

A scanning electron micrograph (SEM) of Escherichia coli bacteria. The image shows numerous rod-shaped bacteria, some appearing in clusters and others more isolated. The bacteria have a textured, slightly irregular surface. The background is dark, making the lighter-colored bacteria stand out. The overall image has a blue tint.

2<sup>ND</sup> EDITION

# Escherichia coli

Pathotypes and Principles of Pathogenesis

EDITED BY **MICHAEL S. DONNENBERG**



# Escherichia Coli Second Edition Pathotypes And Principles Of Pathogenesis

**Victor A. Garcia-Angulo, Mauricio J.  
Farfan, Alfredo G. Torres**



## **Escherichia Coli Second Edition Pathotypes And Principles Of Pathogenesis:**

**Escherichia coli** Michael Donnenberg, 2013-06-12 The 2e of *Escherichia coli* is a unique comprehensive analysis of the biology and molecular mechanisms that enable this ubiquitous organism to thrive. Leading investigators in the field discuss the molecular basis of *E. coli* pathogenesis followed by chapters on genomics and evolution. Detailed descriptions of distinct strains reveal the molecular pathogenesis of each and the causes of intestinal and extra intestinal infections in humans. This work concludes with a presentation of virulence factors common to two or more pathotypes. The book is a great resource for references and up to date knowledge for anyone who studies *E. coli* pathogenesis either as established investigators or investigators new to the field. It is also an excellent text for those who teach mechanisms of pathogenesis to graduate students and medical students and wish to have a source of knowledge from which to develop lectures. Offers a single source of information of *E. coli* pathogenesis written by expert authors. Presents comprehensive coverage on molecular mechanisms, biology, evolution, and genomics and recent advances. *Escherichia coli* Nadia Boisen, Karen A. Krogfelt, James P. Nataro, 2013-06-12 Enteraggregative *Escherichia coli* EAEC are among the most prevalent enteric pathogens worldwide. The pathotype has been implicated in endemic diarrhea in both developing and industrialized populations, epidemic diarrhea, and traveler's diarrhea. A recent outbreak of Shiga toxin-producing EAEC adds a new dimension to the epidemiology of this pathotype. Although the pathogenesis of this pathotype is not fully understood, a number of putative virulence factors have been described. The aggregative adherence fimbriae (AAF) are mucosal adhesins that also elicit inflammatory responses from infected mucosal surfaces. Expression of AAF adhesins is induced by the transcriptional activator AggR, which activates expression of several other secreted but as yet relatively cryptic proteins. EAEC-induced histopathology includes exfoliation of enterocytes, which has been linked to the action of serine protease autotransporter toxins. Epidemiologic evidence supports a model of EAEC pathogenesis comprising the concerted action of multiple virulence factors. *Escherichia coli* Leon G. De Masi, Courtney D. Sturey, Joshua A. Lieberman, Michael S. Donnenberg, 2013-06-12 Pathogenic *Escherichia coli* strains use two separate but closely related systems to export important virulence factors. The type 2 secretion (T2S) and type IV pilus (T4P) systems have considerable structural homology; both contain an outer membrane secretin complex, a pilus structure, and an inner membrane subassembly complex. The pilus structure, which predominantly consists of a major pilin subunit, is assembled from individual monomers, although this process remains poorly understood. However, the exported products are different. The T2S secretes fully folded exoproteins like heat-labile toxin through the outer membrane. In this case, a pseudopilus structure is proposed to act as a piston to push the substrate through the outer membrane pore. In contrast, the T4P substrate is the pilus itself and is used by the bacterium for aggregation and attachment to host cells. *Escherichia coli* Shahista Nisa, Karen M. Scanlon, Michael S. Donnenberg, 2013-06-12 Enteropathogenic *Escherichia coli* (EPEC) strains are a leading cause of diarrhea among infants in developing countries. These bacteria spread via fecal-oral transmission and

colonize the small intestine Typical EPEC differs from atypical strains in that they possess the *bfp* operon and generate a type IV B class of fimbriae known as the bundle forming pilus BFP EPEC uses BFP to attach to intestinal epithelium Upon attachment EPEC translocates effector proteins into the host cell via a type 3 secretion system which is encoded on a pathogenicity island known as the locus of enterocyte effacement Translocated effectors modulate the host response in a number of ways including subversion of immune responses and hijacking of the cytoskeletal system By inducing actin rearrangement EPEC causes the formation of actin pedestals onto which it sits and leads to the effacement of microvilli giving this bacterium a characteristic attaching and effacing phenotype EPEC infections are typically self limiting with rehydration therapy constituting primary treatment but they can be protracted and lethal Breastfeeding provides a great protective effect validating the use of a vaccine to induce a humoral response in mother or child as a potential means of preventative action This chapter provides a detailed discussion on EPEC pathogenesis and host cell responses and summarizes the current detection and treatment options available *Escherichia coli* Timothy J. Wells, Ian R.

Henderson, 2013-06-12 Many virulence factors of *Escherichia coli* need to traverse the inner membrane periplasm and outer membrane to be effective The bacterium has a variety of secretion systems to achieve this Two of these the type I secretion system T1SS and the type V secretion system T5SS are explored in this chapter In *E. coli* the best known T1SS is that used to secrete hemolysin a pore forming toxin found in both uropathogenic and enterohemorrhagic strains of *E. coli* Many proteins are secreted via the T5SS in *E. coli* with the proteins having a wide range of virulence functions This chapter will focus on these two systems the mechanism of biogenesis the function of the secreted proteins and current attempts to use these systems in biotechnological applications ***Escherichia coli*** Sivapriya Kailasan Vanaja, Dakshina M. Jandhyala, Emily M. Mallick, John M. Leong, Sowmya Balasubramanian, 2013-06-12 Enterohemorrhagic *Escherichia coli* EHEC can cause food borne disease outbreaks associated with contaminated beef or fresh produce resulting in diarrhea hemorrhagic colitis and or hemolytic uremic syndrome the triad of anemia thrombocytopenia and renal failure Intestinally colonized cattle are a major source of human infection Upon colonic infection EHEC utilizes a type III secretion system to translocate into mammalian cells bacterial effector proteins that target cellular functions such as epithelial barrier integrity vesicular transport and cytoskeletal structure Translocated effectors induce attaching and effacing lesions characterized by microvillar effacement intimate attachment and actin pedestal formation beneath bound bacteria Systemic disease relies on the production of Shiga toxin a potent inhibitor of ribosome function that triggers cell death inflammation and vascular damage Most current therapies are only supportive in nature because antibiotic treatment may increase Shiga toxin production Therefore outbreak prevention early diagnosis and the development of new therapeutic strategies are critical *Escherichia coli* David M. Gordon, 2013-06-12 Although *E. coli* is primarily a commensal of mammals and to a lesser extent birds it can be isolated from a variety of host species as well as soil sediments and water It has long been recognized that *E. coli* exhibits quite extensive

substructuring and that the relative abundance of the most common phylo groups varies with respect to host age and sex host species as well as geographical location Strains belonging to some phylo groups are much more frequently encountered in water samples than strains belonging to other phylo groups The extent to which strain survival in the external environment has determined the evolutionary origins of the various diarrheal pathotypes is unknown There is a growing body of evidence that indicates commensal E coli like the diarrheal pathotypes exhibits at some tissue specificity within the gastrointestinal tract However there is little evidence to suggest that commensal E coli exhibit extensive host specificity as is the case with many of the diarrheal pathotypes Escherichia coli Jason W. Sahl,Carolyn R. Morris,David A. Rasko,2013-06-12

Escherichia coli is a normal inhabitant of the healthy gut but is also an important and widespread human and animal pathogen E coli has been associated with human infections including diarrhea urinary tract infections and meningitis E coli are designated into pathogenic variants pathovars also known as pathotypes based largely on molecular markers associated with specific disease presentations Many of these biomarkers are present on mobile genetic elements which provide difficulties in accurate identification and surveillance of these pathogens E coli was one of the first bacteria to have the complete genome decoded and these organisms have been the focus of genomic studies for approximately the last 15 years While early studies suggested the diversity of the species may be limited the generation of multiple genomes rapidly identified significant genomic diversity Whole genome sequence analysis has demonstrated significant genetic variability even within each pathovar Furthermore next generation sequencing has identified the distribution of genes across the E coli species and provided insights into the evolution of the species In the coming years decreased sequencing costs are likely to positively affect the understanding of pathogenesis in this important human pathogen Escherichia coli Sujay Chattopadhyay,Evgeni V. Sokurenko,2013-06-12 Why do bacteria cause disease in humans Is disease adaptive for the pathogen or just a biological accident And if disease is adaptive how does it influence the long term or short term fitness for the pathogen and how is it sustained in nature In this chapter we try to address these questions by dissecting the molecular mechanisms of both pathogenicity and evolution of Escherichia coli one of the most notorious and versatile human pathogens which is also one of the most common human commensal bacteria We examine how and more importantly why horizontally transferred virulence factors and pathoadaptive mutations are acquired by and sustained by certain E coli lineages The evolution of pathogenicity is thus reviewed from the perspective of E coli ecology with the discussion of various models of virulence evolution in general and some of its paradoxes We hope to shed light from the evolutionary perspective on how professional accidental or opportunistic pathogens might be defined Escherichia coli Vasilios Kalas,Ender Volkan,Scott J. Hultgren,2013-06-12 The chaperone usher CU pathway constitutes one of the most prevalent mechanisms for the assembly of adhesive pili on the surface of Gram negative bacteria Studies at the interface of genetics biochemistry and structural biology have detailed the functions of the chaperone and the usher providing a step by step understanding of pilus biogenesis by this

sophisticated molecular machine Further work has elucidated the molecular basis of specificity in host recognition by CU pili Snapshots in CU pilus assembly and CU pilus mediated pathogenesis have unveiled necessary molecular details for the design and application of promising antibiotic compounds that may soon prevent and treat acute chronic and recurrent bacterial infections in humans **Escherichia coli** Liam J. Worrall,Julien R.C. Bergeron,Natalie C.J. Strynadka,2013-06-12 The bacterial type III secretion system is used by pathogenic Gram negative bacteria to transfer toxin proteins directly into the cytoplasm of eukaryotic hosts Pathogenic E coli species including EPEC EHEC and Shigella spp use specialized T3SSs to deliver effector proteins into their mammalian hosts in order to manipulate the host response in their favor Central to the T3SS is the injectisome a syringe shaped molecular nanomachine that spans both bacterial membranes and host cell membrane providing a continuous channel from the bacterial to host cytoplasm The last 5 years have witnessed significant progress in our understanding of the structure of the injectisome and the pathways that regulate its assembly and secretion In this chapter we will discuss these advances focusing on the T3SSs of E coli spp including Shigella We will first give an overview of the structural architecture of the injectisome and then discuss the mechanisms that regulate both its assembly and secretion **Escherichia coli** Kwang Sik Kim,2013-06-12 E coli is the most common Gram negative organism causing neonatal meningitis and neonatal meningitis continues to be an important cause of mortality and morbidity throughout the world Our incomplete knowledge of its pathogenesis and pathophysiology contributes to such mortality and morbidity Recent reports of neonatal meningitis caused by E coli strains producing CTX M type or TEM type extended spectrum lactamases create a challenge E coli invasion of the blood brain barrier is a prerequisite for penetration into the brain and requires specific microbial host factors as well as microbe and host specific signaling molecules Blockade of such microbial host factors and host cell signaling molecules is shown to be efficient in preventing E coli penetration into the brain the essential step in the development of E coli meningitis Continued investigation of the microbial and host factors contributing to E coli invasion of the blood brain barrier is likely to identify new targets for prevention and therapy of E coli meningitis thereby limiting the exposure to emerging antimicrobial resistant E coli *Escherichia coli* Rachel R. Spurbeck,Harry L.T. Mobley,2013-06-12 Uropathogenic E coli UPEC are a genotypically diverse subset of extraintestinal pathogenic E coli that cause urinary tract infections UPEC have evolved from commensal E coli by acquisition of virulence factors through horizontal gene transfer Through reductive evolution asymptomatic bacteriuria strains have evolved from UPEC to live a commensal like lifestyle in the urinary tract UPEC unlike diarrheagenic E coli have no core set of virulence factors instead this pathotype uses flagella to ascend the urinary tract and a variety of adhesins iron acquisition systems and toxins to colonize the bladder and kidneys While distinct virulence factors have been associated with uropathogenicity there is also functional redundancy Some virulence factor genes such as those encoding type 1 and P fimbriae undergo phase variation leading to a bacterial population with mixed expression Strain variation resulting from both a heterogeneous set of virulence

factors and phase variation leads to a phenotypic diversity that complicates vaccine development against UPEC and likely allows for recurrent infections

**Escherichia coli** Lisa M. Willis,Chris Whitfield,2013-06-12 *Escherichia coli* isolates produce a range of cell surface polysaccharides which mediate interactions between the bacteria and their environment The best studied glycoconjugates are lipopolysaccharide LPS and capsular polysaccharide CPS LPS is a component of the outer membrane in all *E. coli* strains and it plays a critical role in the barrier properties of the cell envelope and resistance to host factors including cationic antimicrobial peptides and the complement system LPS is also a biologically active molecule that activates TLR4 mediated signaling leading to endotoxic shock In contrast only some strains of *E. coli* make capsular polysaccharides CPSs The capsule plays a major role in evasion of the host immune system and is particularly important for the pathogenesis of uropathogenic and meningitis associated *E. coli* This chapter discusses the biosynthesis of LPS and capsule as well as their contributions to the virulence of pathogenic *E. coli*

**Escherichia coli** Victor A. Garcia-Angulo,Mauricio J. Farfan,Alfredo G. Torres,2013-06-12 In addition to the well established and extensively studied categories of pathogenic *E. coli* there are other groups of *E. coli* associated with diarrheal and or inflammatory bowel diseases that have not been thoroughly characterized or which are considered newly emergent pathogens This chapter focuses on three representatives of these groups of pathogenic *E. coli* and the current progress understanding their role in pathogenesis Diffusely adherent *E. coli* DAEC are a collection of isolates that colonize the small bowel considered potentially diarrheagenic and that can cause childhood diarrhea Adherent and invasive *E. coli* AIEC are a group of mucosa associated bacteria with invasive properties in Crohn's disease patients and can survive and replicate extensively in macrophages Finally *E. coli* O104 H4 a hybrid Shiga toxin producing enteroaggregative *E. coli* which caused a large outbreak in Europe in 2011 displays a unique combination of virulence traits resulting in the development of hemolytic uremic syndrome in an unusually large proportion of infected patients This chapter summarizes recent progress in understanding the pathogenesis and the clinical outcome of these types of *E. coli* infections

**Escherichia coli** Anthony T. Maurelli,2013-06-12 *Shigella* spp and enteroinvasive *Escherichia coli* are agents of bacillary dysentery a disease that remains a scourge of impoverished communities with little access to clean water Because of the low infectious dose needed to cause disease refugees and displaced peoples are also at risk of dysentery outbreaks The characteristics of dysentery diarrhea fever blood in stools are direct results of the bacteria's ability to invade epithelial cells of the large intestine and induce a robust inflammatory response Genes encoding invasion and a type III secretion system and its secreted effectors are all found on a large plasmid Other virulence genes are encoded in pathogenicity islands on the chromosome The four species of *Shigella* are genetically closely related to *E. coli* and evidence suggests that *Shigella* evolved independently from at least seven ancestral lineages of *E. coli* The evolution of *Shigella* by gene acquisition virulence plasmid and gene loss black holes and antivirulence genes provides a paradigm for the evolution of bacterial pathogens from commensal ancestors

**Escherichia coli** Abigail

Clements, Cedric N. Berger, Mariella Lomma, Gad Frankel, 2013-06-12 Enterohemorrhagic E coli EHEC enteropathogenic E coli EPEC and Shigella use a type 3 secretion system T3SS to inject dozens of effector proteins into the host cell The effectors manipulate host cell processes including the host cytoskeleton immune response cell survival and gut integrity EPEC and EHEC share a large number of common effectors and some homologous effectors can be found in Shigella however there is also considerable variability within and between pathotypes For many effectors detailed molecular mechanisms of action have been described by identifying host interacting partners homologous proteins or enzymatic activities However understanding effector biology within the context of infection with multiple effectors various cell populations and host genetic differences remains a challenge

**Aquatic one health—the intersection of marine wildlife health, public health, and our oceans** Stephanie Norman, Samantha Shields, Ayanna Carla N. Phillips Savage, Claudia Venegas, Stephanie Plön, Dusan Palic, 2023-06-30

**The Routledge History of American Science** Timothy W. Kneeland, 2022-12-01 The Routledge History of American Science provides an essential companion to the most significant themes within the subject area The field of the history of science continues to grow and expand into new areas and to adopt new theories to explain the role of science and its connections to politics economics religion social structures intellectual history and art This book takes North America as its focus and explores the history of science in the region both nationally and internationally with 27 chapters from a range of disciplines Part I takes a chronological look at the history of science in America from its origins in the Atlantic World through to the American Revolution the Civil War the World Wars and ending in the postmodern era Part II discusses American science in practice from scientists as practitioners laboratories and field experiences to science and religion Part III examines the relationship between science and power The chapters touch on the intersection of science and imperialism environmental science in U S politics as well as capitalism and science Finally Part IV explores how science is embedded in the culture of the United States with topics such as the growing importance of climate science the role of scientific racism the construction of gender and how science and disability studies converge The final chapter reviews the way in which society has embraced or rejected science with reflections on the recent pandemic and what it may mean for the future of American science This book fills a much needed gap in the history and historiography of American science studies and will be an invaluable guide for any student or researcher in the history of science in America

**Mandell, Douglas, and Bennett's Principles and Practice of Infectious Diseases** John E. Bennett, MD, MACP, Raphael Dolin, MD, Martin J. Blaser, MD, 2014-08-28 After thirty five years Mandell Douglas and Bennett s Principles and Practice of Infectious Diseases 8th Edition is still the reference of choice for comprehensive global guidance on diagnosing and treating the most challenging infectious diseases Drs John E Bennett and Raphael Dolin along with new editorial team member Dr Martin Blaser have meticulously updated this latest edition to save you time and to ensure you have the latest clinical and scientific knowledge at your fingertips With new chapters expanded and updated coverage increased worldwide perspectives and



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