

Routine internal quality control as recommended by EUCAST

Version 3.1, valid from 2013-01-01

<i>Escherichia coli</i>	ATCC 25922
<i>Pseudomonas aeruginosa</i>	ATCC 27853
<i>Staphylococcus aureus</i>	ATCC 29213
<i>Enterococcus faecalis</i>	ATCC 29212
<i>Streptococcus pneumoniae</i>	ATCC 49619
<i>Haemophilus influenzae</i>	NCTC 8468 ¹
<i>Campylobacter jejuni</i>	ATCC 33560

Version number	Strain/page	Changes
		Cells containing a change or an addition from v 3.0 are marked blue.
3.1, 2013-02-11	First page	Typo corrected for <i>Campylobacter jejuni</i> . The correct ATCC number is 33560.
	ATCC 25922	Typo corrected on ceftaroline MIC range. 0.03.0.12 changed to 0.03-0.12.

Version number	Strain/page	Changes
		Cells containing a change or an addition from v 2.1 are marked yellow.
3.0, 2013-01-01	ATCC 25922	QC ranges updated ² : Cefalexin (zone). QC ranges added : Ceftaroline (MIC and zone).
	ATCC 29213	QC ranges added : Ceftaroline (MIC and zone).
	ATCC 49619	Clarification regarding differentiation between haemolysis and growth. QC ranges added : Ceftaroline (MIC).
	NCTC 8468	QC ranges added : Ceftaroline (range to be established).
	ATCC 33560	New QC strain . All ranges new.

¹ NCTC 8468 is susceptible to beta-lactam antibiotics and often easier to read on MH-F than the commonly recommended ATCC 49247 showing variable inhibition zones for beta-lactam antibiotics due to PBP mutations.

² Updated by EUCAST.

***Escherichia coli* ATCC 25922**

(NCTC 12241, CIP 76.24, DSM 1103, CCUG 17620, CECT 434)

Mueller-Hinton agar, McFarland 0.5, air, 35±1°C, 18±2h. Read zone edges as the point showing no growth viewed from the back of the plate against a dark background illuminated with reflected light.

Antimicrobial agent	MIC (mg/L)		Disk content (µg)	Inhibition zone diameter (mm)	
	Target ¹	Range ²		Target ¹	Range ³
Amikacin	1-2	0.5-4	30	23	19-26
Amoxicillin	4	2-8	-	-	-
Amoxicillin-clavulanic acid	4/2 ⁴	2/1-8/4 ⁴	20-10	21	18-24 ⁵
Ampicillin	4	2-8	10	19	16-22 ⁵
Ampicillin-sulbactam	4/2 ⁴	2/1-8/4 ⁴	10-10	22	19-24 ⁵
Aztreonam	0.12	0.06-0.25	30	32	28-36
Cefadroxil	-	-	30	17	14-20
Cefalexin	8	4-16	30	18	15-21
Cefepime	0.03-0.06	0.015-0.12	30	34	31-37
Cefixime	0.5	0.25-1	5	25	23-27
Cefotaxime	0.06	0.03-0.12	5	28	25-31
Cefoxitin	4	2-8	30	26	23-29
Cefpodoxime	0.5	0.25-1	10	26	23-28
Ceftaroline	0.06	0.03-0.12 ³	5	27	24-30
Ceftazidime	0.12-0.25	0.06-0.5	10	26	23-29
Ceftibuten	0.25	0.12-0.5	30	31	27-35
Ceftriaxone	0.06	0.03-0.12	30	32	29-35
Cefuroxime	4	2-8	30	23	20-26
Chloramphenicol	4	2-8	30	24	21-27
Ciprofloxacin	0.008	0.004-0.015	5	35	30-40
Colistin	0.5-1	0.25-2 ³	-	-	-
Doripenem	0.03	0.015-0.06	10	31	27-35
Ertapenem	0.008	0.004-0.015	10	33	29-36
Fosfomycin ⁶	1	0.5-2 ³	-	-	-
Gentamicin	0.5	0.25-1	10	23	19-26
Imipenem	0.12	0.06-0.25	10	29	26-32
Levofloxacin	0.015-0.03	0.008-0.06	5	33	29-37
Mecillinam	0.06-0.12	0.03-0.25	10	27	24-30
Meropenem	0.015-0.03	0.008-0.06	10	31	28-34
Moxifloxacin	0.015-0.03	0.008-0.06	5	32	28-35
Nalidixic acid	2	1-4	30	25	22-28
Netilmicin	-	≤0.5-1	10	21	18-24
Nitrofurantoin	8	4-16	100	20	17-23
Norfloxacin	0.06	0.03-0.12	10	32	28-35
Ofloxacin	0.03-0.06	0.015-0.12	5	31	29-33
Piperacillin	2	1-4	30	24	21-27
Piperacillin-tazobactam	2/4	1/4-4/4	30-6	24	21-27
Ticarcillin	8	4-16	75	27	24-30
Ticarcillin-clavulanic acid	8/2	4/2-16/2	75-10	27	24-30
Tigecycline ⁶	0.12	0.03-0.25	15	24	20-27
Tobramycin	0.5	0.25-1	10	22	18-26
Trimethoprim	1	0.5-2	5	25	21-28
Trimethoprim-sulfamethoxazole	≤0.5/9.5 ²	-	1.25-23.75	26	23-29

¹ Calculated by EUCAST² From International Standards Organisation, ISO 20776-1: 2006, except ranges in bold/italics established by EUCAST.³ From Clinical and Laboratory Standards Institute, M100-S22: 32:3, 2012, except ranges in bold/italics established by EUCAST. All ranges have been validated by EUCAST.⁴ Ranges and targets are valid for a 2:1 ratio of beta-lactam agent to beta-lactamase inhibitor. EUCAST is currently collecting data to establish control ranges with fixed beta-lactamase inhibitor concentrations, in accordance with EUCAST breakpoints.⁵ Ignore growth that may appear as a thin inner zone on some batches of Mueller-Hinton agars.⁶ For MIC test conditions, see Clinical and Laboratory Standards Institute, M100-S22: 32:3, 2012.

***Pseudomonas aeruginosa* ATCC 27853**
(NCTC 12903, CIP 76.110, DSM 1117, CCUG 17619, CECT 108)

Mueller-Hinton agar, McFarland 0.5, air, 35±1°C, 18±2h. Read zone edges as the point showing no growth viewed from the back of the plate against a dark background illuminated with reflected light.

Antimicrobial agent	MIC (mg/L)		Disk content (µg)	Inhibition zone diameter (mm)	
	Target ¹	Range ²		Target ¹	Range ³
Amikacin	2	1-4	30	22	18-26
Aztreonam	4	2-8	30	26	23-29
Cefepime	1-2	0.5-4 ³	30	27	24-30
Ceftazidime	2	1-4	10	24	21-27
Ciprofloxacin	0.5	0.25-1	5	29	25-33
Colistin	1-2	0.5-4 ³	-	-	-
Doripenem	0.25	0.12-0.5	10	32	28-35
Fosfomycin ⁴	4	2-8 ³	-	-	-
Gentamicin	1	0.5-2	10	20	17-23
Imipenem	2	1-4	10	24	20-28
Levofloxacin	1-2	0.5-4	5	23	19-26
Meropenem	0.5	0.25-1	10	30	27-33
Netilmicin	2	0.5-8	10	18	15-21
Piperacillin	2-4	1-8	-	-	-
Piperacillin-tazobactam	2-4/4	1/4-8/4	30-6	26	23-29
Ticarcillin	16	8-32	-	-	-
Ticarcillin-clavulanic acid	16/2	8/2-32/2	75-10	24	20-28
Tobramycin	0.5	0.25-1	10	23	20-26

¹ Calculated by EUCAST

² From International Standards Organisation, ISO 20776-1: 2006.

³ From Clinical and Laboratory Standards Institute, M100-S22: 32:3, 2012, except ranges in bold/italics established by EUCAST. All ranges have been validated by EUCAST.

⁴ For MIC test conditions, see Clinical and Laboratory Standards Institute, M100-S22: 32:3, 2012.

Staphylococcus aureus* ATCC 29213
(NCTC 12973, CIP 103429, DSM 2569, CCUG 15915, CECT 794)

* β -lactamase-producing strain (weak)

Mueller-Hinton agar, McFarland 0.5, air, 35±1°C, 18±2h. Read zone edges as the point showing no growth viewed from the back of the plate against a dark background illuminated with reflected light.

Antimicrobial agent	MIC (mg/L)		Disk content (μ g)	Inhibition zone diameter (mm)	
	Target ¹	Range ²		Target ¹	Range ³
Amikacin	2	1-4	30	21	18-24
Ampicillin	-	-	2	18	15-21
Azithromycin	1	0.5-2	-	-	-
Benzylpenicillin	0.5-1	0.25-2	1 unit	15	12-18
Cefoxitin	2	1-4	30	27	24-30
Ceftaroline	0.25	0.12-0.5 ⁴	5	27	24-30
Chloramphenicol	4-8	2-16	30	24	20-28
Ciprofloxacin	0.25	0.12-0.5	5	24	21-27
Clarithromycin	0.25	0.12-0.5	-	-	-
Clindamycin	0.12	0.06-0.25	2	26	23-29
Daptomycin ⁵	0.25-0.5	0.12-1	-	-	-
Doxycycline	0.25	0.12-0.5	-	-	-
Erythromycin	0.5	0.25-1	15	26	23-29
Fosfomycin ⁵	1-2	0.5-4 ⁴	-	-	-
Fusidic acid	0.12	0.06-0.25	10	29	26-32
Gentamicin	0.25-0.5	0.12-1	10	22	19-25
Levofloxacin	0.12-0.25	0.06-0.5	5	26	23-29
Linezolid	2	1-4	10	24	21-27
Minocycline	0.12-0.25	0.06-0.5	30	26	23-29
Moxifloxacin	0.03-0.06	0.015-0.12	5	28	25-31
Mupirocin	0.12	0.06-0.25	200	34	31-37
Netilmicin	≤0.25 ²	-	10	23	20-26
Nitrofurantoin	16	8-32	100	20	17-23
Norfloxacin	1	0.5-2	10	21	18-24
Ofloxacin	0.25-0.5	0.12-1	5	24	21-27
Quinupristin-dalfopristin	0.5	0.25-1	15	24	21-27
Rifampicin	0.008	0.004-0.015	5	33	30-36
Teicoplanin	0.5	0.25-1	-	-	-
Telavancin	0.25-0.5	0.12-1	-	-	-
Tetracycline	0.25-0.5	0.12-1	30	27	23-31
Tigecycline ⁵	0.06-0.12	0.03-0.25	15	22	19-25
Tobramycin	0.25-0.5	0.12-1	10	23	20-26
Trimethoprim	2	1-4	5	25	22-28
Trimethoprim-sulfamethoxazole	≤0.5/9.5 ²	-	1.25-23.75	29	26-32
Vancomycin	1	0.5-2	-	-	-

¹ Calculated by EUCAST

² From International Standards Organisation, ISO 20776-1: 2006.

³ Established and validated by EUCAST.

⁴ From Clinical and Laboratory Standards Institute, M100-S22: 32:3, 2012.

⁵ For MIC test conditions, see Clinical and Laboratory Standards Institute, M100-S22: 32:3, 2012.

***Enterococcus faecalis* ATCC 29212**

(NCTC 12697, CIP 103214, DSM 2570, CCUG 9997, CECT 795)

Mueller-Hinton agar, McFarland 0.5, air, 35±1°C, 18±2h. Read zone edges as the point showing no growth viewed from the back of the plate against a dark background illuminated with reflected light.

Antimicrobial agent	MIC (mg/L)		Disk content (µg)	Inhibition zone diameter (mm)	
	Target ¹	Range ²		Target ¹	Range ³
Ampicillin	1	0.5-2	2	18	15-21
Gentamicin	8	4-16	30 ⁴	15	12-18
Imipenem	1	0.5-2	10	27	24-30
Linezolid	2	1-4	10	22	19-25
Nitrofurantoin	8	4-16	100	21	18-24
Quinupristin-dalfopristin	4	2-8	15	14	11-17
Teicoplanin	0.5	0.25-1 ⁵	30	18	15-21
Tigecycline ⁶	0.06	0.03-0.12	15	23	20-26
Trimethoprim	0.25	0.12-0.5 ⁵	5	28	24-32
Trimethoprim-sulfamethoxazole	≤0.5/9.5 ²	-	1.25-23.75	30	26-34
Vancomycin	2	1-4	5	13	10-16

¹ Calculated by EUCAST² From International Standards Organisation, ISO 20776-1: 2006.³ Established and validated by EUCAST.⁴ Screening disk for high-level aminoglycoside-resistance in enterococci.⁵ From Clinical and Laboratory Standards Institute, M100-S22: 32:3, 2012.⁶ For MIC test conditions, see Clinical and Laboratory Standards Institute, M100-S22: 32:3, 2012.

Streptococcus pneumoniae* ATCC 49619*/*
(NCTC 12977, CIP 104340, DSM 11967, CCUG 33638)

* Penicillin-intermediate strain

** Zone edges for *S. pneumoniae* on MH-F are often accompanied by α -haemolysis. Read inhibition of growth and not inhibition of haemolysis. Tilt the plate to easier differentiate between haemolysis and growth. There is usually growth in the whole area of α -haemolysis but on some MH-F media, there is additional α -haemolysis without growth.

Mueller-Hinton agar + 5% horse blood and 20 mg/L β -NAD, McFarland 0.5, 5% CO₂, 35 \pm 1°C, 18 \pm 2h. Read zone edges as the point showing no growth viewed from the front of the plate with the lid removed and with reflected light.

Antimicrobial agent	MIC (mg/L)		Disk content (μ g)	Inhibition zone diameter (mm)	
	Target ¹	Range ²		Target ¹	Range ³
Amoxicillin	0.06	0.03-0.12	-	-	-
Ampicillin	0.12	0.06-0.25	2	28	25-31
Azithromycin	0.12	0.06-0.25	-	-	-
Benzylicillin	0.5	0.25-1	1 unit	19	16-22
Cefaclor	2	1-4	30	28	25-31
Cefepime	0.06-0.12	0.03-0.25	30	34	31-37
Cefotaxime	0.06	0.03-0.12	5	31	28-34
Cefpodoxime	0.06	0.03-0.12	10	32	29-35
Ceftaroline	0.015	0.008-0.03 ⁴	5	IP	IP
Ceftriaxone	0.06	0.03-0.12	30	35	32-38
Cefuroxime	0.5	0.25-1	30	31	28-34
Chloramphenicol	4	2-8	30	27	24-30
Ciprofloxacin	-	-	5	25	22-28
Clarithromycin	0.06	0.03-0.12	-	-	-
Clindamycin	0.06	0.03-0.12	2	25	22-28
Daptomycin ⁵	0.12-0.25	0.06-0.5	-	-	-
Doripenem	0.06	0.03-0.12	10	34	31-37
Doxycycline	0.03-0.06	0.015-0.12	-	-	-
Ertapenem	0.06-0.12	0.03-0.25	10	31	28-34
Erythromycin	0.06	0.03-0.12	15	29	26-32
Imipenem	0.06	0.03-0.12	10	38	34-42
Levofloxacin	1	0.5-2	5	24	21-27
Linezolid	0.5-1	0.25-2	10	26	23-29
Meropenem	0.12	0.06-0.25	10	34	30-38
Minocycline	-	-	30	28	25-31
Moxifloxacin	0.12	0.06-0.25	5	27	24-30
Nitrofurantoin	8	4-16	100	28	25-31
Norfloxacin	4	2-8	10	21	18-24
Ofloxacin	2	1-4	5	21	18-24
Oxacillin	-	-	1	11	8-14
Rifampicin	0.03	0.015-0.06	5	29	26-32
Teicoplanin	-	-	30	21	18-24
Telithromycin	0.008-0.015	0.004-0.03	15	30	27-33
Tetracycline	0.12-0.25	0.06-0.5 ⁴	30	31	28-34
Tigecycline ⁵	0.03-0.06	0.015-0.12	15	27	24-30
Trimethoprim-sulfamethoxazole	0.25/4.75-0.5/9.5	0.12/2.4-1/19	1.25-23.75	23	20-26
Vancomycin	0.25	0.12-0.5	5	20	17-23

¹ Calculated by EUCAST

² From International Standards Organisation, ISO 20776-1: 2006.

³ Established and validated by EUCAST.

⁴ Clinical and Laboratory Standards Institute, M100-S22: 32:3, 2012.

⁵ For MIC test conditions, see Clinical and Laboratory Standards Institute, M100-S22: 32:3, 2012.

IP = In Preparation

***Haemophilus influenzae* NCTC 8468**
(CIP 54.94, CCUG 23946)

Mueller-Hinton agar + 5% horse blood and 20 mg/L β -NAD, McFarland 0.5, 5% CO₂, 35±1°C, 18±2h. Read zone edges as the point showing no growth viewed from the front of the plate with the lid removed and with reflected light.

Antimicrobial agent	MIC (mg/L)		Disk content (µg)	Inhibition zone diameter (mm)	
	Target	Range		Target ¹	Range ²
Amoxicillin-clavulanic acid	IP	IP	2-1	20	17-23
Ampicillin	IP	IP	2	22	19-25
Benzylpenicillin	IP	IP	1 unit	16	13-19
Cefaclor	IP	IP	30	27	24-30
Cefepime	IP	IP	30	32	29-35
Cefixime	IP	IP	5	30	27-33
Cefotaxime	IP	IP	5	32	29-35
Cefpodoxime	IP	IP	10	31	28-34
Ceftaroline	IP	IP	5	IP	IP
Ceftibuten	IP	IP	30	33	30-36
Ceftriaxone	IP	IP	30	37	33-41
Cefuroxime	IP	IP	30	28	25-31
Chloramphenicol	IP	IP	30	34	30-38
Ciprofloxacin	IP	IP	5	35	31-39
Doripenem	IP	IP	10	29	26-32
Ertapenem	IP	IP	10	30	27-33
Erythromycin	IP	IP	15	15	12-18
Imipenem	IP	IP	10	28	25-31
Levofloxacin	IP	IP	5	35	32-38
Meropenem	IP	IP	10	31	28-34
Minocycline	IP	IP	30	30	27-33
Moxifloxacin	IP	IP	5	32	29-35
Nalidixic acid	IP	IP	30	30	27-33
Ofloxacin	IP	IP	5	33	30-36
Rifampicin	IP	IP	5	23	20-26
Telithromycin	IP	IP	15	18	15-21
Tetracycline	IP	IP	30	31	28-34
Trimethoprim-sulfamethoxazole	IP	IP	1.25-23.75	30	26-34

¹ Calculated by EUCAST

² Established and validated by EUCAST.

IP = In Preparation

***Campylobacter jejuni* ATCC 33560**

(NCTC 11351, CIP 702, DSM 4688, CCUG 11284)

Mueller-Hinton agar + 5% horse blood and 20 mg/L β -NAD, McFarland 0.5, microaerobic environment, $41\pm 1^\circ\text{C}$, 24h. Read zone edges as the point showing no growth viewed from the front of the plate with the lid removed and with reflected light. The MH-F plates should be dried prior to inoculation to reduce swarming (at $20\text{-}25^\circ\text{C}$ over night or at 35°C , with the lid removed, for 15 min).

Antimicrobial agent	MIC (mg/L)		Disk content (μg)	Inhibition zone diameter (mm)	
	Target	Range		Target ¹	Range ²
Ciprofloxacin	IP	IP	5	38	34-42
Erythromycin	IP	IP	15	31	27-35
Tetracycline	IP	IP	30	34	30-38

¹ Calculated by EUCAST

² Established and validated by EUCAST.

IP = In Preparation