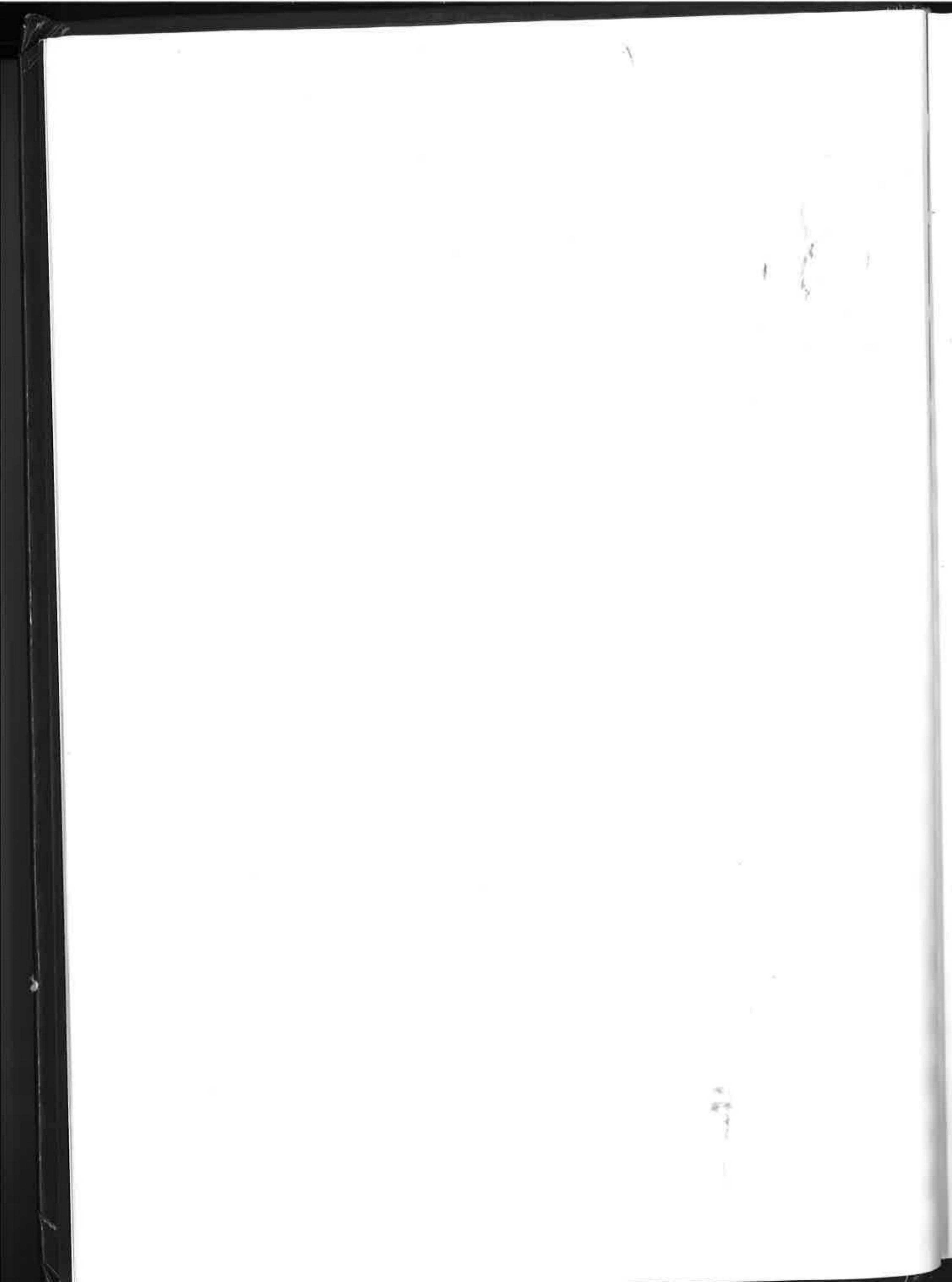


**Blackwell** Publishing



## Table of Contents

Contributors List Foreword Preface

- 1. Influenza A Virus David L. Suarez
- 2. Molecular Determinants of Pathogenicity for Av Michael L. Perdue
- 3. Ecology of Avian Influenza in Wild Birds David E. Stallknecht and Justin D. Brown
- 4. Epidemiology of Avian Influenza in Agricultura David E. Swayne
- 5. Pathobiology of Avian Influenza Virus Infection David E. Swayne and Mary Pantin-Jackwood

**Color Plate Section** 

. .

- 6. The Global Nature of Avian Influenza David E. Swayne
- 7. The Beginning and Spread of Fowl Plague (H7 Across Europe and Asia (1878–1955) Erhard F. Kaleta and Catherine P. A. Rülke
- 8. High Pathogenicity Avian Influenza in the Amer David E. Swayne
- 9. Highly Pathogenic Avian Influenza Outbreaks i Excluding the Asian H5N1 Virus Outbreaks *Dennis J. Alexander, Ilaria Capua, and Guus K*
- 10. Avian Influenza in Australia Leslie D. Sims and Andrew J. Turner
- 11. Multicontinental Epidemic of H5N1 HPAI Viru Leslie D. Sims and Ian H. Brown
- 12. Avian Influenza Control Strategies David E. Swayne
- 13. Avian Influenza Diagnostics and Surveillance M. Erica Spackman, David L. Suarez, and Dennis A
- 14. Mass Depopulation as an Effective Measure for Elizabeth A. Krushinskie, Martin Smeltzer, Patri

	ix xiii
	XV
	3
vian Influenza Viruses	23
	43
al and Other Man-Made Systems	59
ons in Birds and Mammals	87
	123
High Pathogenicity Avian Influenza)	145
ericas	191
in Europe, Asia, and Africa Since 1959,	217
Koch	239
us (1996–2007)	251
	287
Methods A. Senne	299
or Disease Control Purposes trice Klein, and Harm Kiezenbrink	309

**V**11

### 15. Methods for Disposal of Poultry Carcasses Boris Brglez and John Hahn

- 16. Farm and Regional Biosecurity Practices Carol J. Cardona
- 17. Farm Biosecurity Risk Assessment and Auc David Shapiro and Bruce Stewart-Brown
- 18. Methods for Inactivation of Avian Influenz Nathan G. Birnbaum and Bethany O'Brien
- 19. Vaccines, Vaccination, and Immunology fe David E. Swayne and Darrell R. Kapczynsk
- 20. Public Health Implications of Avian Influe. Nancy J. Cox and Timothy M. Uyeki
- 21. The Role of Educational Programs in the No. Nathaniel L. Tablante
- 22. Trade and Food Safety Aspects for Avian David E. Swayne and Colleen Thomas
- 23. Control of Low Pathogenicity Avian Influ David A. Halvorson
- 24. The Economics of Avian Influenza Anni McLeod
- 25. Global Strategy for Highly Pathogenic A and Postoutbreak Recovery Juan Lubroth, Subhash Morzaria, and Ale

Index

### viii

Contents

\$			333
			353
udits	ł	5	369
za Virus in the Environment		18	391
n for Avian Influenza Viruses in Poultry			407
iski ienza Viruses			453
Control of Avian Influenza			485
n Influenza Viruses			499
uenza			513
			537
Avian Influenza: Progressive Control and Erad	icati	on,	561
lejandro B. Thiermann			
			587

## **Contributors** List

### Dennis J. Alexander (retired)

Virology Department VLA Weybridge Woodham Lane, Addlestone Surrey KT15 3NB, United Kingdom

### Nathan G. Birnbaum

National Center for Animal Health Emergency Management Veterinary Services Animal and Plant Health Inspection

Service U.S. Department of Agriculture 4700 River Road Riverdale, Maryland 20737, USA

### **Boris Brglez**

109 Bourke Place Cary, North Carolina 27511, USA

### Ian H. Brown

Veterinary Laboratories Agency-Weybridge Addlestone Surrey KT15 3NB, United Kingdom

### Justin D. Brown

Southeastern Cooperative Wildlife Disease Study Department of Population Health College of Veterinary Medicine The University of Georgia Athens, Georgia 30602, USA

Ilaria Capua

OIE/FAO Reference Laboratory for Newcastle Disease and Avian Influenza Virology Department Istituto Zooprofilattico Sperimentale delle Venezie (IZSVe)

Viale dell'Università 10

35020 Legnaro, Padova, Italy

### **Carol J. Cardona**

Veterinary Medicine Extension School of Veterinary Medicine University of California, Davis Davis, California 95616, USA

### Nancy J. Cox

Director, Influenza Division Director, WHO Collaborating Center for Surveillance, Epidemiology and Control of Influenza

Centers for Disease Control and Prevention 1600 Clifton Road NE, Mail Stop A-20 Atlanta, Georgia 30333, USA

### John W. Hahn (Retired)

Veterinary Services, Arkansas Area Office
Animal and Plant Health Inspection Services
U.S. Department of Agriculture
9801 Holt Drive
Rogers, Arkansas 72756, USA

### **David A. Halvorson**

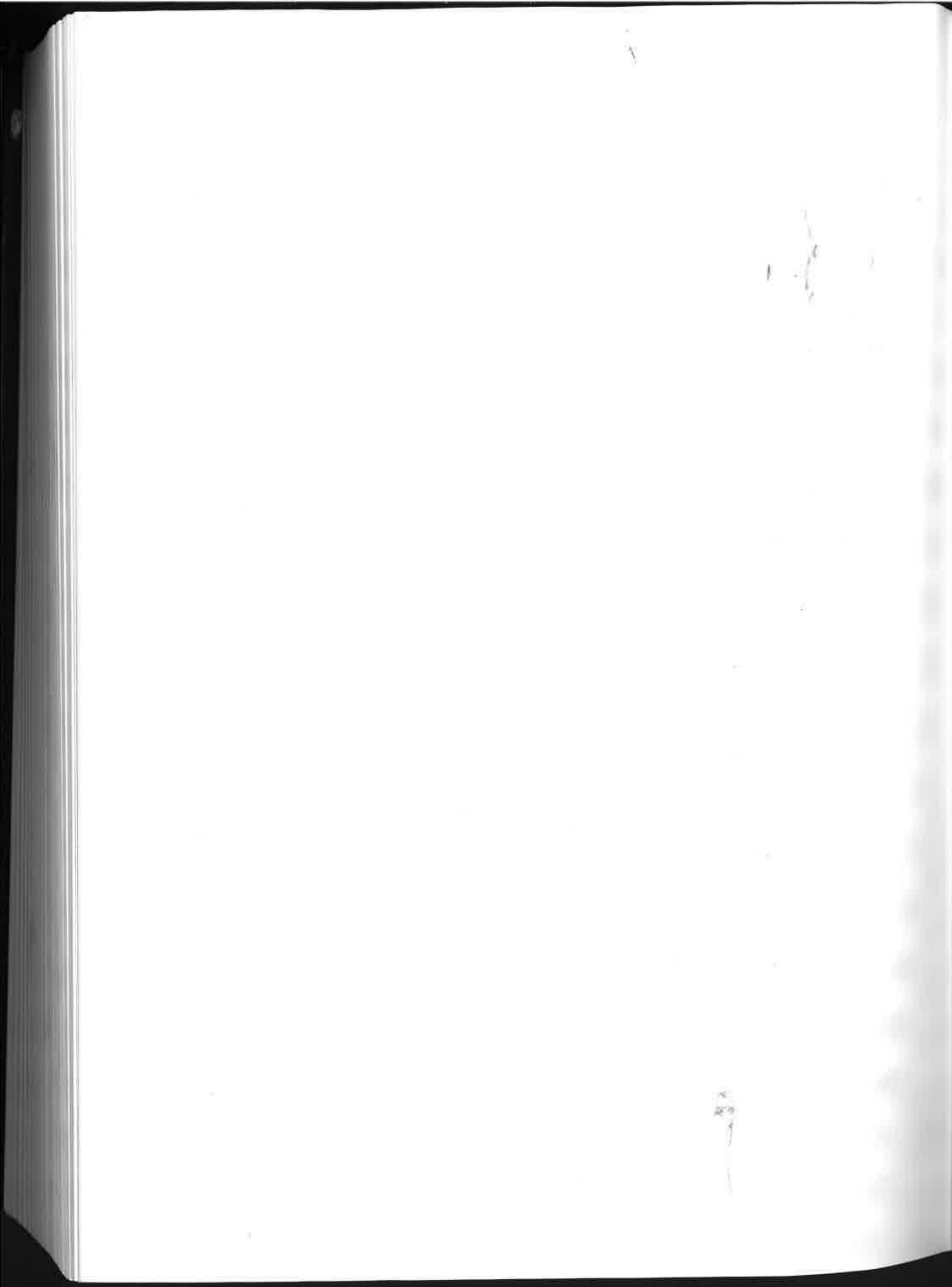
College of Veterinary Medicine University of Minnesota 1971 Commonwealth Avenue Saint Paul, Minnesota 55108, USA

### Erhard F. Kaleta

Clinic for Birds, Reptilia, Amphibia and Fish Justus Liebig University Giessen Veterinary Faculty Frankfurter Strasse 91–93 D-35392 Giessen, Germany

### Darrell R. Kapczynski

Southeast Poultry Research Laboratory
Agricultural Research Service
U.S. Department of Agriculture
934 College Station Road
Athens, Georgia 30605, USA





Adaptation of anseriformes to AI, 32 of charadriiformes to Al, 32 of human influenza and pathogenicity, 32-33, 458 of pigs to AI and pathogenicity, 32of poultry to AI transmission, 68–69 of turkeys to AI transmission, 69 Adjuvants, 417, 421. See also Oil adjuvants Africa. See also Egypt; South Africa HP AI H5N1 virus control strategies of, 274–75 HP AI H5N1 virus outbreaks in, 218t HP AI in poultry impacting economics in, 545t Agar gel immunodiffusion assay (AGID) AI confirmation through, 300 for antibody detection, 305 principles of, 301–2 seven-well pattern used for test by, 301f AGID. See Agar gel immunodiffusion assay AI. See Avian influenza Aldehydes, 398 Alkaline hydrolysis cost associated with, 348 disposal methods of poultry carcasses through, 347–48 mobile unit for, 348f Amino acid HA representative isolate subtypes and sequence of, 7f HP AI and PCS insertions of, 28-29 nucleotide accumulated insertions resulting in codon of, 28 PCS of HA in Australian H7 subtype and sequence of, 242t purine stretches duplication giving rise to, 29 virulence and PCS changes in, 27 Animal welfare, 314

AI adaptation with, 32 AI distribution among species of, 43, 45 AI isolation among species of, 44t reservoirs in, 46 Antigenic drift by, 455 human influenza vaccination and, 14 poultry and, 14–15 Antigenic shift human influenza from, 15 461-62 pigs impacted by, 15–16 poultry impacted by, 15 Antiviral drugs, 24–25, 461 Aptosis, 91 Aquatic birds and, 72f LP AI reservoirs in, 63-64 Asia. See also Hong Kong; North Korea; Vietnam H5N1 virus from, 248 254t 112 266-67 ducks and necrosis from HP AI H5N1 virus from, 108f AI H5N1 virus from, 106t 112 from, 253–55, 257–58 H5N1 virus from, 259–62 HP AI control strategies for targeted countries in, 566t



- Anseriformes, 7. See also Aquatic birds
- human influenza epidemics caused
- human influenza pandemics from,
- LP AI and HP AI between poultry
- Australia and risks posed by HP AI clades of HP AI H5N1 virus from,
- dogs and HP AI H5N1 virus from,
- ducks and HP AI H5N1 virus from, 102, 104-5, 104f, 107f, 109-10f,
- ducks pathobiology groups with HP felids and HP AI H5N1 virus from,
- fowl plague spread across, 173-74 genetic studies on HP AI H5N1 virus Hong Kong and disease from HP AI

- HP AI H5N1 virus civets from, 112-13
- HP AI H5N1 virus control strategies of, 271–74
- HP AI H5N1 virus from, 251-53 HP AI H5N1 virus outbreaks in,
- 218t
- HP AI H5N1 virus westward movement from, 262–65, 563–65
- HP AI in poultry impacting food and economic livelihood in, 546-47
- humans and HP AI H5N1 virus from, 110-11
- mammal and avian summary data for HP AI H5N1 virus from, 101t
- mammals and lesions from HP AI H5N1 virus from, 111t
- mammals with HP AI H5N1 virus from, 109–10
- MDTs for HP AI H5N1 virus from, 100 - 101
- MDTs in chickens with HP AI H5N1 virus from, 103t
- MDTs in ducks with HP AI H5N1 virus from, 106t
- mink and HP AI H5N1 virus from, 112
- pathobiology of HP AI from, 100-102
- pigs and HP AI H5N1 virus from, 111
- poultry diseases and writers from, 151
- seals and HP AI H5N1 virus from, 111-12
- sparrows and HP AI H5N1 virus from, 105f
- wild birds and HP AI H5N1 virus from, 105, 107–9
- Audit. See Biosecurity audit
- Australia. See also New South Wales; Queensland; Victoria
- amino acid sequence around PCS of HA of H7 subtype in, 242t
- control strategies for HP AI in, 247-
- HA similarities in H7 subtype in, 246t

Australia (continued) HP AI H5N1 virus from Asia impacting, 248 HP AI H7 subtype origins in, 246–47 HP AI in, 239 HP AI in wild birds in, 239–40 HP AI outbreaks and lessons learned in, 245 HP AI variations in clinical disease in, 245–46 Austria, 167–68 Avian influenza (AI). See related topics Baudet, E.A.R.F., 150 Belgium, 231 Biosecurity. See also Biosecurity audit; Biosecurity risk assessment advice for, 77 alternatives to, 353 birds linking population considered for, 359–60 communication importance for regional, 364 control strategies challenge with HP AI and implementation of, 573 cost concerns of poultry farms and, 355, 361–62 definition of, 391 economics of poultry and, 554–55 educational programs and training in, 495 elements of, 354 goals of, 353 history of, 76, 370 HP AI and regional quarantines for, 364-65 HP AI fought with, 290 humans and personal safety issues for, 580 LP AI fought with, 290 LP AI outbreak in poultry and control strategies of, 364 LPMs and domestic ducks creating risks in, 361 outbreak's importance to, 359 plan development for, 354-56 populations associated with disease risk and plan for, 358–59 poultry and concerns with forming regional, 363–64 poultry and sources of information on, 496t poultry and voluntary movement control programs of, 362–64 poultry transmission of Al and plan for, 357–58 poultry travel between LPMs and risks with, 359–60 risk factors determined for, 355, 374– 75, 375t

survival time of AI in environment and plan for, 356–57 tasks and circumstances for, 373 template for small producer and plan for, 356t unusual population plans for, 361 USA control strategies for poultry with, 515–17 vaccination and high level of, 431 vaccination as alternative to, 353 Vietnam and costs of vaccination and, 539–40 wild bird movement patterns and, 362 wild birds transmission of AI and plan for, 358 Biosecurity audit definition of, 369 explanation of, 379 general considerations of, 371 justification for, 370 Biosecurity risk assessment. See also Biosecurity risk assessment form AI outbreak observations used for, 374t application of results from, 377–79 basis for, 372t compartmentalization supported from results of, 378–79 complexes and scores from, 380f, 382f complexes managed with help of, 379-81 contract growers rewarded with low scores in, 379 definition of, 369 educational programs and training in, 495 experimental data and retrospective data aiding, 373 farm manager presence needed for, 377 history of, 370 individual questions contributing to, 381f justification of, 370 methods for, 372 poultry spreading AI and, 373 practical use of, 378t standardization of, 371 Biosecurity risk assessment form AREA section in, 376 farm identification in, 375–76 FARM section in, 376–77 HOUSE section in, 377 Blum, F., 156 Boehmer, F., 156 Brieg, A., 150 Brunswick poultry exhibition chicken breeders fate at, 169t fowl plague at, 168–70

### Index

Germany and spreading of fowl plague from, 169 Greve and recording of fowl plague at, 168–69 Burnet, F.M., 163 Calcium hydroxide, 399 Calcium oxide, 399 California, 518f Canada chickens and lesions from outbreak of HP AI H7N3 virus in, 207 HP AI H5N9 virus in, 198–99 HP AI H7N3 virus and disposal method of composting in, 343f HP AI H7N3 virus control strategies of, 208–9 HP AI H7N3 virus outbreak in, 207– human infections of HP AI H7N3 virus in, 209 Carbon dioxide  $(CO_2)$ euthanasia of poultry with, 311–12 euthanasia of wild birds in a chamber with compressed, 326 euthanasia of wild birds through culling bag with frozen, 326-28 mass depopulation and euthanasia from caged-house methods and, 322-23 mass depopulation and Water-based foam compared to gassing with, 320-21 mass depopulation of floor-reared poultry by free standing panel enclosure and, 316–17 mass depopulation of floor-reared poultry by live haul cage enclosures and, 319–20 mass depopulation of floor-reared poultry by plastic tenting and, 317mass depopulation of floor-reared poultry by whole house gassing of. 319 mass depopulation through, 313 Cats. See Felids C&D. See Cleaning and disinfection Cell-mediated immunity (CMI) human influenza recovery and, 458-59 overview of, 408–9 Centanni, E., 149 Cervical dislocation, 325–26 Charadriiformes, 7. See also Aquatic birds; Shorebirds AI adaptation with, 32 AI distribution among species of, 43, 45

AI isolation among species of, 44t

Index

AI subtype diversity in, 47 reservoirs in, 46 Chiba, 173 Chickens Brunswick poultry exhibition and fate of breeders of, 169t Canada and HP AI H7N3 virus causing lesions in, 207 Chile and HP AI H7N3 virus causing lesions in, 206 Columella on farming of, 149-50 Doyle on fowl plague spread by commercial trade of, 170 environmental persistence of AI on, European farming of, 149–50 fowl plague clinical signs in, 155t, 193f fowl plague control strategies with vaccination of, 175-76 fowl plague gross pathology for, 155–56, 156t fowl plague through commercial trade of, 170-71 global production and trade of, 499 HA cleavage responsible for variations in AI replication in, 88-89t history of, 59-60 housing during Roman era for, 60 HP AI and lesions in, 93t HP AI and vaccines protecting, 413-14t HP AI H5N1 virus and post intranasal inoculation of, 91f HP AI H5N2 virus creating lesions in, 200f HP AI outbreak causing massive mortality in, 199f HP AI replication in nasal epithelium of, 90f HP studies in, 11 immunology and vaccination of ducks and geese compared to, 415 incubation period for AI in, 69 infectious period for AI in, 69 lesions from fowl plague in, 193t LP AI and age based mortality rate of, 13 LP AI and embryonation of eggs from, 4 LP AI and lesions in, 93t LP AI and turkeys compared to, 75-MDTs from HP AI H5N1 virus with Asian lineage for, 103t MDTs from HP AI in other poultry compared to, 92-93

salmonella reduction time-PPE increased for, 392, 403, 473 temperature guidelines for, 505t preparation following AI event for, vaccination for HP NAI in, 504t 392-93 Chile QACs for, 397-98 HP AI H7N3 virus control strategies safety aspects of disinfection in, 399 in, 206–7 selection criteria for disinfectant in, HP AI H7N3 virus outbreak in, 205-399-400 soaps and detergents used in, 394, lesions in chickens from outbreak of 396 HP AI H7N3 virus in, 206 sodium carbonate for, 399 Chu, C.M., 161 sodium dichlorotriazine trione for, Citric acid, 398 397 Civets, 112–13 sodium hydroxide for, 398-99 Clades special considerations with, 402-3 of Asian HP AI H5N1 virus, 254t terminology for, 391-92 HP AI H5N1 virus and spatial worker health and safety for, 403 distribution of, 257f Cleavage HP AI H5N1 virus and WHO chickens and variations of AI classification of, 253 replication from HA and, 88–89t Cleaning and disinfection (C&D) of HA0 of HP AI H5N1 virus, 258t aldehydes for, 398 of HA and HP AI cellular approved disinfection for, 494t pathobiology, 11 calcium hydroxide for, 399 of HA and LP AI cellular calcium oxide for, 399 pathobiology, 11 chemical disinfectants recommended of HA of HP AI, 88 for, 395t of HA of LP AI, 88 citric acid for, 398 CMI. See Cell-mediated immunity control strategies for poultry facilities CO<sub>2</sub>. See Carbon dioxide with, 522 Columella, L.I.M., 149-50 cost of, 550 Compartmentalization cresols for, 397 biosecurity risk assessment used for disinfectant use guidelines in, 399 supporting, 378-79 disinfection process in, 402 global strategy with zoning and, 581 educational programs training for, Complexes 493 biosecurity risk assessment for EPA registered disinfectants and managing, 379–81 active ingredients for, 395t biosecurity risk assessment scores for, equipment for, 402-3 380f, 382f ethanol used for, 396 Composting feed system and, 403 costs associated with, 345 hypochlorites for, 397 disposal methods of poultry carcasses inorganic acids for, 398 through, 342-45 iodine used for, 396 HP AI H7N3 virus in Canada and peroxygen compounds used for, 396 disposal method of, 343f phenols used for, 397 test results for, 344t planning, 393 Virginia and, 343-45 post disinfection actions with, 402 Contract growers, 379 poultry facilities and dry cleaning in, Controlled marketing, 529 400-401 Control strategies. See also Biosecurity; poultry facilities and response Death; Mass depopulation procedures with, 391-92 of Africa for HP AI H5N1 virus, poultry facilities and routine, 393 274-75 poultry facilities and water system of Asia for HP AI H5N1 virus, 271cleaning in, 400 74 poultry facilities and wet cleaning in, of Australia for HP AI, 247-48 401–2 of Canada for HP AI H7N3 virus, poultry facilities with LP AI and, 208 - 9529-30 C&D in poultry facilities for, 522 poultry producers and chemical of Chile for HP AI H7N3 virus, methods for, 394 206 - 7

Control strategies (continued)	HP AI ai
costs and economics impacted by,	580
538-39	HP AI in
costs associated with movement and,	and, 5
549–50	HP AI in
decreasing host susceptibility in,	and be
291	immunity
diagnostics and surveillance in, 290–	internatio
91	for LP A
diagnostics and surveillance methods	LP AI ar
for HP AI and, 569	LP AI ar
disease information systems for,	for, 51
580	LP AI ar
educational programs for, 289-90,	for, 52
485, 522–523	LP AI ar
epidemiology-based measures for,	humar
579	LP AI ar
of Europe for HP AI H5N1 virus,	infecte
274–75	LP AI ar
FAO role in, 294	manur
for fowl plague and poultry trade,	LP AI ar
174	vehicle
for fowl plague and vaccination of	LP AI ar
chickens, 175–76	LP AI m
for fowl plague and vaccination of	for, 51
geese, 175	LP AI ou
genetic resistance and, 291-92	biosec
goals of, 289	LP AI re
history of successful, 571	LP AI sp
for HP AI, 288–89	popula
HP AI and challenge of countries	527-2
with current disease endemic for,	of Mexic
574	205
HP AI and challenge of ducks as	of Middl
reservoirs for, 574	virus,
HP AI and challenge of economic	national
assessments for, 574–75	of The N
HP AI and challenge of economic	virus,
inadequacies for, 575	OIE role
HP AI and challenge of inadequate	poultry a
disease information systems for,	identif
573	poultry i
HP AI and challenge of inadequate	poultry i
epidemiological expertise for, 573	515-1
HP AI and challenge of inadequate	poultry p
veterinary services for, 572-73	521
HP AI and challenge of public sector	poultry v
for, 575	and, 5
HP AI and challenge of sustainable	poultry v
long-term regional coordination	for, 29
for, 575	poultry v
HP AI and challenge of wild birds as	and, 5
reservoirs for, 574	regional
HP AI and challenge with biosecurity	of Texas
implementation for, 573	210-1
HP AI and cost of, 293	of USA
HP AI and international commitment	of USA
to, 571–72	vaccinati
HP AI and national and regional	552-5
commitment to, 571	vaccines

### Index

- HP AI and targeting of source for, Asian targeted countries 566t n poultry and Vietnam costs enefits of, 540t y for, 292 onal implementation for, 579 1, 287–88 nd cost of, 292–93 nd identification of sources 7 - 18nd specific measures for eggs 26 nd specific measures for ns for, 526–27 and specific measures for ed birds for, 525–26 ind specific measures for e for, 526 and specific measures for les and equipment for, 527 nd vaccination for, 530 novement in poultry identified utbreak in poultry and curity for, 364 esponse measures for, 525 preading to different ations and prevention with, co for HP AI H5N2 virus, le East for HP AI H5N1 275 implementation for, 575, 578 Netherlands for HP AI H7N7 230-31 in, 294 and exposure risk level fication for, 521–22 in USA and, 513 in USA and biosecurity for, population cross-over and, with confined populations 519-20 with infection and elimination with nonconfined populations 20-21 implementation for, 578 for HP AI H5N2 virus, for fowl plague, 195 for HP AI H5N2 virus, 201–2 tion programs and, 429–31, 3, 569–70
  - and proper use in, 570–71

Cost

- of alkaline hydrolysis, 348
- of biosecurity and concerns of poultry farms, 355, 361–62
- of C&D, 550
- of composting, 345
- of control strategies for movement, 549–50
- of disposal methods, 550
- economics of control strategies and, 538–39
- economics of poultry rehabilitation and, 538–39
- HP AI control strategies and, 293
- of incineration, 342
- of landfill, 340
- LP AI control strategies and, 292–93 of on-site burial, 338
- of poultry and loss of production, 550–51
- poultry vaccines comparisons with, 427
- reporting and confirmation with effective animal health information system and, 549
- reporting and confirmation with
- laboratory staff and equipment and, 549
- of in situ plasma vitrification, 349 vaccines and, 530
- Vietnam biosecurity and vaccination and, 539–40
- Vietnam control strategies for HP AI in poultry and benefits and, 540t
- Cresols. See Cresylic acid
- Cresylic acid (Cresols), 397
- Culling bag, 326–28
- Death, 311
- Diagnostics and surveillance methods. See also Agar gel immunodiffusion
  - assay; Elisa antibody testing
- advanced analysis in, 304
- AI assay characteristics in, 300t
- antibody detection in, 304-5
- antigen detection immunoassays in, 301
- control strategies and, 290-91
- direct detection of AI in clinical samples for, 456
- educational programs covering, 488– 89
- HI assay used in, 302-3
- HP AI control strategies and, 569
- LP AI illegal sources and, 523–24
- MN used for, 457
- molecular/nucleic acid-based tests in. 302, 456-57
- NI assay used in, 303
- rapid point of care tests for, 456

RT-PCR assay for, 456-57 sample collection, processing, and handling for, 305 sequence analysis in, 304 VI and, 299-301, 456 in vivo Pathotyping in, 304 Disposal methods cost of, 550 educational programs considerations with poultry carcass and, 491, 493 history of poultry carcasses and, 333-35 HP AI H7N3 virus in Canada and composting for, 343f LP AI H7N1 virus infected poultry carcasses and, 334t poultry carcasses and alkaline hydrolysis for, 347-48 poultry carcasses and comparative analysis of, 350-51 poultry carcasses and composting for, 342-45 poultry carcasses and incineration for, 341-42 poultry carcasses and in situ plasma vitrification for, 348-49 poultry carcasses and introduction to options for, 335–36 poultry carcasses and landfill for, 338-41 poultry carcasses and on-site burial for, 336–38 poultry carcasses and rendering for, 345-47 poultry carcasses and sources of information on, 494t Dixon, Edmund Saul, 59 Dogs, 112 Domestic birds, 9. See also Poultry Doyle, T.M. fowl plague spread through commercial chicken trade and, 170 ND differentiation from fowl plague and studies of, 159, 161, 164, 170 Ducks AI infection spatial and temporal variation in, 47 biosecurity risks of LPMs and domestic, 361 control strategies and challenges of HP AI reservoirs in, 574 history of, 61 HP AI H5N1 virus of Asian lineage and, 102, 104-5, 104f, 107f, 109-10f, 266–67 HP AI H5N1 virus of Asian lineage and MDTs for, 106t HP AI H5N1 virus of Asian lineage and pathobiology groups for, 106t

HP AI in domestic, 99

HP studies in, 11 Educational programs immunology and vaccination of AI information and sources for, 487t chickens compared to geese and, basic requirements and key 415 components for, 485 LP AI and age based mortality rate biosecurity risk assessment training of, 13 in, 495 LP AI in domestic, 99 biosecurity training in, 495 maintenance cycle for AI in, 48f C&D training through, 493 Minnesota turkeys with AI and HA control strategies and necessity of, subtypes in AI of, 517t 289-90, 485, 522-23 necrosis from HP AI H5N1 virus of diagnostics and surveillance methods Asian lineage and, 108f covered in, 488–89 wild birds commingling with disposal methods for poultry domestic, 74 carcasses and considerations of, 491, 493 Eckroade, Robert, 199f emergency preparedness and response Economics training in, 489, 490t control strategies for HP AI and evaluating target audience need for, challenge of assessments for, 574-485-86 HP AI H5N1 virus infecting humans control strategies for HP AI and and focus of, 486, 488 challenge of inadequacies for, 575 LP AI and HP AI information for, cost of poultry rehabilitation 486 impacting, 538–39 mass depopulation and euthanasia costs associated with control considerations in, 489, 491 strategies impacting, 538-39 vaccination strategies included in, disease phases and issues with society 493, 495 and, 538t Egypt, 543f for global strategy, 582 Electrocution HP AI creating international market mass depopulation and euthanasia shocks and impacting, 544 from caged-house methods and, HP AI creating USA market shocks 323 and impacting, 544-46 mass depopulation of poultry with, HP AI H5N1 virus impacting, 565 313-14 HP AI impacting African poultry and, Elisa antibody testing, 305 545t Emus, 104f HP AI in poultry impacting Asian England food and livelihood in, 546-47 HP AI H5N1 virus outbreak in, 221 HP AI in poultry impacting Middle HP AI H7N3 virus outbreak in, 219 Eastern food and livelihood in, 546 HP AI H7N7 virus outbreak in, human influenza effecting, 541 219-21 humans contracting disease from Environmental persistence birds minimized and benefits for, on chicken of AI, 70 537 on poultry of AI, 70 market shock impacting, 538 on wild birds of AI, 48 poultry and HP AI long term **Environmental Protection Agency** prevention impacting, 555-57 (EPA), 392, 3951 poultry biosecurity impacting, 554-55 EPA. See Environmental Protection poultry losses impacting Agency compensation in, 551-52 Ercolani, G.B., 165 poultry productivity improved Ethanol, 396 through avoiding disease and Europe. See also Austria; Belgium; benefits in, 537–40 Germany; Great Britain; Italy; The poultry restocking impacting, 553-54 Netherlands; Turkey reporting and confirmation chicken farms in, 149-50 enforcements and benefits in, 548fowl cholera legislation for, 176 49 fowl plague and third epizootic in, USA and fowl plague impacting, 196 170 vaccination and considerations with, fowl plague epidemics in, 164t 552-53 fowl plague legislation for, 176

Europe (*continued*) fowl plague scientific progress in, 148-49 fowl plague spreading through, 171– 72 Gerlach on fowl plague in, 171 HP AI H5N1 virus control strategies of, 274–75 HP AI H5N1 virus outbreaks in, 218t rendering used in, 347 Euthanasia educational programs considering methods of mass depopulation and, 489, 491 mass depopulation and caged-house methods with  $CO_2$  for, 322–23 mass depopulation and caged-house methods with electrocution for, 323 mass depopulation compared to, 309poultry and accepted methods of, 311-12 poultry and CO<sub>2</sub> used for, 311–12 wild birds and cervical dislocation for, 325–26 wild birds and compressed CO<sub>2</sub> in a chamber for, 326 wild birds and culling bag with frozen CO<sub>2</sub> for, 326–28 wild birds and injectable anesthetics for, 324 wild birds and methods for, 324 Exposure. See also Exposure risk index poultry and AI sources of, 67f poultry and control strategies of risk level identification of, 521–22 of poultry to AI, 67–68 turkeys infected with influenza viruses from pigs and, 10 Exposure risk index (ERI), 521 FAO. See Food and Agriculture Organization Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), 392 Felids, 112 Ferry, J.D., 163 FIFRA. See Federal Insecticide, Fungicide, and Rodenticide Act Finch HP AI H5N1 virus five days post intranasal inoculation in zebra, 102f necrosis from HP AI H5N1 virus in house, 103f necrosis from HP AI H5N1 virus in zebra, 100f Food and Agriculture Organization (FAO)

Index Greve and Brunswick poultry control strategies and role of, 294 global strategy and regional exhibition recording of, 168–69 organizations and partners of OIE histopathology of, 156–57 and, 576–77t history of, 145–46 HP AI H5N1 virus and response of history reexamined for, 150 OIE and, 562 HP AI H5N9 virus differentiation poultry sectors defined by, 71, 567t from, 198 Fowl cholera HP AI mistaken for, 166 European legislation for, 176 ILT differentiation from, 161 fowl plague differentiation from, 158t intoxications compared to, 158–59 history of, 157–58 Italy and first epizootic of, 164-66 Fowl plague. See also Chiba Italy and second epizootic of, 166–67 Kleine and Möllers findings on, 154, anamnesis and, 152 Asia and spreading of, 173–74 157 Austria and, 167–68 Künnemann findings on, 154 bacterial examinations of, 157 Lode and Gruber on, 150, 167-68 Baudet on, 150 Maggiora and Valenti findings on, biological properties of, 163–64 154, 167 Nakamura and Iwasa findings on, 154 Brieg on, 150 Brunswick poultry exhibition and, natural and experimental hosts of, 168-70 152, 153t, 154 Burnet and Ferry studies on virus ND differentiation from, 159–61, 160t replication of, 163 New York City LPM and, 192 chicken commercial trade spreading, Perroncito observations on, 145, 149-170-71 51, 154, 161–63, 165–66 chickens and clinical signs of, 155t, Pfenninger and Metzger studies on, 193f 155-56 chickens and lesions from, 193t poultry and, 124–25 chickens gross pathology with, 155– poultry and quarantine phases for, 56, 156t 174-75 chicken vaccination attempt control poultry cleansing and disinfection for, strategies for, 175–76 175 Chu and ND differentiation from, 161 poultry trade and control strategies clinical signs of, 154–55 for, 174 Reinacher and Weiss studies on, 163 contagiousness of, 161 diagnosis criteria in 1920s for, 197t research achievements on, 148t Doyle and commercial chicken trade septicemic spirochetosis spreading, 170 differentiation from, 159, 159t Doyle and ND differentiation from, Straub reports on, 165 159, 161, 164 survival time inside and outside host Ercolani and Piana studies in, 165 of, 163 Europe and spreading of, 171–72 terminology for, 146–47, 146t Europe and third epizootic of, 170 USA and, 191–92, 197–98 European epidemics of, 164t USA and C&D for, 196 European legislation for, 176 USA and control strategies for, 195 European scientific progress for USA and diagnosis of, 194–95 diseases including, 148–49 USA and economic implications of, experimental transmission of, 161–62 196 experimental transmission USA and experimental studies of, reevaluation and for, 162 193–94 fowl cholera differentiation from, USA and lesions and clinical signs 158t of, 192–93 geese gross pathology with, 156 USA and source theories on, 196–97 geese vaccination attempt control USA quarantines for, 195–96 strategies for, 175 virus N discovered through studies Gerlach on Europe and spreading of, of, 172–73 171 virus replication of, 162–63 Germany impacted from Brunswick visibility for, 163 poultry exhibition and, 169 von Ostertag findings on, 154

Freese, R., 157

Gratzl and Köhler on, 150

Geese fowl plague control strategies of vaccination of, 175 fowl plague gross pathology for, 156 history of, 61 HP AI H5N1 virus in, 102-3f HP AI in domestic, 99 immunology and vaccination of chickens compared to ducks and, 415 LP AI in domestic, 99 Gerlach, F., 171 Germany fowl plague at Brunswick poultry exhibition spreading throughout, HP AI H7N7 virus outbreak in, 223 HP AI H7N7 virus spread to, 231 Giemsa, Gustav, 148 GISN. See Global Influenza Surveillance Network Global Influenza Preparedness Plan, 462 Global Influenza Surveillance Network (GISN), 459 Global strategy. See also Control strategies capacity building for, 581 compartmentalization and zoning for, 581 disease control programs and poverty alleviation for, 580 economics for, 582 FAO and OIE regional partners and organizations for, 576–77 for HP AI, 561-63 HP AI and approach of, 566, 568–69 HP AI and guiding principals of implementing, 565-66 HP AI H5N1 virus and reasons for, 564 impacts of, 582 outlook of positivity for, 582 poultry sector restructuring and rehabilitation for, 580-81 research applied to, 582 stakeholder collaboration for, 581 Glycosylation, 30 Gratzl, E., 150 Great Britain. See also England; Scotland HP AI outbreaks and positions in, 221f HP AI outbreaks in, 221-22 Greece, 151 Greve, L, 168–69 H5N1 virus

Africa and Asia and Europe outbreaks of HP AI and, 218t

African control strategies for HP AI humans infected with HP AI and, 453 and, 274–75 humans with HP AI and Asian Asian control strategies for HP AI lineage of, 110–11 and, 271–74 Asian HP AI and westward mammal and avian summary data for movement of, 262-65, 563-65 Australia and risks posed by Asian mammals and experimental infections HP AI and, 248 with HP AI and, 113–14 chicken post intranasal inoculation mammals with HP AI and Asian with HP AI and, 91f lineage of, 109–10 civets with HP AI and Asian lineage mammals with lesions from HP AI of, 112–13 and Asian lineage of, 111t clades of Asian HP AI and, 254t MDTs for chickens with HP AI and clade spatial distribution for HP AI Asian lineage of, 103t and, 257f MDTs for ducks with HP AI and diagnostic tests for HP AI and, 270 Asian lineage of, 106t dogs with HP AI and Asian lineage MDTs for HP AI and Asian lineage of, 112 of, 100–101 ducks with HP AI and Asian lineage Middle Eastern control strategies for of, 102, 104–5, 104f, 107f, 109– HP AI and, 275 10f, 266–67 mink with HP AI and Asian lineage economics impacted by outbreak of of, 112 HP AI and, 565 mutation possibilities of, 33 educational programs focus on necrosis in ducks with HP AI and humans infected with HP AI and, Asian lineage of, 108f 486, 488 necrosis in emus with HP AI and, England and outbreak of HP AI and, 04f necrosis in house finch with HP AI European control strategies for HP AI and, 103f and, 274–75 necrosis in zebra finch with HP AI FAO and OIE responding to HP AI and, 100f and, 562 pathobiology groups for ducks with felids with HP AI and Asian lineage of, 112 pathobiology of Asian lineage of HP future outlook of HP AI and, 275-77 AI and, 100-102 geese with HP AI and, 102-3f pathology of HP AI and, 269–70 genetic studies on Asian HP AI and, pigs with HP AI and Asian lineage 253-55, 257-58 of, 111 global strategy reasoning for HP AI poultry spreading HP AI and, 265and, 564 66, 268, 500 HA0 cleavage site for HP AI and, prepandemic vaccines for HP AI and, 258t 460-61 HA antigenetic change in HP AI and, protein deletions in, 259 258-59 Scotland and outbreak of HP AI and, HA genetic drift in HP AI and, 256f 217, 219 HA PCS variations in, 33, 34-35t, 35 seals with HP AI and Asian lineage Hong Kong and disease from Asian of, 111–12 HP AI and, 259-62 seasonal effects on spreading of HP HP AI and global impact of, 33 AI and, 269 HP and host susceptibility with, 46 sparrows with HP A1 and Asian human infections from poultry with lineage of, 105f HP AI and, 466-70, 472-73 virulence increasing for, 35 humans and distribution of HP AI WHO clade classifications for HP AI and, 465f and, 253 humans and epidemic curve of HP A1 wild bird and poultry transmission of and, 468f HP AI and, 64 humans and female infections of HP wild bird maintenance and AI and, 471f transmission of HP AI and, 50–51 humans and male infections of HP AI and, 471f

### Index

LBM spreading HP AI and, 266

- Asian lineage of HP AI and, 101t

HP AI and Asian lineage of, 106t

wild bird preventative measures for humans against HP AI and, 51

H5N1 virus (continued) wild bird species with, 50t wild bird spreading HP AI and, 267– 68 wild birds with experimental infections of HP AI and, 49–50 wild birds with HP AI and Asian lineage of, 105, 107–9 wild birds with natural infections of HP Al and, 49 zebra finch five days post intranasal inoculation with HP AI and, 102f H5N2 virus chickens and lesions from HP AI and, 200f Italy and outbreak of HP AI and, 224 - 25LP AI H5N2 virus outbreak similarities to outbreak of HP AI and, 203f Mexico and control strategies for HP AI and, 205 Mexico and LP AI H5N2 virus changing to HP AI and, 204–5 Mexico and outbreak of LP AI and, 204poultry and experimental studies of HP AI and, 204t South Africa and outbreak of HP AI and, 222–23 Texas and control strategies for HP AI and, 210–11 Texas and outbreak of HP AI and, 209 - 10USA and control strategies for HP AI and, 201–2 USA and LP AI and, 202, 204 USA and LP AI beginning for, 199-200 USA and LP AI changing to HP AI in outbreak of, 200–201 USA history of HP AI and, 199 H5N3 virus, 222 H5N8 virus, 223–24 H5N9 virus Canada and HP AI and, 198–99 fowl plague differentiation from HP AI and, 198 H5 subtype. See also H5N1 virus; H5N2 virus; H5N3 virus; H5N8 virus; H5N9 virus pathogenicity of, 10 H7N1 virus disposal methods of poultry carcasses infected with LP AI and, 334t Italy and clinical findings of HP AI and, 226, 228 Italy and emergence of HP AI and, 225

Italy and eradication of HP AI and, 228Italy and spreading of HP AI and, 225–26, 227t Italy and wild birds infected with HP AI and, 228 poultry distribution in Italy with HP AI and, 226f H7N2 virus, 462–63 H7N3 virus Canada and control strategies for HP AI and, 208–9 Canada and human infections with HP AI and, 209 Canada and outbreak of HP AI and, 207 - 9chickens and lesions from Canadian outbreak of HP AI and, 207 chickens and lesions from Chilean outbreak of HP AI and, 206 Chile and control strategies for HP AI and, 206–7 Chile and outbreak of HP AI and, 205-6disposal method of composting in Canada for HP A1 and, 343f England and outbreak of HP AI and, 219 human illness caused by HP AI and, 464-66 Pakistan and outbreak of HP AI and, 224 poultry in Queensland infected by outbreak of HP AI and, 244 poultry in Victoria infected by outbreak of HP AI and, 243-44 H7N4 virus, 244–45 H7N7 virus Belgium and spreading of HP AI and, 231 England and outbreak of HP AI and, 219-21 Germany and outbreak of HP AI and, 223 Germany and spreading of HP AI and, 231 human illness caused by HP AI and, 464-66 The Netherlands and control strategies for HP AI and, 230–31 The Netherlands and humans infected with HP AI and, 231–32 The Netherlands and outbreak of HP AI and, 229–30 The Netherlands and pigs infected with HP AI and, 232–33, 500 North Korea outbreak of HP AI and, 233 poultry in Victoria infected by outbreak of HP AI and, 241-43

### Index

HA of Australian, 242t Australia and origins of HP AI and, 246-47 HA similarities in Australian, 246t pathogenicity of, 10 RNA recombination leading to outbreaks in, 29 H9N2 virus, 462–63 HA0, 258t Hemagglutinin (HA). See also HA0 AI classified by subtypes of, 62 amino acid sequence of representative isolates for subtypes of, 7f Australian H7 subtype and amino acid sequence around PCS of, 242t birds and subtype distribution of, 63t chickens and variations of AI replication from cleavage of, 88– 89t cleavage of HP AI in, 88 cleavage of LP AI in, 88 elements essential to AI of, 26f glycosylation influencing pathogenicity of, 30 H5N1 virus variations at PCS of, 33, 34–35t, 35 H7 subtype in Australia and similarities in, 246t HP AI cellular pathobiology and cleavage of, 11 HP AI H5N1 virus and antigenetic change of, 258–59 HP AI H5N1 virus and genetic drift of, 256f HP and changes in, 12 human influenza and SA binding to, 457-58 LP AI and PCS of, 26–27 LP AI cellular pathobiology and cleavage of, 11 Minnesota turkeys AI detection and ducks Al subtypes of, 517t mutations at PCS of, 27-28, 28t pathogenicity of AI and role of, 25 PCS and lab manipulation of, 30 PCS changes and problems in, 35–36 vaccines and in vitro expressed, 422 vaccines and in vivo expressed, 422vaccine strain selection and, 425-26 viral assembly process and, 5–6 viral infection and role of, 4–5 Hemagglutinin inhibition assay (HI assay), 302–3

H7 subtype. See also H7N1 virus;

virus; H7N7 virus

H7N2 virus; H7N3 virus; H7N4

amino acid sequence around PCS of

HI assay. See Hemagglutinin inhibition assay

Index

High pathogenicity (HP)

ann) an fi

- Africa and Asia and Europe outbreaks of H5N1 virus AI with, 218t
- African control strategies for H5N1 virus AI with, 274–75
- African economics impacted by poultry infected by AI with, 545t
- in AI and embryonation of chicken eggs, 4
- AI documented epidemics with, 129-34t
- amino acid insertions at PCS for AI with, 28–29

aptosis produced by AI with, 91 aquatic birds and poultry and

infections LP AI and AI with, 72f Asian control strategies for H5N1

virus AI with, 271–74

Asian food and economic livelihood impacted by poultry infected by AI with, 546–47

Asian H5N1 virus AI and westward movement and, 262-65, 563-65

Asian H5N1 virus AI with, 251–53

Australia and AI with, 239

Australia and control strategies for AI with, 247–48

- Australia and lessons learned from outbreaks of A1 with, 245
- Australia and origins of H7 subtype AI with, 246-47
- Australia and risks posed by Asian H5N1 virus AI with, 248
- Australia and variations in clinical disease of AI with, 245-46
- Belgium and spreading of H7N7 virus AI with, 231

biosecurity and regional quarantines for AI with, 364-65

- biosecurity fighting AI with, 290 Canada and control strategies for
- H7N3 virus Al with, 208-9
- Canada and H5N9 virus AI with, 198-99
- Canada and human infections with H7N3 virus AI with, 209

Canada and outbreak of H7N3 virus AI with, 207–9

- challenges of AI which is, 16
- chicken and post intranasal inoculation with H5N1 virus AI

with, 91f

- chicken mortality in outbreak of AI with, 199f
- chickens and lesions from AI with, 93t

chickens and lesions from Canadian outbreak of H7N3 virus AI with, 207

- chickens and lesions from Chilean 206
- chickens and lesions from H5N2 virus AI with, 200f chickens and studies of, 11
- virus AI with, 206–7
- with, 205–6
- lineage AI with, 112-13
- 254t
- clade spatial distribution for H5N1 virus AI with, 257f
- cleavage of HA of AI with, 88 cleavage of HAO of H5N1 virus AI with, 258t
- control strategies and challenge of biosecurity implementation for AI with, 573
- control strategies and challenge of countries with current endemic of AI with, 574
- control strategies and challenge of ducks as reservoirs for AI with, 574
- control strategies and challenge of economic assessments for AI with, 574-75
- control strategies and challenge of economic inadequacies for AI with, 575
- control strategies and challenge of inadequate disease information
- systems for AI with, 573
- inadequate cpidemiological
- expertise for AI with, 573
- inadequate veterinary services for AI with, 572–73
- control strategies and challenge of public sector for AI with, 575
- control strategies and challenge of sustainable long-term regional
- control strategies and challenge of wild birds as reservoirs for AI with, 574
- control strategies cost for AI with, 293
- control strategies for AI with, 288-89
- control strategies for targeted Asian countries with AI with, 5661
- control strategies for targeting source of AI with, 580

outbreak of H7N3 virus AI with,

Chile and control strategies for H7N3 Chile and outbreak of H7N3 virus AI

civets with H5N1 virus of Asian clades of Asian H5N1 virus AI with,

control strategies and challenge of control strategies and challenge of

coordination for AI with, 575

control strategies of diagnostics and surveillance methods for AI with, 569

control strategies with international commitment for AI with, 571-72

control strategies with national and regional commitment for AI with, 571

diagnostic tests for H5N1 virus AI with, 270

disposal method of composting in Canada for H7N3 virus AI with, 343f

dogs with H5N1 virus of Asian lineage AI with, 112

ducks and AI with, 99

ducks and studies in, 11

ducks with H5N1 virus of Asian lineage AI with, 102, 104-5, 104f, 107f, 109-10f, 266-67

economics impacted by outbreak of H5N1 virus Al with, 565

economics of international market shocks from AI with, 544

economics of poultry and long term prevention of AI with, 555-57

economics of USA market shocks from AI with, 544–46

educational programs focus on humans infected by H5N1 virus A1 with, 486, 488

educational programs providing information on LP AI and AI with,

England and H7N3 virus AL with, 219

England and H7N7 virus AI with, 219-21

England and outbreak of H5N1 virus AI with, 221

European control strategies for H5N1 virus AI with, 274–75

FAO and OIE response to H5N1 virus with, 562

felids with H5N1 virus of Asian lineage AI with, 112

food safety risks with LP NAI and NAI with, 506-7

fowl plague and AI with, 166

fowl plague differentiation from H5N9 virus AI with, 198

future outlook of H5N1 virus AI with, 275–77

geese and AI with, 99

geese and H5N1 virus AI with, 102-

genetic studies on Asian H5N1 virus AI with, 253–55, 257–58

Germany and outbreak of H7N7 virus AI with, 223

High pathogenicity (HP) (continued) Germany and spreading of H7N7 virus AI with, 231 global nature of AI with, 123, 135-36 global strategy approach for AI with, 566, 568-69 global strategy for AI with, 561-63 global strategy implementation 266 guiding principals for AI with, 565-66 global strategy reasoning for AI with, 564 Great Britain and outbreaks of AI with, 221–22 Great Britain and positions of outbreaks of AI with, 221f of H5N1 virus and global impact, 33 of H5N1 virus and host susceptibility, HA antigenetic change in H5N1 virus AI with, 258–59 HA changes associated with, 12 HA cleavage and cellular 111t pathobiology of AI which is, 11 HA genetic drift in H5N1 virus AI with, 256f history of AI with, 128, 135 Hong Kong and disease from Asian H5N1 virus AI with, 259–62 human illness caused by H7N3 virus 93 AI with, 464–66 human illness caused by H7N7 virus AI with, 464–66 human infections from poultry with 547 H5N1 virus AI with, 466–70, 472– humans and distribution of H5N1 virus AI with, 465f humans and epidemic curve of H5N1 204 - 5virus AI with, 468f humans and female infections of H5N1 virus AI with, 471f humans and male infections of H5N1 virus AI with, 471f humans and recent infections of AI with, 454–55t, 464 humans and risk of transmission of AI with, 500–501 humans infected with H5N1 virus with, 453 humans with H5N1 virus of Asian lineage AI with, 110–11 Ireland and outbreak of H5N8 AI with, 223–24 Italy and clinical findings of H7N1 virus AI with, 226, 228 Italy and emergence of H7N1 virus AI with, 225 Italy and eradication of H7N1 virus AI with, 228 90-91

### Index

- Italy and outbreak of H5N2 virus AI with, 224–25
- Italy and spreading of H7N1 virus AI with, 225–26, 227t
- Italy and wild birds infected with
- H7N1 virus AI with, 228
- LBM spreading H5N1 virus AI with,
- LP AI giving way to AI with, 73–74 LP AI H5N2 virus outbreak
- similarities to outbreak of H5N2 AI with, 203f
- LP compared to, 3
- mammal and avian summary data for Asian lineage of H5N1 virus AI with, 101t
- mammals and experimental infections with H5N1 virus AI with, 113–14 mammals with H5N1 virus of Asian lineage AI with, 109–10 mammals with lesions from H5N1
- virus of Asian lineage AI with,
- MDTs for chickens with H5N1 virus of Asian lineage AI with, 103t MDTs for ducks with H5N1 virus of Asian lineage AI with, 106t MDTs of chickens compared to other forms of poultry for AI with, 92–
- MDTs of H5N1 virus of Asian lineage AI with, 100–101 measures for stamping out AI with,
- Mexico and control strategies for H5N2 virus AI with, 205 Mexico and LP AI H5N2 virus changing to H5N2 virus AI with,
- Middle Eastern control strategies for H5N1 virus AI with, 275 Middle Eastern food and economic livelihood impacted by poultry infected by AI with, 546
- mink with H5N1 virus of Asian
- lineage AI with, 112 molecular and biological features of AI which is, 10-11
- nasal epithelium of chicken and
- replication of AI with, 90f
- necrosis in ducks with H5N1 virus of Asian lineage AI with, 108f
- necrosis in emus with H5N1 virus AI with, 104f
- necrosis in house finch with H5N1
- virus AI with, 103f
- necrosis in zebra finch with H5N1
- virus AI with, 100f
- necrosis produced by AI with,

- The Netherlands and control strategies for H7N7 virus AI with, 230 - 31
- The Netherlands and humans infected with H7N7 virus AI with, 231–32
- The Netherlands and outbreak of H7N7 virus AI with, 229–30
- The Netherlands and pigs infected with H7N7 virus AI with, 232-33, 500
- North Korea and outbreak of H7N7 virus AI with, 233
- Pakistan and H7N3 virus AI with, 224
- pathobiology groups for ducks with H5N1 virus of Asian lineage AI with, 106t
- pathobiology of Asian lineage of H5N1 virus AI with, 100–102
- pathology of H5N1 virus AI with, 269–70
- pigs with H5N1 virus of Asian lineage AI with, 111
- poultry and gross lesions from AI with, 93–94, 93–96f, 96
- poultry and microscopic lesions from AI with, 96–98f, 97t, 98
- poultry and replication of AI with, 88
- poultry and syndromes inflicted by AI with, 87–88
- poultry clinical signs of AI with, 92–
- poultry distribution in Italy with H7N1 virus AI with, 226f
- poultry eggs pasteurization time with infections of NAI with, 506t
- poultry experimental studies with H5N2 virus AI with, 204t
- poultry in New South Wales infected by outbreak of H7N4 virus AI with, 244–45
- poultry in Queensland infected by outbreak of H7N3 virus AI with, 244
- poultry in Victoria infected by outbreak of H7N3 virus AI with, 243-44
- poultry in Victoria infected by outbreak of H7N7 virus AI with, 241-43
- poultry spreading H5N1 virus AI with, 265–66, 268, 500
- poultry tissue and cellular sites of viral replication and damage of AI with, 98–99
- poultry trade restrictions from NAI with, 499–500
- poultry trade risks of LP NAI and NAI with, 501–2
- predicting AI which is, 12-13

prepandemic vaccines for H5N1 virus AI with, 460–61 public health implications of AI with, 293–94 ratites and AI with, 99-100 recommended measures for responders to AI with, 473 regulation of AI with, 126 Scotland and outbreak of H5N1 virus AI with, 217, 219 seals with H5N1 virus of Asian lineage AI with, 111–12 seasonal effects on spreading of H5N1 virus AI with, 269 South Africa and H5N2 virus AI with, 222–23 South Africa and H5N3 virus AI with, 222 sparrows with H5N1 virus of Asian lineage AI with, 105f species variation in response to AI with, 90 Texas and control strategies for H5N2 virus AI with, 210-11 Texas and outbreak of H5N2 virus AI with, 209–10 Turkey and timeline for outbreak in AI with, 548t USA and H5N2 virus AI with, 199 USA and LP AI H5N2 virus changing to AI with, 200-201 USA control strategies for H5N2 virus AI with, 201–2 vaccination for chickens infected with NAI with, 504t vaccination for poultry infected with NAI with, 503-4 vaccines for AI with, 407, 432-33 vaccines protecting chickens from AI with, 413–14t vaccines protection assessment and AI with, 413–15 Vietnam costs and benefits for control strategies on poultry with AI with, 540t WHO clade classification for H5N1 virus AI with, 253 wild bird and poultry transmission of AI H5N1 virus with, 64 wild bird maintenance and transmission of AI H5N1 virus with, 50–51 wild bird preventative measures for humans against AI H5N1 virus with, 51 wild birds and AI with, 99, 125-26 wild birds in Australia and AI with, 239-40

wild birds spreading AI H5N1 virus with, 267–68

49-50 with, 102f Hirst, G.K., 161 Histopathology, 156-57 History of biosecurity, 76, 370 outbreaks in, 359 poultry vaccines, 426 of chickens, 59-60 outbreak, 205–6 outcomes, 571 carcasses, 333-35 of ducks, 61 148-49 of fowl cholera, 157-58 of fowl plague, 145–46 of fowl plague and bacterial examinations, 157 Italy, 164–66 150 in Italy, 166-67 of fowl plague and third epizootic in Europe, 170 of fowl plague differentiation from ND, 159–61 exhibition, 168-70 City, 192 implications, 196 of fowl plague in USA and source theories, 196–97

148t of fowl plague spreading through Europe, 171–72

- wild birds with experimental infections of AI H5N1 virus with,
- wild birds with H5N1 virus of Asian lineage AI with, 105, 107-9 wild birds with natural infections of AI H5N1 virus with, 49 zebra finch five days post intranasal inoculation with H5N1 virus AI
- biosecurity and importance of of biosecurity risk assessment, 370 of broad homosubtypic protection of of Chile and HP AI H7N3 virus of composting in Virginia, 343-45 of control strategies with successful of disposal methods of poultry
- of European chicken farms, 149-50 of European scientific progress for fowl plague and other diseases,
- of fowl plague and first epizootic in
- of fowl plague and reexamination,
- of fowl plague and second epizootic
- of fowl plague in Brunswick poultry
- of fowl plague in LPM of New York
- of fowl plague in USA, 191-92, 197-
- of fowl plague in USA and economic
- of fowl plague research achievements.

- of fowl plague spread through
- commercial chicken trade, 170-71
- of fowl plague spread to Austria, 167-68
- of fowl plague terminology, 146-47 of fowl plague virus replication, 162-63
- of fowl plague visibility, 163
- of Geese, 61
- of global nature of AI, 124
- of horses and AI, 64
- of HP AI, 128, 135
- of HP AI arising from LP AI, 73-74
- of HP AI H5N1 virus from Asia. 251-53
- of HP AI H5N1 virus from Asia and genetic studies, 253-55, 257-58
- of HP AI H5N1 virus in Asia and disease in Hong Kong, 259-62
- of HP AI H5N1 virus in Asia and westward movement of virus, 262-65, 563-65
- of HP AI H5N1 virus outbreak in England, 221
- of HP AI H5N1 virus outbreak in Scotland, 217, 219
- of HP AI H5N2 virus in USA, 199
- of HP AI H5N2 virus outbreak in Italy, 224–25
- of HP AI H5N2 virus outbreak in South Africa, 222–23
- of HP AI H5N2 virus outbreak in Texas, 209–10
- of HP AI H5N3 virus outbreak in South Africa, 222
- of HP AI H5N8 virus outbreak in Ireland, 223–24
- of HP AI H5N9 virus in Canada, 198–99
- of HP AI H7N3 virus outbreak in Canada, 207–9
- of HP AI H7N3 virus outbreak in England, 219
- of HP AI H7N3 virus outbreak in Pakistan, 224
- of HP AI H7N7 virus outbreak in England, 219–21
- of HP AI H7N7 virus outbreak in Germany, 223
- of HP AI in Australia, 239
- of HP AI in wild birds, 125-26
- of HP AI outbreaks in Great Britain, 221 - 22
- of HP AI regulation, 126
- of HP AI risk of transmission to humans, 500–501
- of HP AI through documented epidemics, 129–34t
- of human illness caused by HP AI H7N3 virus, 464-66

History (continued) of human illness caused by HP AI H7N7 virus, 464-66 of human infections of HP AI H5N1 virus from poultry, 466-70, 472-73 of human influenza, 65 of humans and birds, 59 of incineration in Virginia, 341–42 of landfills in Virginia, 338–41 of LP AI in poultry, 125 of LP AI in wild birds, 125–26 of LP AI outbreaks in Minnesota poultry, 514–15, 516t of LP AI regulation, 126 of man-made systems and examples of LP AI, 127–28 of Mexico and LP AI H5N2 virus outbreak, 204 of OIE, 145 of pigs and AI, 64–65 of poultry AI vaccines, 416 of poultry and fowl plague, 124–25 of poultry and other bird trade restrictions and AI isolations, 502of poultry art and writing, 151–52 of poultry diseases and writers from ancient Greece, 151 of poultry diseases and writers from Asia, 151 of poultry diseases and writers from Rome, 151 of poultry's commercial era, 60, 71 of rendering in Europe, 347 of rendering in Virginia, 346 of TADs of zoonotic nature, 563–64 of terminology for AI, 126–27 of turkeys, 60–61 of USA and AI outbreaks, 514 of USA and civil freedoms, 147 of USA and LP AI H5N2 virus outbreak, 202, 204 of USA science and technology, 147– 48 of vaccines for HP AI, 407, 432–33 of vaccines for LP AI, 407–8, 432 of vaccine strain selection, 425 of virulence changes in AI, 25 of wild birds and AI, 43 of wild birds and domestic ducks commingling, 74 Hong Kong, 259–62 Horses, 64 HP. See High pathogenicity Human(s). See also Human influenza biosecurity and personal safety issues of, 580 economic benefits of minimizing disease from birds spreading to, 537

vaccines and new strategies for, 459educational programs focus on HP AI H5N1 virus infecting, 486, 488 60 history of birds and, 59 Humoral immunity, 408, 458–59 HP AI and recent infections of, 454– Hypochlorites, 397 55t, 464 HP AI H5N1 virus distribution in, ILT. See Infectious Laryngotracheitis 465f Immune system, 409 Immunology. See also Cell-mediated HP AI H5N1 virus epidemic curve immunity; Humoral immunity; for, 468f HP AI H5N1 virus from poultry Immune system; Mucosal infecting, 466–70, 472–73 immunity HP AI H5N1 virus infecting, 453 Al virus infection and host in terms HP AI H5N1 virus infecting females of, 411 of, 471f antigen response in, 409–11 HP AI H5N1 virus infecting males assessment of, 433 components of innate immunity in, of, 471f HP AI H5N1 virus with Asian 410 lineage in, 110–11 vaccination of chickens compared to HP AI H7N3 virus causing illness in, ducks and geese for, 415 vaccine protection of poultry and 464-66 HP AI H7N3 virus outbreak in basis from, 412 Canada infecting, 209 vaccines and vaccination for poultry HP AI H7N7 virus causing illness in, and basis in, 408 464-66 Inactivation HP AI H7N7 virus outbreak in The NAI in poultry products and methods Netherlands infecting, 231–32 for, 504–5 poultry facilities and dry heat for AI HP AI risk of transmission to, 500– and, 393–94 501 LP AI and recent infections of, 454t poultry facilities and steam for AI LP AI causing illness in, 462–64 and, 394 wild birds with HP AI H5N1 virus poultry facilities and UV light for AI and preventative measures for, 51 and, 393 Human influenza procedures for, 70–71 age and attack rates of, 455–56 Incineration box incinerator diagram for, 341f antigenic drift and vaccination with, costs associated with, 342 antigenic drift causing epidemics of, disposal methods of poultry carcasses through, 341–42 Virginia and, 341–42 antigenic shift causing pandemic of, Incubation period, 69 461-62 antigenic shift impacting, 15 Infectious Laryngotracheitis (ILT), 161 CMI contributing to recovery from, Infectious period, 69 Influenza viruses. See also Global 458-59 economic effects of, 541 Influenza Preparedness Plan; fear of, 540-41 Global Influenza Surveillance GISN and formulating vaccines for, Network; Human influenza; Notifiable avian influenza 459 HA binding to SA in, 457–58 life cycle of, 4–6 history of, 65 nomenclature of, 4 humoral immunity contributing to poultry infected by, 10 recovery from, 458–59 species specificity of, 8–9 turkeys exposed to pigs and, 10 pathogenicity and adaptation of, 32– viral diversity mechanisms of, 13–14 33, 458 pigs as mixing vessel for AI and, 5 viral protein and, 5–6 virulence influenced by mutation of public health impact of, 453, 455–56 RNA viruses subpopulations proteins in, 30 wild birds and, .6-8 resistance to antiviral drugs for, wild birds and separation in North 24-25, 461American v. Eurasian types of, vaccination annually for prevention of, 459 6-7

### Index

Injectable anesthetics, 324 Inorganic acids, 398 Inorganic compounds, 396 In situ plasma vitrification cost associated with, 349 disposal methods of poultry carcasses through, 348–49 system diagram of, 349f Interspecies transmission of AI, 62f, 87 common cases of, 68 Intoxication, 158-59 In vivo Pathotyping, 304 Ireland, 223–24 Italy fowl plague and first epizootic in, 164-66 fowl plague and second epizootic in, 166--67 HP AI H5N2 virus outbreak in, 224-HP AI H7N1 virus and clinical findings in, 226, 228 HP AI H7N1 virus emergence in, 225 HP AI H7N1 virus eradication in, 228 HP AI H7N1 virus infected poultry and distribution in, 226f HP AI H7N1 virus infecting wild birds in, 228 HP AI H7N1 virus spreading in, 225-26, 227t Iwasa, T., 154 Kaupp, B.F., 152 Klee, Robert, 152 Kleine, F.K., 154, 157 Koch, Robert, 148-49 Köhler, H., 150

Landfill costs associated with, 340 disposal methods of poultry carcasses through, 338–41 problems with, 339 Virginia and history with, 338-41 LBM. See Live bird market Legislation, 176 Lesions chickens and fowl plague causing, 193t chickens and HP AI creating, 93t chickens and HP AI H5N2 virus creating, 200f chickens and HP AI H7N3 virus in Canada causing, 207 chickens and HP AI H7N3 virus in Chile causing, 206 chickens and LP AI creating, 93t

Künnemann, O., 154

in mammals from HP AI H15N1 control strategies and specific virus of Asian origin, 111t poultry with HP AI and gross, 93–94, 526 93–96f, 96 control strategies and specific poultry with HP AI and microscopic, 96–98f, 97t, 98 526-27 poultry with LP AI and gross, 92 control strategies and specific poultry with LP AI and microscopic, 92 with, 525–26 USA fowl plague clinical signs and, control strategies and specific 192-93 Liposomes, 421–22 526 Live bird market (LBM) control strategies and specific AI distribution through, 9–10 measures for vehicles and HP AI H5N1 virus spreading through, equipment with AI with, 527 266 control strategies cost for AI with, Live poultry marketing (LPM), 71 292-93 biosecurity and risks of domestic control strategies for AI with, 287-88 ducks in, 361 control strategies for poultry biosecurity and risks of poultry travel movement and AI with, 518 between, 359–60 control strategies of biosecurity for fowl plague in New York City and, control strategies of vaccination for frequency of AI in, 75 AI with, 530 LP AI introduced into commercial control strategies preventing poultry through, 74-75, 123-24 LP AI prevention for, 523 of AI with, 527-28 ND compared to AI in, 372-73 diagnostics and surveillance methods species commingling and AI in, 76 Lode and Gruber, 150, 167-68 24 Low pathogenicity (LP) disposal methods of poultry carcasses AI regulation with, 126 aquatic birds and poultry and 334t infections HP AI and AI with, ducks age based mortality rate when exposed to AI which is, 13 aquatic birds as reservoirs for AI ducks and AI with, 99 with, 63-64 educational programs providing biosecurity fighting AI with, 290 California turkey farms and movement of AI with, 518f features of AI with, 128 C&D for poultry facilities with AI food safety risks with HP NAI and with, 529–30 NAI with, 506-7 cellular pathobiology and HA geese and AI with, 99 cleavage of AI which is, 11 global nature of AI with, 123-24, challenges of AI which is, 16 135-36 chicken eggs embryonation and AI HA PCS for AI with, 26-27 with, 4 host susceptibility for AI with, 46 chickens age based mortality rate HP AI H5N2 virus outbreak when exposed to AI which is, 13 similarities to outbreak of H5N2 chickens and lesions from AI with, AI with, 203f 93t HP AI originating from, 73–74 chickens compared to turkeys in HP compared to, 3 terms of AI with, 75-76 human illness caused by AI with, cleavage of HA of AI with, 88 462–64 controlled marketing for poultry humans and recent infections of AI flocks infected with AI with, 529 with, 454t control strategies and identifying LPM and commercial poultry sources of AI with, 517-18 introduced to AI with, 74-75, 123control strategies and response to sources of AI with, 525 LPM and prevention of AI with, 523

### Index

measures for eggs with AI with,

measures for humans with AI with.

measures for infected birds with AI

measures for manure with AI with,

poultry outbreak of AI with, 364

spreading to different populations

for illegal sources of AI with, 523-

infected with H7N1 virus AI with,

information on HP AI and AI with,

Low pathogenicity (LP) (continued) man-made systems and examples of AI with, 127–28 mass depopulation for poultry flocks infected with AI with, 528–29 measures for stamping out AI with, 548 Mexico and HP AI H5N2 virus changing from H5N2 virus AI with, 204–5 Mexico and outbreak of H5N2 virus AI with, 204 Minnesota poultry and outbreaks of AI with, 514–15, 516t molecular and biological features of AI which is, 10-11poultry and, 125 poultry and clinical signs of AI with, 91–92 poultry and global nature of AI with, 127 poultry and gross lesions from AI with, 92 poultry and isolated AI with, 65 poultry and microscopic lesions from AI with, 92 poultry and replication of AI with, 88 poultry and syndromes inflicted by AI with, 87 poultry eggs pasteurization time with infections of NAI with, 507t poultry tissue and cellular sites of viral replication and damage of AI with, 92 poultry trade risks of HP NAI and NAI with, 501–2 poultry vaccines for live AI with, 422–23 ratites and AI with, 99 recommended measures for responders to AI with, 473 serological surveillance and sentinel birds detecting AI with, 435–36 species variation in response to AI with, 90 turkeys and sources of AI with, 72f USA and accidental sources of AI with, 523 USA and H5N2 virus AI with, 202, 204 USA and H5N2 virus beginning as AI with, 199–200 USA and HP AI H5N2 virus changing from AI with, 200–201 vaccines for AI with, 407–8, 432 vaccines protection assessment and AI with, 413–14 wild birds and AI with, 99, 125-26 wild birds and prevention of AI with, 523

LP. See Low pathogenicity LPM. See Live poultry marketing Lush, D., 161 M2 protein, 4, 5 Maggiora, A., 154, 167 Maintenance cycle for ducks with AI, 48f for poultry with AI, 69–70, 75–76 for wild birds with AI, 48–49 Mammals. See also Civets; Felids; Humans; Mink; Pigs; Seals AI infections in, 64–65 avian immune system compared to immune system of, 409 HP AI H5N1 virus experimental infections in, 113–14 HP AI H5N1 virus with Asian lineage and lesions in, 111t HP AI H5N1 virus with Asian lineage and summary data for avian species and, 101t HP AI H5N1 virus with Asian lineage in, 109–10 Man-made systems. See also Live poultry marketing LP AI examples in, 127–28

poultry introduced to AI through, 71– reservoirs of AI in, 514 Mann, G., 157 Market shocks economics impacted by, 538 HP AI and international economics of, 544 HP AI and USA economics of, 544– 46 Mass depopulation. See also Death animal welfare issues with, 314  $CO_2$  use in, 313 educational programs considering methods of euthanasia and, 489, 491 euthanasia and caged house methods with  $CO_2$  for, 322-23euthanasia and caged house methods with electrocution for, 323 euthanasia compared to, 309–10 information sources on methods of, 492t LP AI infected poultry flocks and, 528-29 poultry and electrocution for, 313–14 poultry and selection criteria for, 312-13 poultry and SOPs for, 315 poultry that is floor-reared and  $CO_2$ gassing of whole house for, 319 poultry that is floor-reared and CO<sub>2</sub> with free standing panel enclosure for, 316–17

### Index

poultry that is floor-reared and CO<sub>2</sub> with live haul gage enclosures for, 319-20 poultry that is floor-reared and CO<sub>2</sub> with plastic tenting for, 317–18 poultry that is floor-reared and methods for, 315–16 PPE used in, 314–15 strategy of, 310-11 water-based foam accepted methods for, 321 water-based foam compared to CO<sub>2</sub> gassing for, 320–21 worker health concerns with, 314–15 Matrix gene, 8f MDTs. See Mean death times Mean death times (MDTs) for chickens with HP AI H5N1 virus with Asian lineage, 103t for ducks with HP AI H5N1 virus with Asian lineage, 106t of HP AI H5N1 virus with Asian lineage, 100–101 of HP AI in chicken compared to other poultry, 92–93 Metzger, E., 155–56 Mexico HP AI H5N2 virus control strategies of, 205 LP AI H5N2 virus changing to HP AI H5N2 virus in, 204–5 LP AI H5N2 virus outbreak in, 204 Microneutralization test (MN), 457 Middle East HP AI H5N1 virus control strategies of, 275 HP AI in poultry impacting food and economic livelihood in, 546 Mink, 112 Minnesota HA subtypes in AI of ducks and detection of AI in turkeys from, 517t LP AI outbreaks in poultry in, 514– 15, 516t turkeys and use of vaccines in, 532f Möllers, B., 154, 157 Morphology, 3–4 Mucosal immunity, 411–12 Mutations H5N1 virus and possibilities for, 33 HA PCS and, 27-28, 28t importance and effects of, 24–25 RNA viruses and ease of, 24 virulence of influenza viruses influenced by proteins and, 30

NA. See Neuraminfdase

NAHEMS. See National Animal Health Emergency Management System

NAI. See Notifiable avian influenza Nakamura, N., 154 Nasal epithelium, 90f National Animal Health Emergency Management System (NAHEMS), 489 National Poultry Improvement Plan (NPIP), 123, 488 ND. See Newcastle disease Necrosis in ducks with HP AI H5N1 virus of Asian lineage, 108f in emus with HP AI H5N1 virus, 104f in house finch with HP AI H5N1 virus, 103f HP AI producing, 90–91 in zebra finch with HP AI H5N1 virus, 100f Negri, A., 157 The Netherlands HP AI H7N7 virus and control strategies of, 230-31 HP AI H7N7 virus outbreak in, 229-30 HP AI H7N7 virus outbreak infecting humans in, 231-32 HP AI H7N7 virus outbreak infecting pigs in, 232–33, 500 Neuraminidase (NA), 4 viral assembly process and, 5-6 virulence and pathogenicity implications of, 31 Neuraminidase inhibition assay (NI assay), 303 Newcastle disease (ND) Chu and fowl plague differentiation from, 161 Doyle and fowl plague differentiation from, 159, 161, 164 fowl plague differentiation from, 159–61, 160t LPMs and AI compared to, 372-73 New South Wales, 244-45 New York City, 192 NI assay. See Neuraminidase inhibition assay Nonstructural gene (NS), 31 North Korea, 233 Notifiable avian influenza (NAI) food safety risks with HP NAI and LP of, 506–7 inactivation methods for poultry products with, 504-5 poultry eggs pasteurization time with infections of HP of, 506t poultry eggs pasteurization time with infections of LP of, 507t poultry trade restrictions related to HP of, 499–500

poultry trade risks related to HP NAI human influenza adaptation and, 32and LP of, 501-2 33, 458 trade risk mitigation for countries free NA impacting virulence and, 31 of, 503 NS impacting virulence and, 31 vaccination for chickens infected with pigs AI adaptation and, 32–33 HP of, 504t polymerase complex impacting vaccination for poultry infected with virulence and, 31–32 HP of, 503-4 virulence conflicting with, 71 NPIP. See National Poultry Pattern recognition receptors (PRRs), Improvement Plan 409-10 NS. See Nonstructural gene PCS. See Proteolytic cleavage site Nucleotides, 28 Peroxygen compounds, 396 Perroncito, Edward, 145, 149-51, 154, Office Internationale des Epizooties 161-63, 165-66, 165f (OIE) Personal protective equipment (PPE) control strategies and role of, 294 C&D and increased level of, 392, global strategy and regional 403, 473 organizations and partners of FAO mass depopulation and use of, 314and, 576–77t history of, 145 Pesticide Product Label System (PPLS), HP AI H5N1 virus and response of 392 FAO and, 562 Petényi, J.S., 165 OIE. See Office Internationale des Petri, Julius Richard, 148 Epizooties Pfenninger, W., 155–56 Oil adjuvants, 421 Phenols, 397 On-site burial Piana, o.V., 165 costs associated with, 338 Pigs cross section and longitudinal section antigenic shift impacting, 15-16 of, 337f history of AI in, 64--65 disposal method of poultry carcasses HP AI H5N1 virus with Asian through, 336–38 lineage in, 111 problems with, 338 HP AI H7N7 virus outbreak in The in Virginia, 336-38 Netherlands infecting, 232-33, 500 Ostriches. See Ratites human influenza and AI viruses Outdoor rearing, 76 mixed in, 5 influenza viruses and turkeys Pakistan, 224 exposure to, 10 PAMPs. See Pathogen-associated pathogenicity and AI adaptation in, molecular patterns 32-33 Pasteur, Louis, 148, 157 Point of care test. See Rapid point of Pathobiology care tests concepts of, 66–67 Polymerase complex, 31–32 ducks infected with HP AI H5N1 Poultry. See also Brunswick poultry virus of Asian lineage and groups exhibition; Chickens; Ducks; Live for, 106t poultry marketing; National Poultry of HP AI H5N1 virus with Asian Improvement Plan; Turkeys Lineage, 100–102 AI isolations after trade restrictions HP AI HA cleavage and cellular, 11 for other birds and, 502-3 LP AI HA cleavage and cellular, 11 AI transmission efficiency in water poultry with AI and concepts of, 66f birds  $v_{.}$ , 514 terms of, 66t ancient Greek writers on diseases in, Pathogen-associated molecular patterns 151 (PAMPs), 409–10 antigenic drift and, 14–15 Pathogenicity. See also High antigenic shift impacting, 15 pathogenicity; Low pathogenicity art and writing on, 151–52 glycosylation influencing HA and, Asian food and economic livelihood impacted by HP AI in, 546-47 of H5 subtype, 10 Asian writers on diseases in, 151 of H7 subtype, 10 biosecurity and voluntary movement HA role in AI and, 25 control programs for, 362-64

### Index

Poultry (continued) biosecurity cost concerns of farms with, 355, 361–62 biosecurity plan and transmission of AI through, 357–58 biosecurity regional plan concerns for, 363–64 biosecurity risk assessment and AI spreading through, 373 biosecurity risks of travel between LPMs with, 359–60 biosecurity sources of information for, 496t C&D chemical methods for producers of, 394 C&D dry cleaning for facilities with, 400-401 C&D for LP AI in facilities with, 529-30 C&D response procedures for facilities with, 391–92 C&D routine for facilities with, 393 C&D water system cleaning for facilities with, 400 C&D wet cleaning for facilities with, 401 - 2 $CO_2$  used for euthanasia of, 311–12 commercial era of, 60, 71 controlled marketing for LP AI infected flocks of, 529 control strategies and exposure risk level identification for, 521–22 control strategies and LP AI movement in, 518 control strategies for confined populations of, 519–20 control strategies for nonconfined populations of, 520–21 control strategies for population cross-over in, 521 control strategies of biosecurity for LP AI outbreak in, 364 control strategies of C&D for facilities with, 522 control strategies of eliminating infected, 291 cost of loss of production for, 550-51 disposal method comparative analysis for carcasses from, 350–51 disposal method of alkaline hydrolysis for carcasses from, 347– disposal method of composting for carcasses from, 342–45 disposal method of incineration for carcasses from, 341–42 disposal method of in situ plasma vitrification for carcasses from, 348-49

disposal method of on-site burial for carcasses from, 336–38 disposal method of rendering for carcasses from, 345–47 disposal method options introduction 494t 333-35 537-40 551-52 of, 538–39 HP AI for, 555–57 educational considerations with 491, 493 543f of, 313–14 311-12 exposure to AI of, 67–68 fowl plague and, 124–25 fowl plague control strategies and trade of, 174 fowl plague disinfection and cleansing for, 175 174-75 500 93–96f, 96 96–98f, 97t, 98 98-99

### Index

- disposal method of landfill for
- carcasses from, 338–41
- for carcasses from, 335–36
- disposal methods and sources of
- information regarding carcasses of,
- disposal methods for LP AI H7N1 virus infected carcasses of, 334t disposal methods of carcasses from,
- dry heat for inactivation of AI in facilities with, 393–94 economic benefits of avoiding disease and increasing productivity in,
- economic compensation for loss of,
- economics and cost of rehabilitation
- economics of biosecurity for, 554-55 economics of long term prevention of
- economics of restocking, 553–54
- disposal methods for carcasses of,
- Egypt and layer market chains of,
- electrocution for mass depopulation
- environmental persistence of AI on,
- euthanasia accepted methods for,
- exposure sources of AI for, 67f
- FAO defined sectors for, 71, 567t
- fowl plague quarantine phases for,
- global production and trade of, 499–
- global strategy and restructuring and rehabilitation for sectors of, 580–81 HP AI and gross lesions in, 93–94,
- HP AI and microscopic lesions in,
- HP AI and tissue and cellular sites of viral replication and damage in,

- HP AI clinical signs in, 92–93
- HP AI H5N1 virus spreading through, 265-66, 268, 500
- HP AI H5N2 experimental studies on, 204t
- HP AI H7N1 virus distribution in Italy for, 226f
- HP AI H7N3 virus outbreak in Queensland infecting, 244
- HP AI H7N3 virus outbreak in Victoria infecting, 243–44
- HP AI H7N4 virus outbreak in New
- South Wales infecting, 244–45 HP AI H7N7 virus outbreak in
- Victoria infecting, 241–43 HP AI impacting African economics
- and, 545t HP AI inflicted syndromes in, 87–88
- HP AI replication in, 88
- HP NAI and LP NAI risks through trade of, 501-2
- HP NAI and pasteurization times for eggs of, 506t
- HP NAI causing restrictions in trade of, 499–500
- humans infected with HP AI H5N1 virus from, 466–70, 472–73
- immunology as basis for vaccine protection of, 412
- immunology as basis for vaccines and vaccination of, 408
- inactivation methods for NAI infected products of, 504–5
- influenza viruses infecting, 10
- Kaupp and book on, 152
- Klee and book on, 152
- LP AI and gross lesions in, 92
- LP AI and HP AI between aquatic birds and, 72f
- LP AI and microscopic lesions in, 92
- LP AI and tissue and cellular sites of viral replication and damage in, 92
- LP AI clinical signs in, 91–92
- LP AI global nature of, 127
- LP AI in, 125
- LP AI inflicted syndromes in, 87
- LP AI isolation in, 65
- LP AI outbreaks in Minnesota with, 514–15, 516t
- LP AI replication in, 88
- LPM introducing LP AI to commercial, 74–75, 123–24
- LP NAI and pasteurization times for eggs of, 507t
- maintenance cycle of AI in, 69-70, 75-76
- man-made systems introducing AI to, 71–72
- market chains of, 542–44

mass depopulation by CO<sub>2</sub> gassing of whole house for floor-reared, 319

mass depopulation by CO<sub>2</sub> with free standing panel enclosure for floorreared, 316–17

- mass depopulation by CO<sub>2</sub> with live haul cage enclosures for floorreared, 319–20
- mass depopulation by CO<sub>2</sub> with plastic tenting for floor-reared, 317-18
- mass depopulation criteria for, 312-
- mass depopulation for LP AI infected flocks of, 528-29

mass depopulation methods for floorreared, 315–16

mass depopulation SOPs for, 315 MDTs from HP AI in chickens

compared to other forms of, 92-93 Middle Eastern food and economic

- livelihood impacted by HP AI in, 546
- mucosal immunity in, 411

outdoor rearing risks of AI for, 76

pathobiology concepts for AI in, 66f production and international trade in meat of, 541t

production sectors of, 541-42

Roman writers on diseases in, 151 secondary spread of AI between

flocks of, 75

steam for inactivation of AI in facilities with, 394

system continuum and country examples of, 542t

- Thailand and meat market chains of, 543f
- transmission of AI and adaptation of, 68-69

USA control strategies for, 513

USA control strategies of biosecurity for, 515–17

UV light for inactivation of AI in facilities with, 393

vaccination for HP NAI in, 503-4 vaccination issues for, 424-25

vaccine cost comparisons for, 427

vaccine potency for, 416–17

vaccines and mass administration for, 427-28

vaccines and posthatch parental administration for, 427

vaccine's broad homosubtypic protection for, 426

vaccines for AI in, 416

vaccines for live LP AI in, 422-23

vaccine studies for AI in other birds and, 418–20t

van Heelsbergen and book on, 152

various minor species of, 61 economic benefits and enforcement Vietnam costs and benefits of control for, 548–49 strategies for HP AI in, 540t farmer awareness for pathways of, village poultry introducing AI to 548 commercial, 75f Reservoirs wild birds and transmission of AI in anseriformes, 46 within and between, 358f in charadriiformes, 46 wild birds infected with HP AI H5N1 of HP AI in ducks and wild birds virus transmitted by, 64 creating challenges for control wild birds introducing AI to, 72-74, strategies, 574 73f of LP AI in aquatic birds, 63-64 man-made systems as AI, 514 in wild birds, 46, 513–14 System Risk analysis, 369 Risk assessment. See Biosecurity risk protein; Neuraminidase assessment in AI structure, 3-4 Risk management, 369 H5N1 virus and deletions of, 259 RNA influenza viruses and viral, 5-6 antiviral drugs for human influenza influenza viruses virulence influenced and resistance of subpopulations of by mutations of, 30 viruses in, 24-25, 461 H7 subtype outbreaks from amino acid changes in virulence and, recombination of, 29 make up of, 23-24 amino acid insertions for HP AI at, mutation ease of viruses in, 24 28–29 Rome, 151 H5N1 virus variations at HA and, 33, Rosenthal, W., 157 34-35t, 35 Roux, Pierre Emile, 148 RT-PCR assay, 456-57 35–36 Salmonella, 505t SARS. See Severe acute respiratory syndrome amino acid sequence, 242t Savonuzzi, E., 149 Scotland, 217, 219 Seals, 111–12 Septicemic spirochetosis, 159, 159t Sequence analysis, 304 Serological surveillance LP AI detected by sentinel birds in, (QACs), 397–98 435-36 vaccination and infected birds detected through, 436-37 vaccination success determined through, 435 Severe acute respiratory syndrome (SARS), 563 Shorebirds, 47 Sialic acid (SA), 457–58 Sodium carbonate, 399 Sodium dichlorotriazine trione, 397 through, 345–47 Sodium hydroxide, 398–99 SOPs. See Standard operational procedures South Africa HP AI H5N2 virus outbreak in, 222-23 HP AI H5N3 virus outbreak in, 222 for, 549 Sparrows, 105f

PPE. See Personal protective equipment PPLS. See Pesticide Product Label Protein. See also Hemagglutinin; M2 HA and mutations at, 27-28, 28t HA and problems from changes at, HA lab manipulation and, 30 of HA of Australian H7 subtype and LP AI and HA at, 26-27 HP AI in, 99–100 LP AI in, 99 information system for, 549

Proteolytic cleavage site (PCS) PRRs. See Pattern recognition receptors Public health implications, 293-94 Purines, 29 Quaternary ammonium compounds Queensland, 244 Rapid point of care tests, 456 Ratites. See also Emus Recycling. See Rendering Reinacher, M., 163 Rendering disposal methods of poultry carcasses Europe and, 347 flow chart for process of, 346f Virginia and, 346 Reporting and confirmation cost of effective animal health cost of laboratory staff and equipment

Standard operational procedures (SOPs), 315 Steam. See Wet Heat Sterz, I., 157 Straub, o.V., 165 Stubbs, Evan, 199f Survival time of AI under laboratory conditions, 357f biosecurity plan and environment impacted by AI and, 356–57 fowl plague inside and outside host and, 163 TADs. See Transboundary animal diseases Texas HP AI H5N2 virus control strategies in, 210–11 HP AI H5N2 virus outbreak in, 209-10 Thailand, 543f TLR. See Toll-like receptor Toll-like receptor (TLR), 410 Transboundary animal diseases (TADs) definition of, 561 zoonotic nature of, 563–64 Transmission cycle, 47–48 Turkey (country), 548t Turkeys adaptation to AI transmission of, 69 California and LP AI moving between farms with, 518f history of, 60–61 influenza viruses and exposure of pigs on, 10 LP AI and chickens compared to, 75-76 LP AI sources for, 72f Minnesota ducks' HA subtypes in AI and detection of AI in, 517t vaccines used in Minnesota for, 532f Ultraviolet light (UV light), 393 United States of America (USA). See also California; Minnesota; New York City; Texas; Virginia AI outbreaks in, 514 civil freedoms in, 147 control strategies with biosecurity for poultry in, 515–17 fowl plague and economical implications on, 196 fowl plague and source theories of, 196–97 fowl plague C&D in, 196 fowl plague control strategies of, 195 fowl plague diagnosis in, 194–95

fowl plague experimental studies in, 193-94 fowl plague in, 191–92, 197–98 fowl plague lesions and clinical signs in, 192–93 fowl plague quarantines of, 195–96 H5N2 virus beginning as LP AI, 199-200 HP AI creating market shocks and impacting economics in, 544–46 HP AI H5N2 virus and control strategies of, 201–2 LP AI accidental sources in, 523 LP AI H5N2 virus outbreak changing into HP AI in, 200–201 LP AI H5N2 virus outbreak in, 202, 204 poultry control strategies of, 513 science and technology in, 147–48 USA. See United States of America UV light. See Ultraviolet light Vaccination biosecurity and alternative of, 353 biosecurity during, 431 control strategies and programs for, 429-31, 552-53, 569-70 control strategies for fowl plague in chickens and, 175–76 control strategies for fowl plague in geese and, 175 economics associated with, 552-53 educational programs and strategies for, 493, 495 evaluating, 531 HP NAI in chickens and, 504t HP NAI in poultry and, 503–4 of human influenza and antigenic drift, 14 human influenza prevention and annual, 459 identification of infected animals after, 433–34 immunology of chickens compared to ducks and geese with, 415 justifications for, 531–32 limitations of, 532–33 LP AI and control strategies of, 530 mechanics of, 530–31 of poultry and basis from immunology, 408 poultry issues with, 424-25 priorities for, 431 serological surveillance detecting infected birds after, 436–37 serological surveillance determining success of, 435 surveillance after, 433 vaccine application concepts for emergency program of, 430f

### Index

Vietnam and costs of biosecurity and, 539-40 virological surveillance after, 434–35 Vaccines adjuvants in, 417, 421 banks of, 571 categories of, 417 control strategies and proper use of, 570-71 cost comparisons of poultry and, 427 cost for, 530 criteria for protection with, 412–13 DNA based, 424 HA and selection of strains of, 425-26 HP AI and, 407, 432–33 HP AI and chickens protected by, 413–14t HP AI and protection assessment of, 413-15 HP AI H5N1 virus and prepandemic, 460-61 human influenza and GISN for formulating, 459 human influenza and new strategies with, 459–60 immunology as basis for protection of poultry with, 412 immunology as basis for vaccination of poultry and, 408 inactivated whole AI and, 417 indirect assessment of protection from, 416 licensed AI, 431–32 liposomes in, 421–22 live vectored, 423–24 LP AI and, 407–8, 432 LP AI and protection assessment of, 413–14 management and environmental conditions for, 428–29 Minnesota turkeys and use of, 532f oil adjuvants in, 421 poultry and AI and, 416 poultry and broad homosubtypic protection of, 426 poultry and live LP AI and, 422-23 poultry and mass administration of, 427-28 poultry and other birds with AI and studies on, 418–20t poultry and posthatch parental administration of, 427 poultry and potency of, 416–17 protection measured by interruption of contact transmission and, 415t protection of AL and factors impacting, 415+16 quality control in manufacturing,

426-27

strain selection of, 425 vaccination program for emergency and concepts for applying, 430f in vitro expressed HA for, 422 in vivo expressed HA for, 422-24 Valenti, G.L., 154, 167 Van Heelsbergen, T., 152 VI. See Virus isolation Victoria HP AI H7N3 virus infecting poultry in, 243–44 HP AI H7N7 virus infecting poultry in, 241–43 Vietnam costs and benefits of HP AI control strategies for poultry in, 540t vaccination and biosecurity costs of, 539-40 Viral evolution, 23 Virchow, Rudolf, 156 Virginia composting used in, 343-45 incineration used in, 341-42 landfill history in, 338-41 map of AI outbreaks in, 340f on-site burial in, 336-38 rendering used in, 346 Virological surveillance, 434-35 Virulence amino acid changes at PCS and, 27 of H5N1 virus increasing, 35 historical changes in AI and, 25 mutation of proteins influencing influenza viruses and, 30 NA impacting pathogenicity and, 31 NS impacting pathogenicity and, 31

pathogenicity conflicting with, 71 polymerase complex impacting pathogenicity and, 31-32 Virus isolation (VI), 299-301, 456 Virus N, 172–73 Von Ostertag, R., 154 Water-based foam, 320-21, 321 Weiss, E., 157, 163 Wet Heat (Steam), 394 WHO. See World Health Organization Wild birds. See also Anseriformes; Charadriiformes; Sparrows AI in, 43 AI isolation among species of, 44-45t AI subtypes in, 46-47 biosecurity and movement patterns of, 362 biosecurity plan and transmission of AI through, 358 control strategies and challenges of HP AI reservoirs in, 574 domestic birds transferring AI to, 9 domestic ducks commingling with, environmental persistence of AI in, 48 euthanasia methods for, 324 euthanasia through cervical dislocation for, 325–26 euthanasia through compressed CO<sub>2</sub> in a chamber for, 326 euthanasia through culling bag with frozen CO<sub>2</sub> for, 326–28 euthanasia through injectable anesthetics for, 324

Index

H5N1 virus found in species of, 50t HP AI H5N1 virus and human preventative measures with, 51 HP AI H5N1 virus experimentally infected in, 49-50 HP AI H5N1 virus maintenance and transmission in, 50-51 HP AI H5N1 virus naturally infected in, 49 HP AI H5N1 virus of Asian lineage and, 105, 107–9 HP AI H5N1 virus spread through, 267-68 HP AI H7N1 virus in Italy infecting, 228 HP AI in, 99, 125–26 HP AI in Australia and, 239-40 influenza viruses found in, 6-8 influenza virus separation between North American v. Eurasian in, 6-7 LP AI in, 99, 125-26 LP AI prevention for, 523 maintenance cycle for AI in, 48-49 poultry and HP AI H5N1 virus transmitted to, 64 poultry and transmission of AI within and between, 358f poultry introduced to AI through, 72-74, 73f research on AI in, 51–52 reservoirs in, 46, 513-14 transmission cycle of AI in, 47-48 World Health Organization (WHO), 253, 462. See also Global Influenza Surveillance Network



# AVIAN INFLUENZA

Avian Influenza provides the first comprehensive guide covering the full spectrum of this complex and increasingly high-profile disease, its history, and its treatment and control. All aspects of avian influenza are dealt with in depth, systematically covering biology, virology, diagnostics, ecology, epidemiology, clinical medicine, and control. The book fuses coverage of the latest discoveries in the basic sciences with a practical approach to dealing with the disease in a clinical setting, and providing instruction and guidance for veterinarians and government animal health officials encountering this disease in the field.

Avian Influenza provides the reader with a global perspective, bringing together chapters written by leading animal health researchers and veterinarians with significant experience working with this disease. Providing a summary and synthesis of important data and research on this virus, its impact on both wild and domesticated birds, and approaches to controlling the spread of the disease, Avian Influenza will be an invaluable resource for all veterinarians, scientists, animal health professionals, and public health officials dealing with this virus.

- Covers full range of topics within avian influenza in one comprehensive and authoritative text
- Provides a summarization of peer-reviewed and empirical data on avian influenza viruses, the infection, and diseases they cause
- Discusses strategies used in control of the disease
- Leading experts are drawn together to provide an international and multi-disciplinary perspective
- Fuses latest developments in basic scientific research with practical guidance on management of the disease

David E. Swayne, DVM, PhD, Diplomate, American College of Veterinary Pathologists; Diplomate, American College of Poultry Veterinarians, is Laboratory Director at the Southeast Poultry Research Laboratory, Agricultural Research Service, U.S. Department of Agriculture, in Athens, Georgia.

### **OTHER TITLES OF INTEREST:**

### Infectious Diseases of Wild Birds

Nancy J. Thomas, D. Bruce Hunter, Carter T. Atkinson 9780813828121

Diseases of Poultry, 12th edition Y. M. Saif 9780813807188



