x** less amount of blood
- Supports quantitative analysis of **80 drugs** and qualitative screening for more than **300 drugs**
- Combines **5** separate workflows on **4** different instruments into **1** single process
- Reduces processing time by **62%**, saving **680 man-hours a year**



#### Consolidation of hair confirmation lab workflows

The consolidation of four different workflows into one:

- Reduces analysis time from **6** to **2** days
- Requires **5x** less hair for analysis



#### Expanded testing scope for drugs

We expanded the scope of our urine testing service to encompass emerging drugs. We also achieved enhanced sensitivity in our testing of controlled drugs in a wide range of edible products, including medications.

- Number of drugs that we can test per run (timeframe): Up from **221** to **230**



#### Improvement works in our Illicit Drugs Laboratory

To better manage the increase in workload of our Illicit Drugs laboratory, we embarked on a project to relook at our laboratory space and work processes. This resulted in:

- An expansion of our laboratory space by **25%** to support better segregation and dedicated processing areas for various drug types. This expansion also accommodated the space needed for our new sample preparation automation system, with expected savings of **0.4 headcount** per year.



#### Automated analysis of urine samples

By automating our laboratory processes, we have been able to do away with the laborious process of manually preparing urine samples. Our new method for cannabinoid analysis is capable of differentiating metabolites of delta-8-THC from delta-9-THC in a single run, as well as processing all samples significantly faster.

- Cannabinoid analysis reduced from **2 working days** to **4 hours**, saving **350 man-hours a year**



### USING DIGITAL TOOLS TO INCREASE PRODUCTIVITY



#### Problem



#### Solution



#### Outcome

Difficulty in evaluating the uptake of Certified Reference Materials (CRMs)

Used Tableau dashboard to examine historical sales data and illustrate revenue from sales

Gained insights into which CRMs should be maintained or discontinued

Analysis of video evidence involving metadata retrieval is time consuming and prone to human error

Developed a Python script to automate the process

Savings of about 2 to 3 man-hours for a video with over 250,000 frames

Substantial time and effort are required to verify exhibit markings in the report drafting process

Created a check bot using Python script to automatically compare exhibit markings from reports with those obtained from the system and flag out errors

Improved efficiency and a higher degree of accuracy and consistency in reports

Tracking the laboratory's turnaround time and performance monthly on Excel is time-intensive

Created a Python script to automate the process and perform data cleaning. Tableau dashboard was also used to improve data visualisation

Latest statistics are updated within minutes and are free from human error

Manual monitoring of quality control data and trend analysis is labour and time-intensive

Leveraged Robotic Process Automation to monitor performance indicators for DNA laboratory processes

Early detection of systemic issues has enabled more effective management of risks



# LEARNING FROM THE EXPERTS

We value constant learning to acquire new knowledge that strengthens our scientific capabilities.

## IMPLEMENTED CODIS 11 TO ENHANCE DISASTER VICTIM IDENTIFICATION (DVI)

We became the first laboratory outside of the United States to implement CODIS 11 – the latest version of the DNA databasing software that was created by the US Federal Bureau of Investigation.

As part of the implementation process, we were trained on:



Direct and familial DNA profile searches



Pedigree tree construction



Kinship determination



This has enabled us to:



Process DNA profiles and perform kinship reconciliation from DVI incidents in-house



Strengthen our capabilities for DVI in mass fatality incidents



## VACCINE LOT RELEASE TRAINING BY EXPERT FROM BELGIUM

Dr Geneviève Waeterloos, Head of Quality of Vaccines and Blood Products at Sciensano, Belgium conducted a Vaccine Lot Release Training for HSA in July 2023.

As part of the training, she shared about Sciensano's experience in lot release of vaccines, current practices of the EU Official Control Authority Batch Release (OCABR) and WHO guidelines.

The session provided us with useful knowledge for improving our future workplans, quality management system and vaccine lot release workflow. It also established a foundation for potential collaborations with Sciensano.

# LOCAL PARTNERSHIPS

We actively share knowledge to promote collaboration and cultivate a well-informed and engaged community.



## SEPTEMBER 2023

### Science Centre Singapore

**Citizen Forensic Science Day** – We provided members of the public with insights about modern-day forensic examination techniques, such as DNA and illicit drugs analyses and trace evidence examination, through a mock-up crime scene, and lectures.

**Virtual CSI Game “ArenaX”** – Upper primary and secondary students were introduced to concepts and scientific techniques of crime scene processing, bloodstain pattern analysis, firearms, fingerprint and DNA analysis through a virtual investigation of a murder.

## OCTOBER 2023

### CNB, MOH, HPB, ICA, SAF, NPARKS, Singapore Customs, MSF and NEA

To enhance the knowledge of public officers from various local agencies dealing with issues of vaping, we conducted a sharing session and a laboratory tour that offered insights into the local drug scene, the rising trend of vaping, legislative controls and potential health risks associated with vaping.



## MARCH 2024

### NTU Odyssey Programme and American Chemical Society NUS Student Chapter

HSA was invited to partner the NTU Odyssey Programme and American Chemical Society NUS Student Chapter to run the Forensic Science Workshop cum Competition 2024.

Our forensic scientists gave lectures on illicit drugs, DNA and bloodstain pattern analysis, and conducted workshops on fourier-transform infrared spectroscopy (FTIR) and handheld Raman spectrometer. The event connected us with over 200 STEM students from NTU and NUS.



# INTERNATIONAL PARTNERSHIPS

We forge close ties with our overseas partners to leverage diverse expertise, resources and perspectives.

## NATIONAL INSTITUTE OF METROLOGY (NIM), CHINA

In November 2023, HSA signed a Memorandum of Understanding (MOU) with NIM China virtually at the 39<sup>th</sup> Asia Pacific Metrology Programme General Assembly and Related Meetings.

The MOU provides a framework for the exchange of knowledge and personnel to increase both HSA and NIMs' scientific and technical capabilities in addressing measurement issues related to clean water, infectious diseases and clinical diagnostic markers. It also covers advanced techniques for nuclear magnetic resonance spectroscopy.



## 2023 ANNUAL PERMANENT FORUM ON INTERNATIONAL PHARMACEUTICAL CRIME & INTERNATIONAL LABORATORY FORUM ON COUNTERFEIT MEDICINES

Through these two forums held in Singapore in September 2023, HSA shared invaluable insights on identifying trends associated with new drug analogues, testing of novel nitroso-impurities in health supplements, and pharmaceutical counterfeiting and adulterated health products.

## ASEAN PHARMACEUTICAL TESTING LABORATORY COMMITTEE (APTLC) MEETING

As the Chair of the 4<sup>th</sup> APTLC Meeting which was held in the Philippines in November 2023, HSA focused on key initiatives to strengthen and enhance the APTLC framework, as well as commemorated the completion of the compilation of test methods and adoption of guidelines by all ASEAN member states.

## ASEAN REFERENCE SUBSTANCES PROJECT

HSA continued its active involvement in the ASEAN Reference Substance Project, establishing secondary drug reference standards for reliable use across ASEAN member countries.

Highlights over the year included spearheading the establishment of an ASEAN Reference Substance (PARS) – Gemfibrozil, together with Brunei, Indonesia and the Philippines, and participation in the Vietnam-led inter-laboratory study of Tobramycin PARS.

## WORLD HEALTH ORGANIZATION

**June 2023** – Our Cigarette Testing Laboratory was redesignated as the WHO Collaborating Centre for Tobacco Testing and Research for another four-year term.

**October 2023** – The monograph on 1-Nitroso-4-Methyl Piperazine (MeNP) in Rifampicin Products that we developed was accepted at the 57<sup>th</sup> WHO Expert Committee Meeting on Specifications for Pharmaceutical Preparations for inclusion in the International Pharmacopoeia.

**October 2023** – Our support to help WHO set up a test strategy for determining “Diethylene Glycol (DEG) and Ethylene Glycol (EG) in liquid preparation for oral use” resulted in a new monograph being published in the International Pharmacopoeia.

## ASEAN COSMETICS TESTING LABORATORY COMMITTEE (ACTLC)

Updates this year included the development of a concept and framework for a harmonised approach on cosmetics method review together with Thailand and Brunei.

We were also joint organisers of the 21<sup>st</sup> ACTLC meeting in November 2023, which saw members agreeing to harmonise the technical review framework on cosmetic testing, and renew their pledge to strengthen collaborative efforts in improving regulatory compliance and product safety.

## PROBABILISTIC GENOTYPING WORKSHOP

We organised a training workshop on the use of Probabilistic Genotyping (PG) and Likelihood Ratios in crime casework. PG is a statistical method for the interpretation of complex DNA profiles and deconvolution of more contributors than currently available methods. It was attended by over 140 participants from HSA and Korea, Malaysia, Brunei, Philippines, Thailand and Indonesia.



## ASIAN FORENSIC SCIENCES NETWORK (AFSN)

### Approved Basic Blood Pattern Analysis (BPA) trainer

In June 2023, our Forensic Chemistry & Physics Laboratory was approved by the International Association of Bloodstain Pattern Analysts (IABPA) to conduct the 40-hour Basic BPA training course.



Only **59 agencies** worldwide are certified to conduct this course



Our first trainees were our AFSN counterparts



### Regional trainer for forensic workshops

Over the year, we successfully conducted workshops for several AFSN workgroups, covering the following topics:

- Introduction to Traffic Crash Reconstruction
- Bloodstain Pattern Analysis
- Practical Vehicle Paint Analysis & Database
- Tape Analysis
- Hair Drug Testing
- Quality System and Method Validation
- Cannabis and NPS Analysis in Various Matrices
- Laboratory Information Management System



### Inter-laboratory and collaborative exercises

We facilitated various inter-laboratory exercises, including one to evaluate the effectiveness of a newly released DNA amplification kit for detecting DNA degradation and inhibition.

We also organised collaborative exercises:

- Document Examination for AFSN Questioned Documents Workgroup
- Bloodstain Pattern Analysis for AFSN CSI Workgroup



## ASIA PACIFIC METROLOGY PROGRAMME (APMP)



In November 2023, Dr Teo Tang Lin, Division Director of HSA's Chemical Metrology Division, became the first Singaporean elected to chair APMP's Technical Committee for Amount of Substance.

From end-2024 to 2027, Dr Teo's duties will include coordinating the review of all chemistry and biology calibration and measurement capability claims of APMP's member institutes to ensure compliance with requirements of the International Committee for Weights and Measures (CIPM) Mutual Recognition Arrangement (MRA).

## ORGANISATION OF SCIENTIFIC AREA COMMITTEES (OSAC) FOR FORENSIC SCIENCE

In July 2023, Ms Nellie Cheng from our Forensic Chemistry & Physics Laboratory was appointed as an Affiliate Member of the Forensic Document Examination (FDE) Subcommittee, Physics/Pattern Interpretation Scientific Area Committee, OSAC for Forensic Science.

The appointment in OSAC acknowledges HSA's international forensic standing, providing an opportunity to influence FDE standards and best practices, while staying informed about emerging topics in the field.

## EUROPEAN NETWORK OF FORENSIC SCIENCE INSTITUTES (ENFSI)

We were the sole Asian representative in the 20-member collaborative DNA Recovery and Activity (ReAct) Study aimed at building a probability repository for evaluating activity-related DNA transfer hypotheses, which are increasingly being raised in court.

We also organised a collaborative exercise on fibre examination for the European Textile and Hair Group.

# BENCHMARKING OF MEASUREMENT CAPABILITIES

Our measurement results are benchmarked to established metrology institutes and reference laboratories.

## PARTICIPATION IN INTERNATIONAL COMPARISONS AND STUDY

Comparisons	Organised by
CCQM Key Comparison on Measurement of Nanoparticle Number Concentration in Liquid Suspension	LGC, United Kingdom
IFCC External Quality Scheme for Reference Laboratory (RELA) for 17 $\beta$ -estradiol	Reference Institute for Bioanalytics (RfB), Germany
CCQM Key Comparisons on <ul style="list-style-type: none"> <li>• Mass Fraction of Oxytetracycline in Oxytetracycline Hydrochloride Material</li> <li>• Mass Fraction of Oxytetracycline Hydrochloride Salt</li> </ul>	International Bureau of Weights and Measures (BIPM)
CCQM Key Comparison on Polar Analyte in High Protein Food Matrix – Metronidazole in Porcine Muscle	The Federal Office of Consumer Protection and Food Safety (BVL), Germany
CCQM Pilot Study on Fire Drill Influenza RNA copy number quantification	LGC, United Kingdom and National Institute of Science and Technology (NIST), United States

## 2023 COLLABORATIVE STUDY FOR DPVS

We were invited by the United States Pharmacopoeia (USP) to contribute to the 2023 Collaborative Study for the Dissolution Performance Verification Standard-Prednisone (DPVS). This study aims to establish acceptance ranges for Prednisone Tablets in USP's Performance Verification Test.



# ACCREDITATIONS/ INTERNATIONAL PEER REVIEW

We expanded our professional accreditations/peer review as part of our ongoing commitment to uphold international standards and best practices.

## ISO/IEC 17043:2010

In August 2023, the Chemical Metrology Laboratory completed its surveillance assessment by the Singapore Accreditation Council (SAC), maintaining its status as the only accredited provider of Proficiency Testing (PT) and External Quality Assessment (EQA) programmes in Singapore for 10 years since 2013.

## ISO/IEC 17025:2017

Pharmaceutical Division's chemical laboratories achieved full compliance in its SAC-SINGLAS extended surveillance assessment, with the following accomplishments:



### Pharmaceutical Laboratory

expanded its scope of accreditation to include three new tests:

- Determination of Dihydrocodeine, Codeine & Pholcodine by high-performance liquid chromatography with diode-array detection (HPLC-DAD)
- Analysis of Sodium Borate by inductively coupled plasma mass spectrometry (ICPMS)
- Determination of Six Nitrosamine Impurities in Western Medicines by liquid chromatography–mass spectrometry (LC-MS)/MS



### Cosmetics Laboratory

expanded its scope of accreditation to include the Identification and Determination of Climbazole in Cosmetic Products



### Cigarette Testing Laboratory

expanded its scope of accreditation to include the Determination of the pH of Smokeless Tobacco Products



## INTERNATIONAL PEER REVIEW

From February to March 2023, Chemical Metrology Laboratory completed its peer review by SAC and international metrology experts from metrology institutes in South Korea, China and United Kingdom. HSA continued to demonstrate capability to disseminate traceability in organic and inorganic chemical measurements and peptide/protein measurements to customers through its metrological services, fulfilling Singapore's obligation towards the International Committee for Weights and Measures (CIPM) Mutual Recognition Arrangement (MRA).