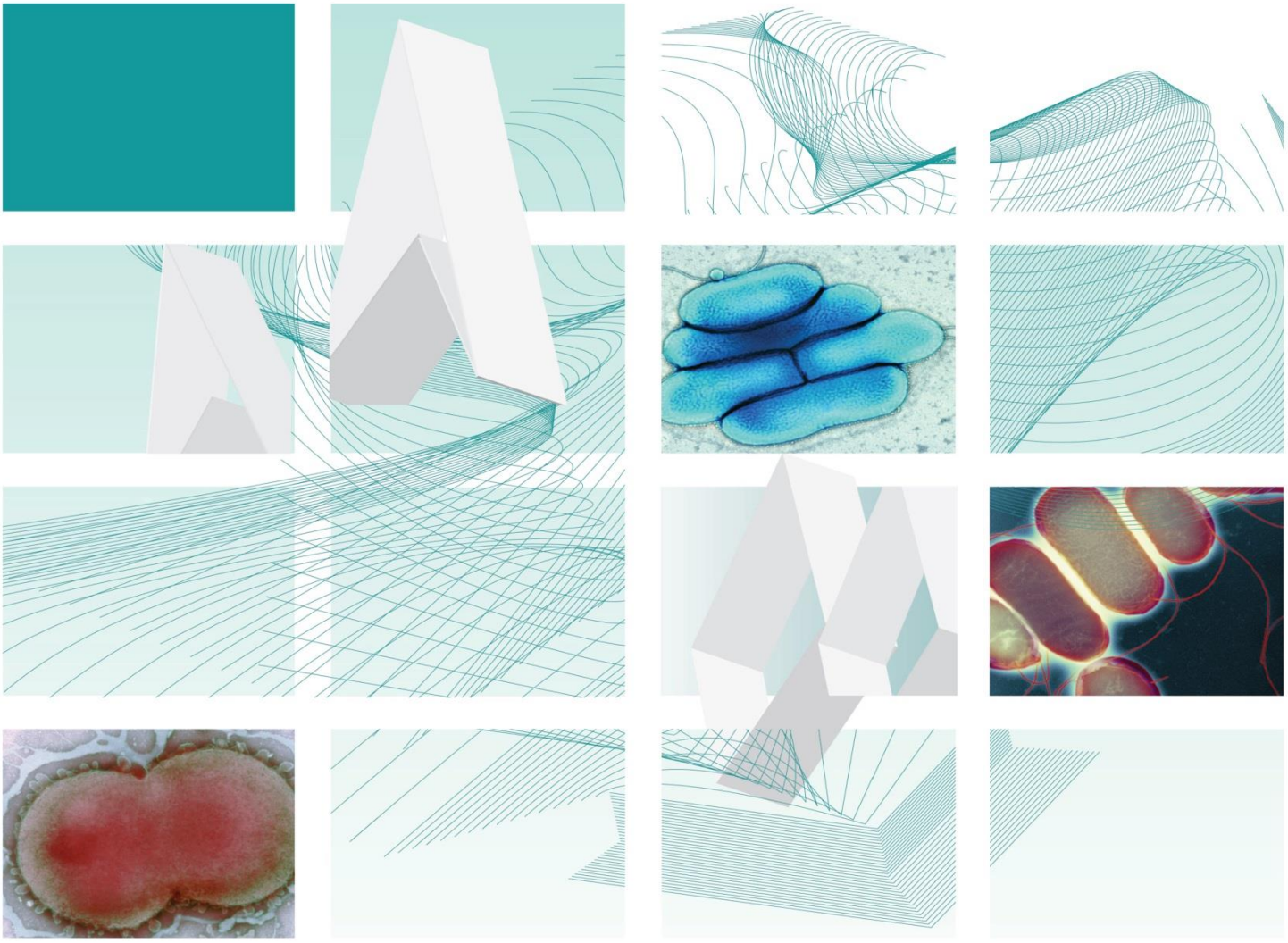
Public Health England

NHS

UK Standards for Microbiology Investigations

ONPG (β-Galactosidase) test



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Acknowledgments

UK Standards for Microbiology Investigations (UK SMIs) are developed under the auspices of Public Health England (PHE) working in partnership with the National Health Service (NHS), Public Health Wales and with the professional organisations whose logos are displayed below and listed on the website https://www.gov.uk/uk-standards-for-microbiology-investigations-smi-quality-and-consistency-in-clinical-laboratories. UK SMIs are developed, reviewed and revised by various working groups which are overseen by a steering committee (see https://www.gov.uk/government/groups/standards-for-microbiology-investigations-steering-committee).

The contributions of many individuals in clinical, specialist and reference laboratories who have provided information and comments during the development of this document are acknowledged. We are grateful to the medical editors for editing the medical content.

For further information please contact us at:

Standards Unit
National Infection Service
Public Health England
61 Colindale Avenue
London NW9 5EQ

E-mail: standards@phe.gov.uk

Website: https://www.gov.uk/uk-standards-for-microbiology-investigations-smi-quality-and-consistency-in-clinical-laboratories

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Logos correct at time of publishing.

Contents

Acknowledgments 2

Contents 3

Amendment table 4

UK SMI: scope and purpose 5

Scope of document 7

Introduction 7

Technical information/limitations 7

1 Safety considerations 9

2 Reagents and equipment 9

3 Quality control organisms 9

4 Procedure and results 9

Appendix: ONPG (β-Galactosidase) test 11

References 12

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Amendment table

Each UK SMI method has an individual record of amendments. The current amendments are listed on this page. The amendment history is available from standards@phe.gov.uk.

New or revised documents should be controlled within the laboratory in accordance with the local quality management system.

Amendment number/date	7/03.12.18
Issue number discarded	3
Insert issue number	4
Anticipated next review date*	03.12.18
Section(s) involved	**Amendment**
Whole document.	Document updated. Technical limitations updated with subheadings. References updated with grades.

*Reviews can be extended up to five years subject to resources available.

UK SMI[#]: scope and purpose

Users of UK SMIs

Primarily, UK SMIs are intended as a general resource for practising professionals operating in the field of laboratory medicine and infection specialties in the UK. UK SMIs also provide clinicians with information about the available test repertoire and the standard of laboratory services they should expect for the investigation of infection in their patients, as well as providing information that aids the electronic ordering of appropriate tests. The documents also provide commissioners of healthcare services with the appropriateness and standard of microbiology investigations they should be seeking as part of the clinical and public health care package for their population.

Background to UK SMIs

UK SMIs comprise a collection of recommended algorithms and procedures covering all stages of the investigative process in microbiology from the pre-analytical (clinical syndrome) stage to the analytical (laboratory testing) and post analytical (result interpretation and reporting) stages. Syndromic algorithms are supported by more detailed documents containing advice on the investigation of specific diseases and infections. Quality guidance notes describe laboratory processes which underpin quality, for example assay validation.

Standardisation of the diagnostic process through the application of UK SMIs helps to assure the equivalence of investigation strategies in different laboratories across the UK and is essential for public health surveillance, research and development activities.

Equal partnership working

UK SMIs are developed in equal partnership with PHE, NHS, Royal College of Pathologists and professional societies. The list of participating societies may be found at https://www.gov.uk/uk-standards-for-microbiology-investigations-smi-quality-and-consistency-in-clinical-laboratorieshttp://www.hpa-standardmethods.org.uk/. Inclusion of a logo in an UK SMI indicates participation of the society in equal partnership and support for the objectives and process of preparing UK SMIs. Nominees of professional societies are members of the Steering Committee and working groups which develop UK SMIs. The views of nominees cannot be rigorously representative of the members of their nominating organisations nor the corporate views of their organisations. Nominees act as a conduit for two way reporting and dialogue. Representative views are sought through the consultation process. UK SMIs are developed, reviewed and updated through a wide consultation process.

Quality assurance

NICE has accredited the process used by the UK SMI working groups to produce UK SMIs. The accreditation is applicable to all guidance produced since October 2009. The process for the development of UK SMIs is certified to ISO 9001:2008. UK SMIs represent a good standard of practice to which all clinical and public health microbiology laboratories in the UK are expected to work. UK SMIs are NICE accredited and represent neither minimum standards of practice nor the highest level

[#] Microbiology is used as a generic term to include the two GMC-recognised specialties of Medical Microbiology (which includes Bacteriology, Mycology and Parasitology) and Medical Virology.

of complex laboratory investigation possible. In using UK SMIs, laboratories should take account of local requirements and undertake additional investigations where appropriate. UK SMIs help laboratories to meet accreditation requirements by promoting high quality practices which are auditable. UK SMIs also provide a reference point for method development. The performance of UK SMIs depends on competent staff and appropriate quality reagents and equipment. Laboratories should ensure that all commercial and in-house tests have been validated and shown to be fit for purpose. Laboratories should participate in external quality assessment schemes and undertake relevant internal quality control procedures.

Patient and public involvement

The UK SMI working groups are committed to patient and public involvement in the development of UK SMIs. By involving the public, health professionals, scientists and voluntary organisations the resulting UK SMI will be robust and meet the needs of the user. An opportunity is given to members of the public to contribute to consultations through our open access website.

Information governance and equality

PHE is a Caldicott compliant organisation. It seeks to take every possible precaution to prevent unauthorised disclosure of patient details and to ensure that patient-related records are kept under secure conditions. The development of UK SMIs is subject to PHE Equality objectives https://www.gov.uk/government/organisations/public-health-england/about/equality-and-diversity.

The UK SMI working groups are committed to achieving the equality objectives by effective consultation with members of the public, partners, stakeholders and specialist interest groups.

Legal statement

While every care has been taken in the preparation of UK SMIs, PHE and the partner organisations, shall, to the greatest extent possible under any applicable law, exclude liability for all losses, costs, claims, damages or expenses arising out of or connected with the use of an UK SMI or any information contained therein. If alterations are made by an end user to an UK SMI for local use, it must be made clear where in the document the alterations have been made and by whom such alterations have been made and also acknowledged that PHE and the partner organisations shall bear no liability for such alterations. For the further avoidance of doubt, as UK SMIs have been developed for application within the UK, any application outside the UK shall be at the user's risk.

The evidence base and microbial taxonomy for the UK SMI is as complete as possible at the date of issue. Any omissions and new material will be considered at the next review. These standards can only be superseded by revisions of the standard, legislative action, or by NICE accredited guidance.

UK SMIs are Crown copyright which should be acknowledged where appropriate.

Suggested citation for this document

Public Health England. (2018). ONPG (ß-Galactosidase) test. UK Standards for Microbiology Investigations. TP 24 Issue 4. https://www.gov.uk/uk-standards-for-microbiology-investigations-smi-quality-and-consistency-in-clinical-laboratories

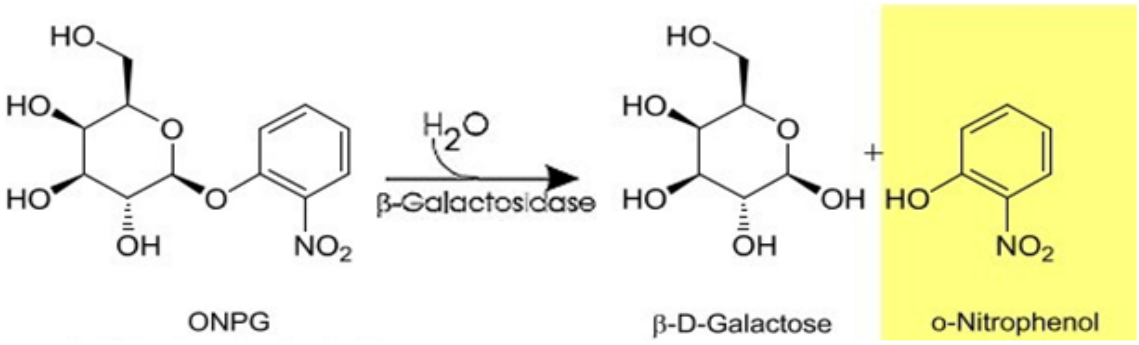
Scope of document

This document covers the procedure for ONPG test. The test is important in differentiating among the Enterobacteriaceae which are commonly classified according to their ability to ferment lactose[1]. It is also used to differentiate *Neisseria lactamica* from other fastidious *Neisseria* species.

This UK SMI should be used in conjunction with other UK SMIs.

Introduction

The ONPG (o-nitrophenyl-β-D-galactopyranoside) test is used to determine the presence or absence of the enzyme β-galactosidase in an organism[2]. The presence of two enzymes, permease and β-galactosidase, are required to demonstrate lactose fermentation. Permease allows the lactose to enter the bacterial cell. In lactose-fermenting bacteria the breakdown of lactose to glucose and galactose involves the enzyme beta-galactosidase[3]. True lactose non-fermenters do not possess either of these enzymes. Late lactose fermenting organisms do not have permease, but do possess β-galactosidase. ONPG is similar in structure to lactose. If β-galactosidase is present, the colourless ONPG is split in to galactose and o-nitrophenol, a yellow compound[4,5]. The reaction is shown as follows:



(Colourless) (Colourless) (Yellow)

Note: "ONPG" (also known as "2-Nitrophenyl β-D-galactopyranoside") is a Chemical analog of the sugar lactose and is hydrolysed by the enzyme lactase. Like β-galactosidase, lactase breaks lactose down into galactose and glucose.

Technical information/limitations

Growth media

The test should be performed, where possible, from a non-selective medium. If the test is performed from selective agar, a purity plate must be included to check for purity of the organism. Organisms that have grown on glucose containing media show less reactivity than those grown on lactose containing media. Glucose inhibits β-galactosidase.

Pigmentation in organisms

The test cannot be performed on organisms containing a yellow pigment or other coloured pigmentation as it makes it difficult to read the test[5].

Interpretation of results

The ONPG solution must be correctly buffered to prevent false negative and false positive reactions.

A heavy inoculum is necessary to obtain a high concentration of enzyme.

Discard the substrate if it looks yellow prior to inoculation.

1 Safety considerations[6-23]

Refer to current guidance on the safe handling of all organisms and reagents documented in this UK SMI.

All work likely to generate aerosols must be performed in a microbiological safety cabinet.

The above guidance should be supplemented with local COSHH and risk assessments.

Compliance with postal and transport regulations is essential.

2 Reagents and equipment

Discrete bacterial colonies growing on solid medium.

ONPG broth (alternatively, commercially available prepared ONPG discs may be used according to the manufacturer's instructions).

Bacteriological straight wire/loop (preferably nichrome) or disposable alternative.

3 Quality control organisms

For Enterobacteriaceae,

Positive control

Escherichia coli NCTC 10418 or NCTC 12241

Negative control

Proteus mirabilis NCTC 10975

For *Neisseria* species,

Positive control

Neisseria lactamica NCTC 10617

Negative control

Neisseria gonorrhoeae NCTC 8375

Note: These strains are validated by NCTC to give this result.

4 Procedure and results[3]

- a loopful of test organism from a culture plate or slant should be sufficient. Include the positive and negative controls with every batch of tests
- inoculate tubes containing ONPG reagent and incubate at 35-37°C for up to 24hr
- examine for yellow colour after 4hr and for up to 24hr

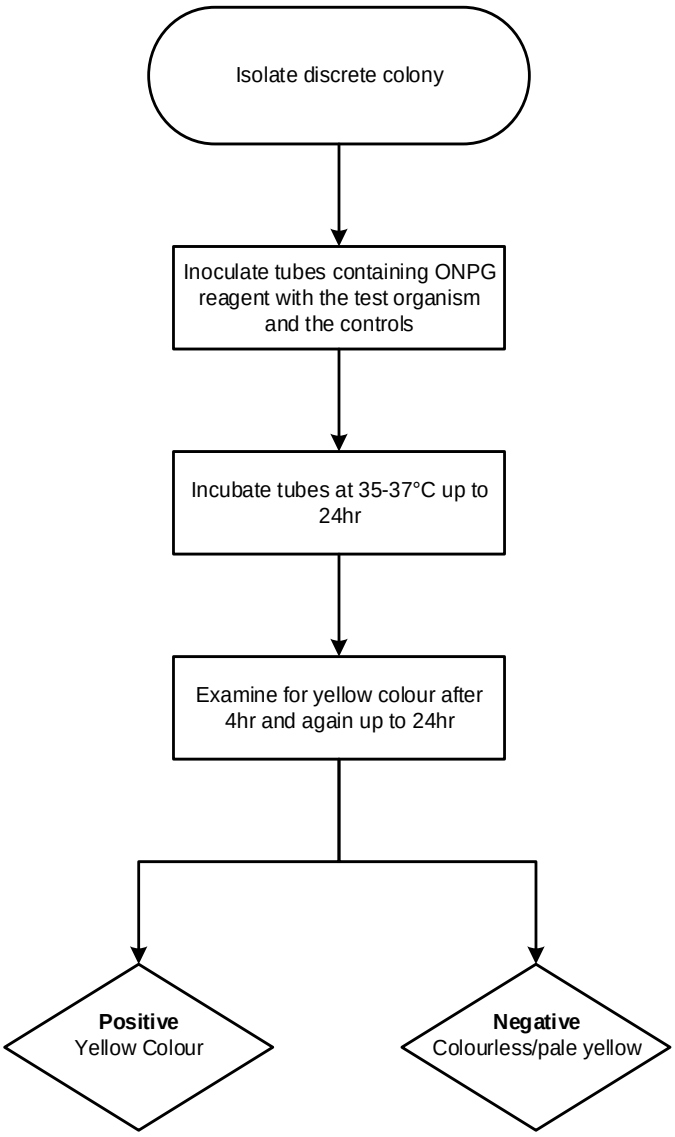
Positive result

Yellow colour (indicates lactose fermenter).

Negative result

Colourless/pale yellow (indicates lactose non-fermenter).

Appendix: ONPG (β-Galactosidase) test



Note:

For Enterobacteriaceae
Positive control: *Escherichia coli* NCTC 10418 or NCTC 12241

Negative control: *Proteus mirabilis* NCTC 10975

For *Neisseria* species
Positive control: *Neisseria lactamica* NCTC 10617

Negative control: *Neisseria gonorrhoeae* NCTC 8375

The flowchart is for guidance only.

References

Modified GRADE table used by UK SMIs when assessing references

Grading of Recommendations, Assessment, Development, and Evaluation (GRADE) is a systematic approach to assessing references. A modified GRADE method is used in UK SMIs for appraising references for inclusion. Each reference is assessed and allocated a grade for strength of recommendation (A-D) and quality of the underlying evidence (I-VIII). A summary table which defines the grade is listed below and should be used in conjunction with the reference list.

Quality/certainty of evidence	Types of evidence
A Strongly recommended	I Evidence from randomised controlled trials, meta-analysis and systematic reviews
B* Recommended but other alternatives may be acceptable	II Evidence from non-randomised studies
	III Evidence from documents describing techniques, methods or protocols
C* Weakly recommended: seek alternatives	IV Non-analytical studies, eg case reports, reviews, case series
D Never recommended	V Expert opinion and wide acceptance as good practice but with no study evidence
	VI Required by legislation, code of practice or national standard/ guideline
	VII Letter /short communication /editorials /conference communication
	VIII Electronic citation

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14. European Parliament. UK Standards for Microbiology Investigations (UK SMIs) use the term "CE marked leak proof container" to describe containers bearing the CE marking used for the collection and transport of clinical specimens. The requirements for specimen containers are given in the EU in vitro Diagnostic Medical Devices Directive (98/79/EC Annex 1 B 2.1) which states: "The design must allow easy handling and, where necessary, reduce as far as possible contamination of, and leakage from, the device during use and, in the case of specimen receptacles, the risk of contamination of the specimen. The manufacturing processes must be appropriate for these purposes". 1998. **A, VI**

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