

VIROLOGY
MCB 5505

VIROIDS & SATELLITES

- I. VIROIDS
 - A. STRUCTURE & SEQUENCE
 - 1. NUCLEOTIDE SEQUENCE -- 246N (CCCvd) TO 375N (CEvd)
 - a. NUMBERING SYSTEM
 - b. ROD SHAPE (20:1 AXIAL RATIO)
 - c. 21 DISTINCT VIROIDS ??
 - (1) >100 NUCLEOTIDE SEQUENCES DETERMINED
 - (2) ISOLATE VARIATION
 - 2. SECONDARY STRUCTURE
 - a. CIRCULAR <=====> LINEAR
 - b. DOUBLE HELICAL, SS CIRCLE
 - c. BASE-PAIRED REGIONS AND LOOPS
 - d. STRUCTURAL TRANSITIONS WITH DENATURATION
 - 3. DOMAINS (FOR PSTvd and CCCvd GROUPS)
 - a. CONSERVED CENTRAL
 - b. PATHOGENIC
 - c. VARIABLE
 - d. TERMINAL T1 & T2 (OR TL AND TR)
 - B. CLASSIFICATION -- BASED ON SEQUENCE AND SELF-CLEAVAGE
 - 1. ASBvd GROUP
 - a. LOW G+C AND SELF-CLEAVAGE
 - b. THREE MEMBERS: ASBvd, PLMvd & CarSAVd
 - 2. PSTvd GROUP
 - a. HIGH G+C AND PSTvd CORE
 - b. ELEVEN MEMBERS: PSTvd, CEvd, CVd-IV, CLvd
TASvd, TPMvd, CSVd, HSVd

CCCvd, CTiVd

HLvd
 - 3. ASSvd GROUP
 - a. HIGH G+C AND ASSvd CORE
 - b. SIX MEMBERS: ASSvd, AGvd, CBLvd,
GYSvd, GYSvd-2 & PBCvd
 - 4. CbVd - SINGLE-MEMBER GROUP
 - C. REPLICATION
 - 1. NO CODING SEQUENCES -- NO REPLICASE
 - 2 + STRANDS ---> - STRANDS ---> + STRANDS
 - 3. RNAP II THE PROBABLE ENZYME
 - a. REPLICATION INHIBITED BY α -AMANITIN (10^{-8} M)
 - b. REPLICATION IN THE NUCLEUS
 - c. PARTIAL REPLICATION *IN VITRO*
 - 4. OTHER POSSIBILITIES
 - 5. MODELS INVOLVE ROLLING CIRCLES
 - 6. MULTIMER CLEAVAGE (HOST OR SELF CLEAVAGE)
 - 7. LIGATION BY PLANT EXTRACTS (RNA LIGASE ?)

- D. PATHOGENESIS
 - 1. INFECTIVITY OF CLONES
 - 2. DISEASE
 - a. LIKE VIRUS INFECTIONS
 - 1. WILTS, STUNTING, LEAF DISTORTIONS, NECROSIS
 - 2. MANY ARE SYMPTOMLESS -- LATENT VIROIDS
 - b. PROTEIN CHANGES (LITTLE NA CHANGES)
 - c. CELL TO CELL MOVEMENT IS RAPID
 - d. SEED AND POLLEN TRANSMISSION
 - e. AGRICULTURAL TRANSMISSION
 - 3. MOLECULAR MECHANISMS
 - a. SEQUENCE COMPARISONS VS. PATHOGENICITY
 - b. HOST RNAs ??
 - (1) U3 snRNA AND PSTVd
 - (2) SPACER BETWEEN 5.8S AND 25S rRNA
 - (3) TRANSPORT OF mRNAs ??
 - c. CONCLUSION: INTERFERES WITH RNA METABOLISM
SPLICING OR mRNA TRANSPORT
- II. SATELLITE VIRUSES (OF PLANTS)
 - A. SATELLITE OF TOBACCO NECROSIS VIRUS (STNV)
 - 1. PARTICLE IS 17 nm IN DIAMETER (TNV IS 30 nm)
 - 2. GENOME IS ssRNA, 1239N, NOT RELATED TO TNV'S
 - 3. ONE ORF --> COAT PROTEIN (195 AA, 22KD)
 - a. N=30 to N=620 (588N)
 - b. LAST 600N ???
 - c. UNRELATED TO COAT OF TNV
 - 4. REPLICATED BY TNV RNA REPLICASE
 - B. OTHERS: STMV, SPMV AND SMWLMV
 - 1. ALL HAVE COAT PROTEIN GENE (STMV HAS A 2ND ORF ?)
 - 2. SMALLEST IS SPMV - 826 N GENOME
- III. SATELLITE RNAs
 - A. SS RNAs PACKED WITHIN VIRION OF HELPER VIRUS
 - B. SMALL SIZE: 230 - 1370 N
 - C. MAY HAVE ORF (CDS) FOR SMALL PROTEIN (10 - 40 Kd)
 - D. MAY ALTER DISEASE PRODUCED BY HELPER VIRUS (USU. ATTENUATES)
 - E. CARNA5 AND RELATIVES
 - 1. SMALL SIZE: ABOUT 350 N; LIMITED HOMOLOGY
 - 2. REPLICATED BY VIRAL REPLICASE
 - 3. ASSOCIATED WITH SEVERE TOMATO DISEASE
 - F. NEPOVIRUS SATELLITES - LARGER WITH ORF
 - 1. ORF PRODUCT UNKNOWN
 - 2. REPLICATED BY VIRAL REPLICASE
 - G. VIROID-LIKE SATELLITES
 - 1. ASSOCIATED WITH FOUR SOBEMOVIRUSES (SOME IN NEPO-)
 - 2. MOST LIKE ASBVd
 - a. SMALL SIZE 325 - 390 N; BASE-PAIRING HAIRPIN
 - b. LINEAR <====> CIRCULAR
 - c. REPLICATE BY ROLLING CIRCLE (HOST RNAPII ?)
 - d. SELF CLEAVAGE
 - 1) HAMMERHEAD STRUCTURE FOR CLEAVAGE (+ & -)
 - 2) STobRSV (-) RNA INVOLVES A "PAPER CLIP"

IV. OTHER SATELLITE VIRUSES

A. PHAGE - P2 AND ITS SATELLITE, P4

1. STRUCTURE

- a. MYOVIRIDAE - CONTRACTILE TAILS
BOTH PHAGE ARE MADE OF THE SAME PROTEINS
BOTH LOOK THE SAME, EXCEPT THAT P4 HAS A
SMALLER HEAD.
- b. DNA - UNIQUE, LINEAR, STICKY ENDS (19 N)
 $P2 = 33 \text{ KB}, 22 \times 10^6$
 $P4 = 11.5 \text{ KB}, 7.7 \times 10^6$

2. GENETIC MAPS ARE KNOWN FOR EACH

- a. P2 LOOKS LIKE NORMAL TEMPERATE PHAGE
- b. P4 UNUSUAL - NO HEAD OR TAIL GENES
HAS GENES WHICH "ACTIVATE" P2

3. LIFE CYCLES

- a. BOTH ARE TEMPERATE PHAGE OF E. COLI
 - 1) BOTH LYSOGENIZE INDEPENDENTLY
 - 2) BOTH HAVE REPRESSOR & INT GENES LIKE LAMBDA
 - 3) BOTH INTEGRATE INTO HOST GENOME SITES
- b. HELPER FUNCTIONS OF P2 ARE HEAD AND TAIL
GENES AND THEIR GENE PRODUCTS.
 - 1) ONLY P2 Lyses INDEPENDENTLY
 - 2) P4 AND P2 INDUCE EACH OTHER

B. ANIMAL VIRUSES

1. PARVOVIRIDAE - DEPENDOVIRUS - AAVs

- a. HELPER IS ADENOVIRUS (OR HERPESVIRUS)
- b. STRUCTURE - SEE NOTES
- c. GENOME IS SS DNA
- d. HELPER FUNCTION(S) OF ADENOVIRUS

2. HEPATITIS D VIRUS - DELTA AGENT

- a. HELPER IS HEPADNAVIRUS (HEPATITIS B VIRUS)
- b. STRUCTURE OF HEPA-D:
 - 1) ENVELOPED WITH HEPA-B SURFACE PROTEIN
SIZE-HETEROGENEOUS, 30-40 nm DIA.
 - 2) NUCLEOPROTEIN CORE
 - a) HEPA-D CODED CORE PROTEIN
 - b) SPHERICAL (ICOSAHEDRAL ?)
 - c) 18 nm IN DIAMETER
 - 3) SS RNA GENOME - 1.7 kb, CIRCULAR
 - a) ONE GENE ON ANTIGENOME
 - b) DELTA ANTIGEN - CORE PROTEIN
22-27 kD (TWO FORMS, "READ THRU")
 - c) REPLICATED BY RNAP II
DOUBLE ROLLING CIRCLE
LIKE VIROIDS & VIRUSOIDS
 - d) SELF CUTTING AND LIGATING
- c. REPLICATES IN NUCLEUS
- d. PATHOGENICITY
 - 1) COINFECTION WITH HEPA-B - MORE FULMINANT
 - 2) SUPERINFECTION (OF HBV CARRIER) IS MORE SEVERE
 - a) MORE FULMINANT CASES, >20%
 - b) OTHERS GO CHRONIC WITH POOR PROGNOSIS