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Evaluation of Five Commercial Sabouraud Gentamicin-Chloramphenicol Agar Media

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Abstract The diagnosis of fungal infections relies on the isolation of the causative agent by culture of clinical specimens. Among the different culture media, Sabouraud glucose agar remains the most widely used. The use of commercial culture media is highly recommended as good laboratory practice in clinical microbiology. Therefore, the comparative performance of five different Sabouraud gentamicin-chloramphenicol agar media, available commercially as plates, was investigated. A total of 124 strains encompassing 45 yeasts and 79 filamentous fungi were cultured. Colonies of the dermatophytes (28 strains) and some related keratinophilic fungi (6 strains) were of overall similar appearance or size on all five media. Conversely, all the *Aspergillus* strains tested (*n*=17) as well as a few other strains of *Hyphomycetes* (*n*=5/18) exhibited important differences in the colour of the colonies. Furthermore, growth of the members of *Mucoraceae* was also affected, with great differences in the diameter of the colonies observed. In addition, quantitative cultures of the yeasts revealed marked variations in the number of the colonies, or even no growth, for two *Candida* species, *Cryptococcus* species, and *Trichosporon cutaneum*. In conclusion, the only formulation that gave good results with all fungal types tested was the one from Becton Dickinson (France).

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Introduction

During the past two decades, the incidence of opportunistic fungal infections has increased markedly as a result of the emergence of the acquired immunodeficiency syndrome, the development of immunosuppressive therapy, and the widespread use of broad-spectrum antibiotics and of invasive devices or procedures [1, 2, 3]. These life-threatening infections require a prompt diagnosis and a full identification of the pathogen in order to initiate appropriate therapy as soon as possible. The biological diagnosis of these infections relies on the isolation of the pathogenic agent by culture of clinical material. Among the different media available, Sabouraud glucose agar medium, with or without cycloheximide, is the most widely used for the isolation of fungi, even though chromogenic media have been developed recently for the detection and direct identification of some yeast species [4, 5].

Among the yeasts isolated, *Candida albicans* remains by far the most common species, but other *Candida* species initially considered nonpathogenic, such as *Candida glabrata*, *Candida krusei*, and *Candida lusitaniae*, are being increasingly reported as causative agents of candidiasis [2, 6, 7]. Other yeasts and some filamentous fungi also account for an increasing number of opportunistic infections. Thus, beside *Cryptococcus neoformans* and the well-known aspergilli, some members of the *Mucoraceae* and the *Hyphomycetes*, such as some *Fusarium* and *Scedosporium* species, have emerged as opportunistic pathogens [8, 9, 10].

In addition, with the changes in lifestyles (sport practice, contact with pets, etc.), the frequency of cutaneous infections, mainly those due to the dermatophytes and some *Candida* species, has increased markedly too. The steady improvement in the standard of living and the greater emphasis on external appearance in the industrialised countries may also explain this higher frequency. Moreover, nondermatophyte keratinophilic fungi, such as *Scopulariopsis brevicaulis*, *Aspergillus versicolor*, *Scytalidium dimidiatum*, *Onychocola canadensis*, and

Chrysosporium species, are now recognised as causative agents of cutaneous infections [11, 12].

In France, a departmental order called the "Guide de Bonne Exécution des Analyses" outlines to laboratories of medical biology the rules with which they must comply. This law states that laboratories must maintain written operative procedures about the preparation and the control of prepared and/or reconstituted reagents. The control of these reagents includes pH control (which requires suitable equipment for agar media) as well as sterility, performance, and quality controls. In addition, the biologist must justify that the results obtained with reagents prepared in his laboratory are similar to those obtained with industrial reagents, if commercially available. All these procedures are restricting and difficult to implement. Therefore, the use of commercialised culture media is highly recommended in laboratories of clinical microbiology.

Like most hospital laboratories of mycology, we have been using, in the Angers and Nancy hospitals, Sabouraud glucose agar media prepared in our laboratories. The present study was undertaken to evaluate the performance of the five Sabouraud gentamicin-chloramphenicol agar plates commercially available in France for isolation of the most common clinically important yeasts and filamentous fungi.

Materials and Methods

Media

Sabouraud glucose agar plates, in 90 mm petri dishes, containing no cycloheximide but supplemented with chloramphenicol and gentamicin, were purchased from Sanofi Diagnostics Pasteur (France), bioMérieux (France), Becton Dickinson (France), AES Laboratoire (France), and Oxoid (France). These culture media are claimed by the manufacturers to allow the isolation of all yeasts and other fungal species from specimens presenting a mixed flora. Becton Dickinson specifies that its medium may be used for the isolation of pathogenic and nonpathogenic fungi (yeasts, strictly saprophytic or opportunistic fungi, dermatophytes, and other related keratinophilic fungi). Table 1 shows the composition of the five culture media and Table 2 the performance controls.

Fungi

A total of 124 fungi encompassing 45 yeasts and 79 filamentous fungi were used in this study (Table 3). Among the yeasts, we compared 34 strains of *Candida* species, six of *Cryptococcus* species, four of *Trichosporon cutaneum*, and one of *Saccharomyces cerevisiae*. The filamentous fungi included 45 strictly saprophytic or opportunistic fungi, 28 dermatophytes, and six related species. These strains were isolated from clinical samples in the

Table 1 Composition of the five commercial Sabouraud glucose agar media tested

	Sanofi Diagnostics	bioMérieux	AES	Oxoid	Becton Dickinson
Component (g/l)					
Glucose	19	19	40	40	40
Peptone	10	9	10	10	10
Malt extract	0	1	0	0	0
Yeast extract	1	2	0	0	0
Agar	12	13	15	15	15
Chloramphenicol	0.5	0.05	0.5	0.05	0.4
Gentamicin	0.04	0.01	0.1	0.1	0.04
pH	6.1	6.8	5.6	5.8	5.6
Peptone type	pancreatic	casein, soy, meat	casein, meat	mycological	pancreatic, peptic

Table 2 Performance controls carried out by the manufacturers of the Sabouraud glucose agar media on each lot of plates before commercial release of the product

Species	Sanofi Diagnostics	bioMérieux	AES	Oxoid	Becton Dickinson
Aspergillus fumigatus	NT	NT	NT	NT	+
Aspergillus niger	NT	+	NT	+	NT
Candida albicans	+	+	+	+	+
Candida glabrata	+	NT	NT	NT	NT
Candida krusei	+	NT	NT	NT	NT
Candida rugosa	+	NT	NT	NT	NT
Candida tropicalis	+	+	NT	NT	NT
Cryptococcus neoformans	+	NT	NT	NT	NT
Saccharomyces cerevisiae	+	NT	NT	+	NT
Trichophyton mentagrophytes	NT	+	NT	NT	+
Enterococcus faecalis	NT	–	NT	NT	NT
Escherichia coli	–	–	–	–	–
Staphylococcus aureus	–	NT	–	NT	–
Pseudomonas aeruginosa	–	NT	NT	NT	–

NT, not tested; +, growth; –, no growth

Table 3 Yeasts and filamentous fungi tested

Organism	No.	Organism	No.
Yeasts	45	Moulds	35
Candida spp.		*Acremonium hyalinulum*	1
C. albicans	5	*Aspergillus* spp.	
C. glabrata	5	*A. flavus*	3
C. inconspicua	1	*A. fumigatus*	3
C. kefyr	5	*A. nidulans*	3
C. krusei	5	*A. niger*	3
C. lusitaniae	5	*A. ochraceus*	2
C. parapsilosis	3	*A. terreus*	3
C. tropicalis	5	*Beauveria* sp.	1
Cryptococcus spp.		*Fusarium* spp.	
C. albidus	1	*F. oxysporum*	1
C. neoformans	5	*F. dimerum*	1
Saccharomyces cerevisiae	1	*F. chlamydosporum*	1
Trichosporon cutaneum	4	*Geotrichum candidum*	1
Dermatophytes	28	*Gliocladium virens*	1
Epidermophyton floccosum	2	*Paecilomyces* spp.	
Microsporum spp.		*P. marquandii*	1
M. canis	5	*P. variotii*	1
M. gypseum	3	*Penicillium chrysogenum*	1
M. langeronii	3	*Scedosporium apiospermum*	5
M. persicolor	3	*Trichoderma viride*	1
Trichophyton spp.		*Trichothecium roseum*	1
T. mentagrophytes	5	*Verticillium chlamydosporium*	1
T. rubrum	4	*Mucoraceae*	10
T. soudanense	3	*Absidia corymbifera*	2
Other keratinophilic fungi	6	*Mucor circinelloides*	3
Chrysosporium spp.		*Rhizomucor pusillus*	2
C. keratinophilum	1	*Rhizopus oryzae*	3
C. tropicum	1		
Myriodontium keratinophilum	1		
Onychocola canadensis	1		
Scopulariopsis brevicaulis	1		
Scytalidium dimidiatum	1		

mycology laboratory of Angers University Hospital (France) and lyophilised for storage, or they were reference strains from the Institut Pasteur de Paris (France) or the Scientific Institute of Public Health, IHEM Culture Collection (Brussels, Belgium).

Culture Conditions

The strains were cultured simultaneously on the five Sabouraud glucose agar plates, and experiments were performed in our two laboratories to confirm the reproducibility of the results. The filamentous fungi were inoculated as a central spot on the plates. For the yeasts, the different culture media were inoculated by plating 100 μl aliquots of a 1/10,000 dilution of a blastospore suspension containing about 10^6 to 10^7 cells/ml.

Thermotolerant moulds and yeasts were incubated at 37°C for 72 h. However, if variations in growth were observed on any particular medium, incubation was extended to 10 days. Incubation was carried out at 25°C for 96 h for the other strictly saprophytic or opportunistic filamentous fungi, and for 10 days for the dermatophytes and related species.

The appearance of the colonies (diameter, texture, and pigmentation) was noted for filamentous fungi, which were also examined microscopically when the colonies did not exhibit the typical standard characteristics [13, 14]. For the yeasts, the number of the colonies was evaluated. Results were considered similar when less than 30% variation was observed between the two laboratories or between the five culture media.

Results

Filamentous Fungi

In contrast to the appearance of dermatophytes and related keratinophilic species, which was similar on all five media, the appearance of the colonies of aspergilli truly varied, depending on the medium used. In fact, not all of the aspergilli tested presented the typical colouration, due to conidial pigmentation (Table 4). For example, on the Sanofi Diagnostics Pasteur and bioMérieux media, colonies of *Aspergillus fumigatus* were velvety beige to grey-brown instead of powdery and dark green, as usually described. Likewise, whereas colonies of *Aspergillus*

Table 4 Pigmentation of the colonies of strictly saprophytic or opportunistic *Hyphomycetes* on commercial Sabouraud agar media

Species (no. of strains)[a]	Sanofi Diagnostics	bioMérieux	AES	Oxoid	Becton Dickinson
Aspergillus flavus (3)	yellow	yellow	yellowish-green	yellowish-green	yellowish-green
Aspergillus fumigatus (3)	beige	grey-brown	dark green	dark green	dark green
Aspergillus nidulans (3)	white	white	cream-buff	cream-buff	cream-buff
Aspergillus niger (3)	yellow	brownish	black	black	black
Aspergillus ochraceus (2)	white	white	ochreous	ochreous	ochreous
Aspergillus terreus (3)	cream	cream	yellowish-brown	yellowish-brown	yellowish-brown
Fusarium oxysporum (1)	white	white	purplish red	purplish red	purplish red
Gliocladium virens (1)	white	white	green	green	green
Paecilomyces marquandii (1)	white	white	lilac	lilac	lilac
Penicillium chrysogenum (1)	white	white	green	green	green
Trichoderma viride (1)	yellow	yellow	green	green	green

[a] No major differences in the pigmentation of the colonies were observed for the other strictly saprophytic or opportunistic *Hyphomycetes* studied: *Fusarium dimerum*, *Fusarium chlamydosporum*, *Paecilomyces variotii*, *Geotrichum candidum*, *Trichothecium roseum*, *Verticillium chlamydosporium*, *Acremonium hyalinulum*, *Beauveria* sp., and *Scedosporium apiospermum*

Table 5 Growth of the *Mucoraceae* on commercial Sabouraud glucose agar media (results from the Angers hospital laboratory)

Species	Diameter of colonies (cm)[a]				
	Sanofi Diagnostics	bioMérieux	AES	Oxoid	Becton Dickinson
Rhizopus oryzae					
IP 1443.83	8.5	7.5	8.5	8.5	8.5
IHEM 5210	8.5	2.5	5	4.5	8.5
IHEM 5215	8.5	8.5	8.5	8.5	8.5
Rhizomucor pusillus					
IP 1127.75	8.5	2	6.5	5	8
IHEM 4897	3	0	0	6	2
Absidia corymbifera					
MLA 98.1250	8.5	3.5	7	7	8.5
IHEM 3809	4	1	3	2.5	5.5
Mucor circinelloides					
MLA 94.1140	4.5	1	4	1.5	7.5
IHEM 6793	8.5	5	4.5	5.5	8
IHEM 6794	8	5.5	5	5	8

MLA, mycology laboratory of Angers University Hospital, France; IP, Institut Pasteur de Paris, France; IHEM, Scientific Institute of Public Health, Belgium

[a] Results correspond to the diameter of colonies obtained after 4 days of incubation at 25°C

niger are typically granular and black carbonaceous, they were downy to velvety and yellow to brownish on these two media.

Similar differences in colony colour were noted for the other sporogenous moulds, i.e. *Penicillium chrysogenum*, *Gliocladium virens*, and *Trichoderma viride*. Indeed, these fungi did not produce the typical green colonies on the Sanofi Diagnostics Pasteur and bioMérieux media after 4 days of incubation at 37°C. Moreover, after 4 days of incubation at 25°C, *Fusarium oxysporum* did not exhibit the purplish-red pigment usually present at the back of the colonies, and the typical lilac coloration of *Paecilomyces marquandii* was not observed. Conversely, no differences in the pigmentation of the colonies were observed for the other saprophytic or opportunistic *Hyphomycetes* studied.

Microscopic observations of the sporogenous moulds exhibiting macroscopic differences showed that the variations were usually due to a deficit of conidial pigmentation. Nevertheless, a deficit of sporulation was also noticed for *Aspergillus nidulans*, *Penicillium chrysogenum*, and *Fusarium oxysporum*.

For the *Mucoraceae*, the diameter of the colonies varied greatly from one culture medium to another. The results presented in Table 5 are those from the Angers hospital, but overall, results obtained in the two laboratories were similar. Among the strains tested, only two strains of *Rhizopus oryzae* produced colonies of similar size on the five media. One strain of *Rhizomucor pusillus* did not grow on either the bioMérieux or the AES medium. As for the other strains, they all produced smaller colonies on the Sabouraud agar plates from bioMérieux and sometimes on the AES and Oxoid media. Overall, the best results for these fungi were obtained with the Sabouraud glucose agar media from Sanofi Diagnostics Pasteur and Becton Dickinson.

Yeasts

Overall, similar results were obtained in our two laboratories. Those obtained in Angers hospital are presented in Table 6. The five culture media yielded similar amounts of growth for six of the *Candida* species tested as well as for the strain of *Saccharomyces cerevisiae*. Conversely, great differences in the number of the colonies that grew on each culture medium were noted for *Candida kefyr*, *Candida lusitaniae*, *Cryptococcus neoformans*, *Cryptococcus albidus*, and *Trichosporon cutaneum*. Actually, after 3 days of incubation at 37°C, none of the strains of *Cryptococcus neoformans*, *Cryptococcus albidus*, or *Trichosporon cutaneum* grew on the bioMérieux medium; likewise, four of the strains of *Candida kefyr* and *Candida lusitaniae* failed to grow on this

Table 6 Growth of yeasts on commercial Sabouraud glucose agar media

Species	No. of colonies[a]				
	Sanofi Diagnostics	bioMérieux	AES	Oxoid	Becton Dickinson
Candida kefyr					
MLA 91.1129	>100	0	>100	>100	>100
MLA 91.1323	>100	0	>100	80	>100
MLA 93.8657	30	0	28	43	42
MLA 93.8779	45	46	43	46	70
MLA 94.4459	80	0	50	60	70
Candida lusitaniae					
MLA 94.6011	130	0	81	6	50
MLA 94.7060	100	1	120	0	120
MLA 94.7315	110	0	37	4	170
MLA 94.7651	100	32	150	120	140
MLA 94.8764	>100	0	>100	0	100
Cryptococcus neoformans					
MLA 92.5461	34	0	0	15	36
MLA 94.0277	>100	0	0	0	50
MLA 94.1563	23	0	25	19	16
MLA 95.3890	>100	0	>100	>100	>100
MLA 95.7786	8	0	1	0	0
Cryptococcus albidus					
MLA 93.5479	41	0	>100	>100	>100
Trichosporon cutaneum					
MLA 93.1422	18	0	19	0	7
MLA 93.1440	6	0	6	1	9
MLA 94.0256	60	0	11	0	31
IHEM 3002	0	0	0	0	0

[a] Results correspond to the number of colonies obtained after 3 days of incubation at 37°C. No major differences were observed in the number of colonies for the other species studied: *Candida albicans*, *Candida glabrata*, *Candida inconspicua*, *Candida krusei*, *Candida parapsilosis*, *Candida tropicalis*, and *Saccharomyces cerevisiae*

medium. Oxoid agar plates also appeared to be poor substrates for yeasts, since we observed a deficit of growth for four strains of *Candida lusitaniae*, three strains of *Cryptococcus neoformans*, and all strains of *Trichosporon cutaneum*. On the AES medium, two strains of *Cryptococcus neoformans* were not detected, and one strain yielded only one colony. Prolonging the incubation time up to 10 days did not modify the amount of colonies, suggesting a growth inhibition rather than an increase in the latency period. Only one strain of *Cryptococcus neoformans* (LMA 95.3890) yielded more than 100 colonies after 10 days of incubation on the bioMérieux medium.

It is important to note that one strain of *Cryptococcus neoformans* was detected only on the Sanofi Diagnostics Pasteur medium, and one strain of *Trichosporon cutaneum* did not grow on any medium. Overall, the best results for the yeasts were obtained on Sabouraud glucose agar media from Sanofi Diagnostics Pasteur and Becton Dickinson.

Discussion

Despite an intensive investigation for the development of general or selective culture media for the isolation and the identification of fungal pathogens, Sabouraud culture medium remains the most widely used in medical mycology. However, the original constituents of this culture medium designed by Raymond Sabouraud are no longer available. Therefore, "Sabouraud glucose agar" is the name recommended for present-day versions of this medium [4]. This name is used to refer to media containing 1% peptone, 1.5–2% agar, and 4% glucose and having a final pH of 5.6, and it should not be applied to any other formulation. However, in practice, formulations used by commercial manufacturers vary greatly. For instance, numerous differences can be seen in the composition of the five Sabouraud glucose agar plates commercially available in France. As shown in Table 1, the presence of 10 g peptone per litre and of 12–15 g agar per litre is the only factor common to all of them. However, substitutes of the original peptone used by Sabouraud (Granulée de Chassaing), such as pancreatic, peptic, or mycological peptone, are used freely by the different manufacturers [15]. Moreover, agar types are never specified, so that variations in agar composition and quality may occur. Likewise, although the original sugar concentration recommended is 40 g/l, Sanofi Diagnostics Pasteur and bioMérieux use a lower glucose concentration (19 g/l). The same manufacturers add yeast extract and the latter malt extract, and their culture media have a final pH higher than that recommended (6.1 and 6.8 instead of 5.6). In addition, the concentrations of antibiotics (gentamicin and chloramphenicol) vary extensively from one to ten-

fold, depending on the culture medium. Finally, it has been demonstrated by Odds et al. [15] that some commercially available culture media contain some undisclosed additives, such as inorganic phosphorus, that may affect the growth and behaviour of fungi. One may speculate that such undeclared additives are also present in some of the culture media that we have tested.

All these variations of formulation may affect the growth or appearance of fungal cultures [4, 15, 16]. For instance, important macroscopic differences in the appearance of the mould colonies that grew on the five Sabouraud glucose agar media were observed, related more often to a deficit of conidial pigmentation rather than to a problem of sporulation. Moreover, a deficit of growth was also observed for most of the *Mucoraceae* on three of the five media. This may lead to a delay in the diagnosis because of the necessity to perform subculturing. Such a delay could be deleterious to the patient, particularly in cases of invasive aspergillosis or mucormycosis, which have a very high mortality rate if appropriate therapy is not commenced rapidly.

Great differences between the five media were also noted in the number of colonies obtained for two of the eight *Candida* species tested (*Candida kefyr* and *Candida lusitaniae*) as well as for *Trichosporon cutaneum* and *Cryptococcus* species. Some strains were not even detected on some media. The most striking example is *Cryptococcus neoformans*: none of the five strains tested grew on the bioMérieux agar plates, two of them were not detected on either the AES or the Oxoid medium, and one was not detected on the Becton Dickinson medium. This may be very injurious to patients with acquired immunodeficiency syndrome, in whom this basidiomycete can cause lethal meningitis unless appropriate treatment is administered. Moreover, one strain was detected only on the Sanofi Diagnostics Pasteur medium, and it is interesting to note that this laboratory is the only one testing the performance of this medium with *Cryptococcus neoformans*.

In conclusion, the only formulation that gave good results with all types of fungi tested was the one from Becton Dickinson. Due to the inability of the other Sabouraud glucose agars to support the growth of some of the most clinically important yeasts and filamentous fungi, improvements of their formulations are required. In addition, our results highlight the need for standardisation of the performance controls by the manufacturers, which should result in better interlaboratory reproducibility. These controls would comprise a set of the major medically important moulds and yeasts and would incorporate at least one strain of *Aspergillus fumigatus* and a member of the *Mucoraceae* as well as some yeast species, including *Cryptococcus neoformans*. Finally, the colony appearance as compared to standard descriptions should be considered, and not solely the observation of growth.

References

1. Jarvis WR: Epidemiology of nosocomial infections with emphasis on *Candida* species. Clinical Infectious Diseases (1995) 20:1526–1530
2. Wingard JR: Importance of *Candida* species other than *C. albicans* as pathogens in oncology patients. Clinical Infectious Diseases (1995) 20:115–125
3. Herbrecht R: The changing epidemiology of fungal infections: are the lipid-forms of amphotericin B an advance? European Journal of Haematology (1996) 57:12–17
4. Odds FC: Sabouraud('s) agar. Journal of Medical and Veterinary Mycology (1991) 29:355–359
5. Freydière AM, Buchaille L, Gille Y: Comparison of three commercial media for direct identification and discrimination of *Candida* species in clinical specimens. European Journal of Clinical Microbiology & Infectious Diseases (1997) 16:464–467
6. Samaranayake YH, Samaranayake LP: *Candida krusei*: biology, epidemiology, pathogenicity and clinical manifestations of an emerging pathogen. Journal of Medical Microbiology (1994) 41:295–310
7. Hazen KC: New and emerging yeast pathogens. Clinical Microbiology Reviews (1995) 8:462–478
8. Ribes JA, Vanover-Sams CL, Baker DJ: Zygomycetes in human disease. Clinical Microbiology Reviews (2000) 13:236–301
9. Connolly JE, McAdams HP, Erasmus JJ, Rosado-de-Christenson ML: Opportunistic fungal infections. Journal of Thoracic Imaging (1999) 14:51–62
10. Anaissie E, Bodey GP, Kantarjian H, Ro J, Vartivarian SE, Hopfer R, Rolston K: New spectrum of fungal infections in patients with cancer. Reviews of Infectious Diseases (1989) 11:369–378
11. Ellis DH, Marley JE, Watson AB, Williams T: Significance of non-dermatophyte moulds and yeasts in onychomycosis. Dermatology (1997) 194, Supplement 1:40–42
12. Gianni C, Cerri A, Crosti C: Non-dermatophytic onychomycosis. An underestimated entity? A study of 51 cases. Mycoses (2000) 43:29–33
13. St. Germain G, Summerbell R: Champignons filamenteux d'intérêt médical: caractéristiques et identification. Star Publishing Company, Belmont, CA (1996) p 314
14. De Hoog GS, Guarro J: Atlas of clinical fungi. Centraalbureau voor Schimmelcultures, Baarn and Delft, The Netherlands/ Universitat Rovira i Virgili, Reus, Spain (1995) p 720
15. Odds FC, Hall CA, Abbott AB: Peptones and mycological reproducibility. Sabouraudia (1978) 16:237–246
16. Kellogg JA, Bankert DA, Chaturvedi V: Variation in microbial identification system accuracy for yeast identification depending on commercial source of Sabouraud dextrose agar. Journal of Clinical Microbiology (1999) 37:2080–2083
17. Stratton CW: Mechanisms of action for antimicrobial agents: general principles and mechanisms for selected classes of antibiotics. In: Lorian V (ed): Antibiotics in laboratory medicine. Williams and Wilkins, Baltimore, MD (1996) pp 579–603