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ENCYCLOPEDIA OF Microbiology

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Editorial Advisory Board

Preface

For the purposes of this encyclopedia, microbiology has been understood to embrace the study of "microorganisms," including the basic science and the roles of these organisms in practical arts (agriculture and technology) and in disease (public health and medicine). Microorganisms do not constitute a well-defined taxonomic group; they include the two kingdoms of Archaebacteria and Eubacteria, as well as protozoa and those fungi and algae that are predominantly unicellular in their habit. Viruses are also an important constituent, albeit they are not quite "organisms." Whether to include the mitochondria and chloroplasts of higher eukaryotes is a matter of choice, since these organelles are believed to be descended from free-living bacteria. Cell biology is practiced extensively with tissue cells in culture, where the cells are manipulated very much as though they were autonomous microbes; however, we shall exclude this branch of research. Microbiology also is enmeshed thoroughly with biotechnology, biochemistry, and genetics, since microbes are the canonical substrates for many investigations of genes, enzymes, and metabolic pathways, as well as the technical vehicles for discovery and manufacture of new biological products, for example, recombinant human insulin.

Within these arbitrarily designated limits, let us consider the overall volume of published literature in microbiology, where to find its core, and strategies for searching for current information on particular topics. Most of the data for this preface are derived from the 1988 Journal Citation Reports Current Contents (T) of the Institute for Scientific Information (ISI). Table I lists the 53 most consequential journals in microbiology, assessed by citation impact factor, the average number of literature citations per article published in a given journal. Table II presents that list sorted by the total number of articles printed in each journal in 1988. Table III shows the distribution of journals citing the *Journal of Bacteriology* and the distribution of journals cited in it.

Obviously, the publications of the American Society for Microbiology (indicated by AMS in the tables) play a commanding role. The society is now making its journals available in electronically searchable form (on optical disks), which will greatly facilitate locating and retrieving the most up-to-date information on any given subject. In addition, interdisciplinary journals such as *Nature (London)*, *Science*, and the *Proceedings of the National Academy of Sciences, U.S.A.* are important sources of prompt news of scientific developments in microbiology. It is difficult to assess how much of their total publication addresses microbiology. As seen in Table III, the bibliographies in the *Journal of Bacteriology* cite half as many articles from the *Proceedings* (2348) as from the *Journal of Bacteriology* itself (5708). The 7038 articles indicated in Table II probably reach some 10,000 per year when these interdisciplinary and other dispersed sources are taken into account. An equal number might be added from overlapping aspects of molecular biology and genetics. To find and read all these titles would tax any scholar, although it could be done as a near full-time occupation with the help of the weekly Current Contents (T) of the ISI. To start afresh, with perhaps a decade's accumulation of timely background, would be beyond reasonable human competence. No one person would intelligently peruse more than a small fraction of the total texts.

The "Encyclopedia of Microbiology" is intended to survey the entire field coherently, complementing material that would be included in an advanced undergraduate and graduate major course of university study. Particular topics should be accessible to talented high school and college students, as well as graduates involved in teaching, research, and technical practice of microbiology.

Even these hefty volumes cannot embrace all current knowledge in the field. Each article does provide key references to the literature available at the time of writing. Acquisition of more detailed and up-to-date knowledge depends on (1) exploiting the review and monographic literature and (2) bibliographic retrieval of the preceding and current research literature. To make greatest use of review literature and monographs, the journals listed in Table II are invaluable. Titles such as *Annual Reviews* should not be misunderstood: these journals appear at annual intervals, but 5 or 10 years of accumulated research is necessary for the inclusion of a focused treatment of a given subject.

To access bibliographic materials in microbiol-

ogy, the main retrieval resources are Medline, sponsored by the U.S. National Library of Medicine, and the Science Citation Index of the ISI. With governmental subsidy, Medline is widely available at modest cost: terminals are available at every medical school and at many other academic centers. Medline provides searches of the recent literature by author, title, and key word, and offers on-line displays of the relevant bibliographies and abstracts. Medical aspects of microbiology are covered exhaustively; general microbiology is covered in reasonable depth. The Science Citation Index must recover its costs from user fees, but is widely available at major research centers. It offers additional search capabilities, especially by citation linkage. Therefore, starting with the bibliography of a given encyclopedia article, one can quickly find (1) all articles more recently published that have cited those bibliographic reference starting points and (2) all other recent articles that share bibliographic information with the others. With luck, one of these articles may be identified as another comprehensive review that has digested more recent or broader primary material.

On a weekly basis, services such as Current Contents on Diskette (ISI) and Reference Update offer still more timely access to current literature as well as abstracts with a variety of useful features. Under the impetus of intense competition, these services are evolving rapidly, to the great benefit of a user community desperate for electronic assistance in coping with the rapidly growing and intertwined networks of discovery. The bibliographic services of Chemical Abstracts and Biological Abstracts would also be potentially invaluable; however, their coverage of microbiology is rather limited.

In addition, major monographs have appeared from time to time—"The Bacteria," "The Prokaryotes," and many others. Your local reference library should be consulted for these volumes.

Valuable collections of reviews also include *Critical Reviews for Microbiology*, *Symposia of the Society for General Microbiology*, *Monographs of the ASM*, and *Proceedings of the International Congresses of Microbiology*.

The articles in this encyclopedia are intended to be accessible to a broader audience, not to take the place of review articles with comprehensive bibliographies. Citations should be sufficient to give the reader access to the latter, as may be required. We do apologize to many individuals whose contributions to the growth of microbiology could not be adequately embraced by the secondary bibliographies included here.

The organization of encyclopedic knowledge is a daunting task in any discipline; it is all the more complex in such a diversified and rapidly moving domain as microbiology. The best way to anticipate the rapid further growth that we can expect in the near future is unclear. Perhaps more specialized series in subfields of microbiology would be more appropriate. The publishers and editors would welcome readers' comments on these points, as well as on any deficiencies that may be perceived in the current effort.

My personal thanks are extended to Kathryn Linenger at Academic Press for her diligent, patient, and professional work in overseeing this series; to my coeditors, Martin Alexander, David A. Hopwood, Barbara H. Iglewski, and Allan I. Laskin; above all, to the many very busy scientists who took time to draft and review each of these articles.

Joshua Lederberg

Table I The Top Journals in Microbiology Listed by Impact Factor

Citation impact rank	Journal title	Number of articles published in 1988	Citation impact rank	Journal title	Number of articles published in 1988
1	*Microbiol. Rev.*	28	28	*FEMS Microbiol. Lett.*	365
2	*Adv. Microb. Ecol.*	10	29	*Am. J. Reprod. Immunol.*	50
3	*Annu. Rev. Microbiol.*	29	30	*Infection*	103
4	*FEMS Microbiol. Rev.*	13	31	*Can. J. Microbiol.*	236
5	*Yeast*	NA	32	*Curr. Microbiol.*	87
6	*J. Bacteriol.*	915	33	*J. Appl. Bacteriol.*	125
7	*Mol. Microbiol.*	94	34	*J. Microbiol. Meth.*	34
8	*Antimicrob. Agents Ch.*	408	35	*B. I. Pasteur*	20
9	*Rev. Infect. Dis.*	213	36	*ZBL Bakt. Mikr. Hyg. A*	164
10	*CRC Crit. Rev. Microbiol.*	12	37	*Ann. Inst. Pasteur Mic.*	58
11	*Syst. Appl. Microbiol.*	52	38	*Vet. Microbiol.*	104
12	*Int. J. Syst. Bacteriol.*	83	39	*Acta Path. Micro. Im. B*	NA
13	*J. Antimicrob. Chemoth.*	352	40	*Protistologica*	NA
14	*Appl. Environ. Microb.*	588	41	*Med. Microbiol. Immun.*	37
15	*J. Clin. Microbiol.*	619	42	*Diagn. Micr. Infec. Dis.*	60
16	*Adv. Appl. Microbiol.*	8	43	*Int. J. Food Microbiol.*	66
17	*Curr. Top. Microbiol.*	53	44	*J. Gen. Appl. Microbiol.*	27
18	*Arch. Microbiol.*	173	45	*Microbiol. Immunol.*	122
19	*J. Gen. Microbiol.*	367	46	*Lett. Appl. Microbiol.*	81
20	*Enzyme Microb. Tech.*	108	47	*Gen. Physiol. Biophys.*	57
21	*Eur. J. Clin. Microbiol.*	161	48	*A. Van Leeuw. J. Microb.*	51
22	*FEMS Microbiol. Ecol.*	42	49	*Symbiosis*	14
23	*J. Med. Microbiol.*	124	50	*Comp. Immunol. Microb.*	27
24	*J. Infection*	68	51	*Microbios.*	61
25	*Eur. J. Protistol.*	37	52	*ZBL Bakt. Mikr. Hyg. B*	76
26	*Microbiol. Sci.*	70	53	*J. Basic Microb.*	69
27	*Appl. Microbiol. Biot.*	270			

NA, Not available.

Table II Microbiology Journals Listed by Total Number of Articles Published per Year (1988)

Journal title	Number of articles published in 1988	Journal title	Number of articles published in 1988
J. Bacteriol.	915	*Int. J. Food Microbiol.*	66
J. Clin. Microbiol.	619	*Microbios.*	61
Appl. Environ. Microb.	588	*Diagn. Micr. Infec. Dis.*	60
Antimicrob. Agents Ch.	408	*Ann. Inst. Pasteur Mic.*	58
J. Gen. Microbiol.	367	*Gen. Physiol. Biophys.*	57
FEMS Microbiol. Lett.	365	*Curr. Top. Microbiol.*	53
J. Antimicrob. Chemoth.	352	*Syst. Appl. Microbiol.*	52
Appl. Microbiol. Biot.	270	*A. Van Leeuw. J. Microb.*	51
ZBL. Bakt. Mikr. Hyg. A	240	*Am. J. Reprod. Immunol.*	50
Can. J. Microbiol.	236	*FEMS Microbiol. Ecol.*	42
Rev. Infect. Dis.	213	*Med. Microbiol. Immun.*	37
Arch. Microbiol.	173	*Eur. J. Protistol.*	37
Eur. J. Clin. Microbiol.	161	*J. Microbiol. Meth.*	34
J. Appl. Bacteriol	125	*Eur. J. Protistology*	29
J. Med. Microbiol.	124	*Annu. Rev. Microbiol.*	29
Microbiol Immunol	122	*Microbiol. Rev.*	28
Enzyme Microb. Tech.	108	*J. Gen. Appl. Microbiol.*	27
Vet. Microbiol.	104	*Comp. Immunol. Microb.*	27
Infection	103	*B. I. Pasteur*	20
Mol. Microbiol.	94	*Acta Path. Micro. Im.*	18
Curr. Microbiol.	87	*Symbiosis*	14
Int. J. Syst. Bacteriol.	83	*FEMS Microbiol. Rev.*	13
Lett. Appl. Microbiol.	81	*CRC Crit. R. Microbiol.*	12
Microbiol. Sci.	70	*Adv. Microb. Ecol.*	10
J. Basic Microb.	69	*Adv. Appl. Microbiol.*	8
		Total	7038

Table III.A Distribution of Journals Cited in *Journal of Bacteriology*, 1979–1988

Journal cited	Number of citations	Journal cited	Number of citations
J. Bacteriol.	5708	*Genetics*	183
P. Natl. Acad. Sci. U.S.A.	2348	*Can. J. Microbiol.*	139
J. Biol. Chem.	1698	*Arch. Biochem. Biophys.*	127
Mol. Gen. Genet.	1157	*Virology*	123
J. Mol. Biol.	1148	*Bacteriol. Rev.*	118
Gene	902	*Cold Spring Harb. Sym.*	110
Nature (London)	820	*Antimicrob. Agents Ch.*	109
Nucleic Acids Res.	804	*Escherichia Coli Sal.*	95
Cell	802	*Plant Physiol.*	80
J. Gen. Microbiol.	701	*J. Biochem.-Tokyo*	78
Infect. Immun.	478	*J. Virol.*	78
Methods Enzymol.	434	*Mol. Cell. Biol.*	68
Anal. Biochem.	411	*J. Infect. Dis.*	67
Biochim. Biophys. Acta	401	*Bio-Technol.*	61
Eur. J. Biochem.	376	*Exp. Gene Fusions*	60
Mol. Cloning Laboratory	363	*Trends Biochem. Sci.*	60
Microbiol. Rev.	361	*Mutat. Res.*	59
Arch. Microbiol.	347	*Syst. Appl. Microbiol.*	55
Embo J.	327	*Phytopathology*	51
Biochemistry-U.S.	310	*Adv. Bacterial Genet.*	50
Science	301	*Photochem. Photobiol.*	50
Appl. Environ. Microb.	294	*Biochimie*	49
FEMS Microbiol. Lett.	257	*J. Exp. Med.*	48
Exp. Mol. Genetics	234	*Agr. Biol. Chem. Tokyo*	47
Plasmid	234	*Int. J. Syst. Bacteriol.*	44
Biochem. Bioph. Res. Commun.	224	*FEMS Microbiol. Rev.*	43
FEBS Lett.	213	*J. Clin. Microbiol.*	42
Biochem. J.	207	*Curr. Microbiol.*	41
Annu. Rev. Microbiol.	194	*J. Cell Biol.*	41
Annu. Rev. Biochem.	188		
Annu. Rev. Genet.	187	All other (1301)	4311

(continues)

Table III.B (*continued*) Distribution of Journals Citing *Journal of Bacteriology*, 1979–1988

Journal citing	Number of citations	Journal citing	Number of citations
J. Bacteriol.	5708	*Curr. Genet.*	117
J. Biol. Chem.	1119	*FEMS Microbiol. Rev.*	115
J. Gen. Microbiol.	963	*J. Basic Microb.*	115
Mol. Gen. Genet.	896	*J. Antimicrob. Chemoth.*	112
Appl. Environ. Microb.	890	*Microb. Pathogenesis*	110
Microbiol. Rev.	759	*Science*	104
Infect. Immun.	663	*Ann. Inst. Pasteur Mic.*	101
FEMS Microbiol. Lett.	648	*Methods Enzymol.*	99
Gene	599	*ZBL Bakt. Mikr. Hyg. A*	98
P. Natl. Acad. Sci. U.S.A.	588	*A. Van Leeuw. J. Microb.*	95
Can. J. Microbiol.	579	*Annu. Rev. Biochem.*	94
Arch. Microbiol.	484	*Plant Physiol.*	88
Mol. Microbiol.	452	*J. Infect. Dis.*	86
J. Mol. Biol.	434	*J. Med. Microbiol.*	85
Nucleic Acids Res.	431	*Folia Microbiol.*	79
Biochim. Biophys. Acta	378	*Genetika*	79
Eur. J. Biochem.	350	*Gene Dev.*	78
Antimicrob. Agents Ch.	340	*Microbios.*	77
Annu. Rev. Microbiol.	316	*Arch. Biochem. Biophys.*	75
Cell	246	*Biotechnol. Bioeng.*	73
Biochimie	238	*Nature (London)*	69
Biochemistry-U.S.	236	*Syst. Appl. Microbiol.*	69
Plasmid	236	*Zh. Mikrob. Epid. Immun.*	67
Embo J.	234	*J. Antibiot.*	66
J. Clin. Microbiol.	214	*Annu. Rev. Genet.*	65
Genetics	201	*Microbiol. Immunol.*	65
Adv. Microb. Physiol.	199	*J. Biochem.-Tokyo*	64
Agr. Biol. Chem. Tokyo	198	*Microbial Ecol.*	60
Mol. Cell. Biol.	197	*Plant Soil*	58
CRC Crit. R. Microbiol.	194	*Anal. Biochem*	56
Curr. Microbiol	193	*Annu. Rev. Cell Biol.*	55
Appl. Microbiol. Biot.	183	*Biotechnol. Lett.*	54
J. Appl. Bacteriol.	169	*Adv. Microb. Ecol.*	53
Mutat. Res.	160	*Enzyme Microb. Tech.*	53
Biochem. Bioph. Res. Commun.	152	*Curr. Sci. India*	52
Rev. Infect. Dis.	141	*Eur. J. Clin. Microbiol.*	51
Biochem. J.	137	*J. Theor. Biol.*	51
Microbiol. Sci.	135	*Bot. Acta*	50
Int. J. Syst. Bacteriol.	128	*Photochem. Photobiol.*	50
FEBS Lett	125		

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How to Use the Encyclopedia

This encyclopedia is organized in a manner that we believe will be the most useful to you, and we would like to acquaint you with some of its features.

The volumes are organized alphabetically as you would expect to find them in, for example, magazine articles. Thus, "Foodborne Illness" is listed as such and would not be found under "Illness, Foodborne." If the first words in a title are not the primary subject matter contained in an article, the main subject of the title is listed first (e.g., "Heavy Metals, Bacterial Resistances," "Marine Habitats, Bacteria," "Method, Philosophy," "Transcription, Viral"). This is also true if the primary word of a title is too general (e.g.,"Bacteriocins, Molecular Biology"). Here, the word "bacteriocins" is listed first because "molecular biology" is a very broad topic. Titles are alphabetized letter-by-letter so that "Cell Membrane: Structure and Function" is followed by "Cellulases" and then by "Cell Walls of Bacteria."

Each article contains a brief introductory Glossary wherein terms that may be unfamiliar to you are defined *in the context of their use in the article*. Thus, a term may appear in another article defined in a slightly different manner or with a subtle pedagogic nuance that is specific to that particular article. For clarity, we have allowed these differences in definition to remain so that the terms are defined relative to the context of each article.

Articles about closely related subjects are identified in the Index of Related Titles at the end of the last volume (Volume 4). The article titles that are cross-referenced within each article may be found in this index, along with other articles on related topics.

The Subject Index contains specific, detailed information about any subject discussed in the *Encyclopedia*. Entries appear with the source volume number in boldface followed by a colon and the page number in that volume where the information occurs (e.g., "DNA repair by bacterial cells, **2**:9"). Each article is also indexed by its title (or a shortened version thereof), and the page ranges of the article appear in boldface (e.g. "Lyme disease, **2:639–646**" means that the primary coverage of the topic of Lyme disease occurs on pages 639–646 of Volume 2).

If a topic is covered primarily under one heading but additional related information may be found elsewhere, a cross-reference is given to the related material. For example, "Biodegradation" would contain all the page numbers where relevant information occurs, followed by "*See also* Bioremediation; Pesticide biodegradation" for different but related information. Similarly, a "*See*" reference refers the reader from a less-used synonym (or acronym) to a more specific or descriptive subject heading. For example, "Immunogens, synthetic. *See* Vaccines, synthetic." A *See under* cross-reference guides the reader to a specific subheading under a term. For example, "Mixis. *See under* Genome rearrangement."

An additional feature of the Subject Index is the identification of Glossary terms. These appear in the index where the word "defined" (or the words "definition of") follows an entry. As we noted earlier, there may be more than one definition for a particular term, and as when using a dictionary, you will be able to choose among several different usages to find the particular meaning that is specifically of interest to you.

Contents

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S

Sexually Transmitted Diseases

Stephen A. Morse
Centers for Disease Control

Glossary

Epidemiology Science of epidemics and epidemic diseases
Gonorrhea Contagious sexually transmitted infection of the genital mucosa caused by the bacterium *Neisseria gonorrhoeae*
Incidence Cases per population accumulated over a period of observation
Prevalence Number of cases ascertained over a fixed (usually short) period of time
Syndrome The aggregate of signs and symptoms associated with any morbid process, together constituting the picture of the disease
Syphilis Acute and chronic infectious disease caused by *Treponema pallidum* and transmitted by direct contact, usually through sexual intercourse

SEXUALLY TRANSMITTED DISEASES (STDs) are infections that are transmitted through sexual contact. Sexually transmitted infections may also be transmitted from pregnant women to their fetuses or during the birth process. Sexually transmitted agents include bacteria, viruses, protozoa, fungi, and ectoparasites. Sexually transmitted agents can cause diseases that range from mildly symptomatic to fatal. STDs are very common infections in both developing and developed countries.

I. Introduction

A. Scope

STDs are a significant medical and public health problem. STDs represent a large proportion of ambulatory patient visits and a growing proportion of hospitalized patients seen by many primary care physicians. In addition, STDs are also implicated in a wide spectrum of acute inflammatory conditions and in a variety of preneoplastic, neoplastic, and postinflammatory complications seen by many dermatologists, urologists, obstetricians, and gynecologists. Pediatricians more frequently diagnose and manage sexually transmitted infections in the neonate and infant, the abused older child, and the adolescent. Internists and infectious disease specialists must deal with the increasing number of patients infected by the human immunodeficiency virus (HIV-1 and HIV-2) who subsequently develop acquired immunodeficiency syndrome (AIDS) and related opportunistic infections. [*See* ACQUIRED IMMUNODEFICIENCY SYNDROME (AIDS).]

Until recently, the scope of STD was limited to five classical infections—gonorrhea, syphilis, chancroid, lymphogranuloma venereum (LGV), and granuloma inguinale (Donovanosis). A major shift in thinking has occurred over the past two decades as clinicians, laboratory scientists, and public health workers became increasingly aware of the broader spectrum of STDs. Our concepts of these infections have changed considerably. The classical "venereal diseases," such as gonorrhea and syphilis, have been overshadowed by other sexually transmitted

infections that are actually more common. Syndromes associated with *Chlamydia trachomatis*, human papillomavirus (HPV), and herpes simplex virus type 2 (HSV-2), have become prominent, in part because of a wider array of laboratory diagnostic techniques. [*See* HERPESVIRUSES; CHLAMYDIAL INFECTIONS, HUMAN.]

With the exception of HIV, the "newly" described sexually transmitted infections long have been recognized, but have achieved recent prominence as STDs for several reasons. The development of new diagnostic tests and the improvement of existing tests have facilitated investigations of the etiology, prevalence, mode of transmission, and clinical consequences of STDs. Changes in sexual behavior have resulted in a higher rate of sexual transmission of infectious agents that have multiple modes of transmission [e.g., hepatitis A, B, and C viruses, cytomegalovirus (CMV), and some enteric pathogens]. In addition, the maturing of the "baby boom" generation in the 1960s and 1970s resulted in an increase in the proportion of young adults in the population that was faster than the increase of the total population; these individuals were also more sexually active than their predecessors. The association of STDs such as AIDS, HPV-associated genital cancers, and chronic recurrent genital herpes with incurable and fatal infections has captured the attention of the media and the public. It has also been recognized that women and children suffer from a disproportionate share of the complications of STDs, for example, pelvic inflammatory disease (PID), infertility, ectopic pregnancy, adverse pregnancy outcome, infant pneumonia, and developmental disability. PID and its sequelae (ectopic pregnancy and infertility) are responsible for the majority of the cost associated with STDs (excluding AIDS). For example, it has been estimated that the economic cost of pelvic inflammatory disease alone exceeds $2 billion per year in the United States.

Even the longest-known STDs are undergoing a resurgence. The number of cases of syphilis and chancroid has increased in recent years to the highest in decades. Much of this increase has been associated with casual sex and the exchange of sex for drugs or money. Although reported gonorrhea cases continue to decline, both the number and variety of antibiotic-resistant strains have increased dramatically, resulting in the use of more expensive antimicrobial therapy regimens.

B. Epidemiology

Currently, at least 25 organisms and 25 syndromes are recognized as sexually transmitted. Many of these have been recognized recently, partly as a result of improved laboratory techniques. Common sexually transmitted agents and the diseases and syndromes they cause are listed in Table I. An in-depth discussion of the biology and epidemiology of all these sexually transmitted agents is beyond the scope of this article. The interested reader is referred to the bibliography for additional references. [*See* EPIDEMIOLOGIC CONCEPTS.]

Common behavioral and biological features characterize the epidemiology of STDs. These infections typically have a long latent or incubation period, so transmission to another individual often occurs before symptoms are apparent. With one exception (hepatitis B), vaccination is ineffective in preventing these infections. Many of the agents listed in Table I are highly adapted to humans and reside on the genital mucosa. Thus, contact between genital mucosal surfaces—sexual intercourse, in most instances—is the major mode of transmission. Behavioral and environmental factors determine whether sexual transmission is the primary route of spread for these agents. For example, in many developing countries hepatitis B and CMV infections are acquired in childhood because of low standards of hygiene or poor living conditions. However, in industrialized countries the same infections are acquired in adulthood through sexual contact. In general, infectious agents are more often spread by sexual contact in persons with an increasing standard of living, since opportunities for person-to-person transmission during childhood are reduced.

Factors that affect the spread of STDs (risk factors) are directly related to patterns of sexual behavior. Risk factors include multiple sexual partners, a history of STDs, urban residence, single marital status, and young age. Thus, the highest rates of STDs are found in urban men and women in their sexually most active years, that is, between 15 and 35 years of age.

Prostitutes are an important reservoir of STDs and play an important role in the spread of these infections in many parts of the world. It is difficult to make generalizations concerning the role of prostitutes because major differences in sexual behavior patterns are known to exist within continents and even within countries. For example, prostitutes as a

Table I Major Sexually Transmitted Agents and the Diseases They Cause

Agents	Disease or syndrome
Bacteria	
Neisseria gonorrhoeae	Urethritis; epididymitis; proctitis; bartholinitis; cervicitis; endometritis; salpingitis and related sequelae (infertility, ectopic pregnancy); perihepatitis; complications of pregnancy (e.g., chorioamnionitis, premature rupture of membranes, premature delivery, postpartum endometritis); conjunctivitis; disseminated gonococcal infection (DGI)
Chlamydia trachomatis	Same as *N. gonorrhoeae*, except for DGI; also, lymphogranuloma venereum,[a] Reiter's syndrome; infant pneumonia
Treponema pallidum	Syphilis[a]
Haemophilus ducreyi	Chancroid[a]
Calymmatobacterium granulomatis	Donovanosis[a]
Mycoplasma hominis	Postpartum fever; salpingitis
Ureaplasma urealyticum	Urethritis; low birth weight (?); chorioamnionitis (?)
?*Gardnerella vaginalis*, *Mobiluncus* sp., ?*Bacteroides* sp.	Bacterial vaginosis
?Group B β-hemolytic streptococci	Neonatal sepsis; neonatal meningitis
Virus	
Herpes simplex virus (HSV-2, HSV-1)	Primary and recurrent genital herpes[a]
Hepatitis B virus (HBV)	Acute, chronic, and fulminant hepatitis B, with associated immune complex phenomena and sequelae including cirrhosis and hepatocellular carcinoma
Cytomegalovirus (CMV)	Congenital infection: gross birth defects and infant mortality, cognitive impairment (e.g., mental retardation, 8th nerve deafness), heterophile-negative infectious mononucleosis, protean manifestations in the immunosuppressed host
Human papilloma virus (HPV)	Condyloma acuminata; laryngeal papilloma in infants; squamous epithelial neoplasias of the cervix, anus, vagina, vulva, penis
Molluscum contagiosum virus (MCV)	Genital molluscum contagiosum
Human immunodeficiency virus (HIV-1, HIV-2)	AIDS and related conditions
Human T-lymphotropic virus type 1	T-cell leukemia/lymphoma; tropical spastic paraparesis
Protozoa	
Trichomonas vaginalis	Vaginitis; urethritis (?); balanitis (?)
Fungus	
Candida albicans	Vulvovaginitis; balanitis; balanoposthitis
Ectoparasite	
Phthirus pubis	Pubic lice infestation
Sarcoptes scabiei	Scabies

[a] These infections are responsible for the syndrome known as genital ulcer disease.

source of disease are named by up to 80% of male patients in some parts of the developing world, compared with less than 20% in Europe and North America.

From a global perspective, societal problems are also important in the epidemiology of STDs. Increasing urbanization with disruption of traditional social structures, increased mobility for economic or political reasons, poor medical facilities, a population with a high proportion of teenagers and young adults, poverty, and high unemployment rates all contribute to the high incidence of STDs and their sequelae.

It is difficult to estimate the global incidence of STDs because many developing countries do not conduct surveillance for these infections or lack the resources for the laboratory confirmation. In developing countries such as those in Africa, the prevalence of gonorrhea, syphilis, and chlamydial infections has been estimated by screening pregnant women in urban settings. Using this approach, the prevalence of gonorrhea has been reported to vary