

# **MDIA5100**

±Xi glfmi±lYfbg\]d

HYfa 'H\fYY''##'&\$&\$

# 7ci fgY'Cj Yfj ]Yk

### GHJZZ7cbHJWh8YHJ]`g

#### 7cbj Ybcfg

| B Ua Y         | 9a U]`                     | 5j U]`UV]`] <b>m</b> | @cWJhjcb                          | D\cbY |
|----------------|----------------------------|----------------------|-----------------------------------|-------|
| 9a a U'5"'>UbY | Yaa U"^UbY4 i bgk "YXi "Ui |                      | ‰) ž@YjY``%ž<br>FcVYfh<br>KYVghYf |       |

#### GWkcc~7cbhJWh~abZcfa Uh]cb

GWXcc``cZhXY`5fhg`UbX`AYX]U

Fcca ' %&ž@Yj Y`' žFcVYfhK YVghYf6i]X]b[fl %(Ł

D\cbY. f\$&L'-',) '(,) \*

9a U]`. 'gUa 4 i bgk "YXi "Ui

K YVg]hY. 'k k k "Ufhg"i bgk "YXi "Ui #gUa

 $\label{eq:hamiltonian} $$HY'GWCC``cZhY'5ftg'UbX'AYX]U'kci`X``]_Y'tc'FYgdYWM\cong \cong m5W_bck`YX[Y'thY'HfUX]tjcbU``7i gtcX]Ubgž thY'6YXY[U'`fPYbg]b[tcb'WJadigŁZ'; UX][U'`fP]tmUbX'5fth/'8Yg][b'7UadigYgŁ'UbX'thY'B[ibbUkU`dYcd'Y'fbigtfU]Ub'8YZYbW': cfW'5WJXYam]b'7UbVYffUŁ'cZthY'`UbXg'k\YfY'YUW\cong WJadig'cZIBGK']g`cWJtYX''$ 

### 7ci fgY 8YHJ] g

### 7 fYX]hDc]bhg \*

### Gi a a UfmcZh\Y 7ci fgY

 $H\Y'] bhYfbg\] d`fYei]fYg`U`hchU``Wcaa]haYbhcZ\$$!\%) $`\cifg`cZkcf_`k]h\`U`\cghcf[Ub]gUh]cb`UbX`WUb`VYhU_Yb`]b`Z]fghz`gYWcbX`cf`h\]fX`hYfaz`cf`cjYf`h\Y`giaaYf`dYf]cX"`\bhYfbg\]d`cddcfhib]h]Yg`UfY`UXjYfh]gYX`j]Uh\Y`: 5GGSK \&SG5A\\bhYfbg\]d$ 

dU[Y.:\htdg.##a ccX`Y"HY`Hi bgk "YXi "Ui #\text{ki fgY#]Yk "d\d3]X1'') \( \text{\lambda} \) "5`HYfbUHj Y`mž'mci 'a Umi]bXYdYbXYbhm UddfcUW\ 'U`fY`Yj Ubhcf[Ub]gUHjcb'hc 'Udd`m\Zcf'Ub']bHYfbg\]d":Df]cf'hc 'gYY\_]b[ 'Ub']bHYfbg\]d\"mci 'a Umk ]g\ hc 'WcbHUWhI BGK '7 UfYYfg'UbX'9a d`cma Ybh! \( \text{\lambda} \) \( \text{\lambd

: cf`a cfY`]bZcfa Uh]cbžj ]g]h\hhdg.#k k k "Ufhg"i bgk "YXi "Ui #gUa #ghi Xmli g#]bhYfbg\]dg": cf`UbmYbei ]f]Ygž d`YUgY`Ya U]`h\Y`K =@I b]hUh<u>: 5GG!K =@4 i bgk "YXi "Ui</u>

Hc VY Y`][ ]V`Y`Zcf`f\]g Wci fgYžmci a i gh\Uj Y`Ua ]b]a i a 'K 5A 'cZ\*) "

### 7ci fgY @YUfb]b[ 'Ci hWca Yg

%" \Uj Y`[ U]bYX`YI dYf]YbWY`cZ]bXi ghfmdfc\WggYg`UbX`dfU\Wj\WYg &" Udd`mh\YcfYhj\WD``\&b\Y'dhg`UbX`dfU\Wj\\WD``g\_]``g`[ U]bYX`]b`h\Y`dfc[ fUa `hc`fYU`!k cfX`\\bh\Y hg \\ " \Uj Y`Yb\Ub\\X'h\Y]f`\\Ud\\j\mZcf`]bXYdYbXYbhYb[ U[ Ya Ybhk ]h\`]bXi ghfmdfcj ]XYfg

### HYUWX]b[ GhfUhY[]Yg

H\]g'Wci fgY'\Ug'bc'Zcfa U`'hYUW\]b['Wca dcbYbh'''

GHJfh'XUhY.

8YHJ]`g.

Ghi XYbhgʻk]``dfYgYbhUʻgUa d`YʻcZzʻfYdcfhgʻcbzʻcf``]b\_gʻhcʻcf][]bU``k cf\_ʻi bXYfhU\_Yb#dfcXi WYX`Xi f]b[`UbX Zcfʻh\Y`di fdcgYgʻcZh\Y`]bhYfbg\]d":H\]gʻa UmVY`U`\c`]gh]Wk f]hhYbʻXcW a YbhfY[`bYk gʻghcfnž'W]YbhdfcZ]YY YhWcfʻfYWcfXgʻcZfYgYUfWk ii bXYfhU\_YbʻhcʻdfYdUfYʻZcfʻUʻXcW a Ybh#Yj Ybh#dfcWyggʻ]bʻh\Y`\cghcf[Ub]nUh]cbž fYdcfh]b[`cbʻhUg\_gʻi bXYfhU\_YbžXYgWf]dh]cbʻcZk cf\_Zck i]bʻfY`Uh]cbʻhcʻUʻ`Uf[YfʻdfcWyggžcfʻg]a]`Ufž']Y`]h g\ci `X`dfcj ]XY`Yj ]XYbWYʻcZdfUWf)WJ`k cf\_ʻi bXYfhU\_YbʻXi f]b[`h\Y`d`UWYa Ybh'`H\]gʻg\ci `X`VY`Ua]b]a i a cZ&) \$`k cfXgʻVi ha Uma U\_Y`i d`a cfY`cZh\Y`Wca V]bYX`hchU``cZ%) \$\$!&) \$\$`k cfXgʻZcf`Vch\`UggYgga Ybh Wca dcbYbhg"

; fUX]b[ k ]``VY`GUhjgZJWcfm# bgUhjgZJWcfmcb`mUbX'bc'Z fh\Yf'ZYYXVUW\_k ]``VY'dfcj ]XYX"

# FYgci fWfg

DfYgWf]VYX F Ygci fWYg

FYWca a YbXYX FYgci fWYg

7 ci fgY '9j U'i Uh]cb 'UbX '8 Yj Y`cda Ybh

 $K Y fYgdcbX hc ZYYXVUW_fYWY]j YX j ]U X]fYWhYa U] hc hY 7 ci fgY 7 cbj Ybcf UbX hY K @I b]hz UbX bZcfa UhJcb dfcj ]XYX jb hY gh XYbhUbX \cghZYXVUW_Zcfa g"$ 

KY\cdYmciYb&mmcif]bhYfbg\]d°

Gi Va ]gg]cb cZ5ggYgga YbhHUg\_g Hi fb]h]b Gi Va ]gg]cb

# 5 WUXYa ]W<cbYghmUbX D`U[]Uf]ga

D`U[]Uf]ga `]g`i g]b[ 'h\Y`k cfXg`cf`]XYUg`cZch\Yfg`UbX`dfYgYbh]b[ 'h\Ya `Ug`mci f`ck b"`±hWJb`hU\_Y`a Ubm Zcfa gžZfca `XY`]VYfUhY`W\YUh]b[ 'hc`UWW]XYbhJ``mWcdm]b[ 'Zfca `U`gci fWY`k ]h\ci hUW\_bck `YX[ Ya Ybh'

IBGK [fcidg'd'U[]Uf]ga ]bhc'h\Y'Zc``ck]b[ 'WUhY[cf]Yg.

 $7 \text{ cdm}b[...i g]b[...h\Y.gUa Y.cf.j Yfmig]a] \Uf'k cfXg'hc'h\Y.cf][]bU''hYl h'cf']XYU'k]h\ci h'U\V_bck `YX[]b[...h\Y.cf][]bU''hYl h'cf']XYU'k]h'cf']$ 

- i bXYfglUbX`mci f`f][\hg`UbX`fYgdcbg]V]`]h]Yg`Ug`U`gh XYbh'Uhi BGK
- VY'Uk UfY'cZd`U[]Uf]ga ž'Wcdmf][\hzil BGK 'Gh XYbh7cXY'cZ7cbXi WhUbX'5WWdhUV`Y'I gY'cZ I BGK '= H'F Ygci fWfg'Dc`]Wh
- VY 'Uk UfY 'cZh\Y 'ghUbXUfXg 'cZVY\Uj ]ci f'Yl dYWhYX 'cZYj YfmcbY ']b 'h\Y 'l BGK 'Wcaaib]hm
- `cWUHY 'gYfj ]WYg'UbX `]bZcfa UH]cb'UVci hI BGK 'UbX'I BGK '@]VfUfm

Gca Y'cZh\YgY'UfYUg'k]``VY'ZJa]`]Uf'hc'mci žch\Yfg'k]``VY'bYk"'; U]b]b['U'gc`]X'i bXYfgHJbX]b['cZU``h\YfY`UhYX'UgdYWhg'cZ9@G9'k]``\Y`d'mci 'a U\_Y'h\Y'a cghicZmci f'ghi X]Yg'UhI BGK "'\\hd.#\gi \YY\\f\i \\XY\g''\\f\f\f\i \bgk\\\YX\i \"\J\\Y\\\f\\\]aY

### 5 WUXYa ]W = b Zcfa Uh cb

: cf'YggYbhJU`'gh XYbh']bZcfa UhJcb'fY`UhJb['hc.

- fYei Yghg 'Zcf'Yl hYbg]cb/
- `UhY`gi Va ]gg]cbg`[ i ]XY`]bYg/
- fYj ]Yk 'cZa Uf\_g/
- I BGK '< YU`h\ 'UbX'GUZYhm'dc`]W[Yg/
- YI Ua ]bUh]cb dfcWYXi fYg/
- gdYWJU`Wcbg]XYfUHjcb`]b`H\Y`Yj YbhcZ]``bYgg`cf`a ]gUXj Ybh fY/
- qh XYbhYei ]miUbX X]qUV]`]m/
- UbX'ch\Yf'YggYbhJU`UWUXYa ]W]bZcfa UhJcbžgYY

\hdg.#k k k "Ufhg"i bgk "YXi "Ui #W ffYbhgh XYbhg#UWJXYa ]W]bZcfa Uh]cb#dfchcWc`g![i ]XY`]bYg#

.

### ⇒a U[Y'7fYX]h

=a U[Y Wci ffYgmcZFcXbYmHcXX!\httq.#k k k "fcXbYmtcXX"Wca #

#### 7F = 7CG

7F = 7CG Dfcj ]XYf 7cXY. \$\$\$-,;

#### 5W\_bck `YX[ Ya YbhcZ7ci bhfm

 $K_{Y'UW\underline{b}ck} YX[Y'hY'6YXY[U''dYcd'Y'k \c'UfY'hY'ffUX]h]cbU''W ghcX]Ubg'cZhY''UbXg'cb'k \]WX'I_BGK_{Ybg]b[hcb'WJa_di_q']q''cWJhYX'''$