



# BIOM9541

A YW Ub]Wg'cZh\Y'<i a Ub'6cXm

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

; fUXI UAY'GWXcc``cZ6]ca YX]WJ`9b[]bYYf]b[]`#`! BGK ``9b[]bYYf]b[]



## 7 ci fgY'8YHJ]`g

7 fYX]hDc]bmg`\*`

Gi a a UfmicZhY'7 ci fgY

9j Yf'k cbXYfYX`lck`@cfX'cZhY'F ]b[ g'cf'5j UHf'k YfY`WYUHYX3'CF`lck`Uh`YH'g WJb`UbU'mgY`hY V]ca YWU]b]Wg'cZhY]f'a cj Ya Ybmg'hc`ja d'fcj Y'dYfZcfa UbW'3'CF'UVci h`lck`k YUfUV'Y`hYVX'bc'c[ mzd`lcbY Uddg`UbX'ga Ufh[ Ufa Ybmg'WJb`VY`i gYX'hc`XYH'WU'UbX'UbU'mgY`i bghUV'Y`[ U]hdUH'fg'UbX`Y'd`k`]h bYi fc'c[ ]WU`WcbX]hcbg'k U`\_`VYH'f3`H\]g`Wci fgY`Wcj Yfg`]b`XYdH`hY'a Yh'cXg'i gYX`]b`hY`UbU'mg]g'cZhY V]ca YWU]b]Wg'cZhY'a i gW`cg\_Y'YHU`gmgH'a "A Yh'cXg'hc`UbU'mgY`VcXmgY`[ a YbhUbX`c`]bh\_]bYa Uh]Wgž c`]bh\_]bYh]Wgž'k cf`\_`UbX`dck Yfž'a i gWY`Zc'fW'g`UbX`UggcV]UH'X`YbYf[ mWc'ghk`]`VY`Wcj YfYX`"5dd`]W]hcbg'cZ V]ca YWU]b]Wg`]b`W]b]W]ž'cVW`dU]hcbU`UbX`fYW'YU]hcbU`UfYUg'k`]`VY`d'fYgYbH'X`"<`[`\\[`h]g`]bW`i XY UWW'gg'hc`B`Yi fcgW]YbW`F`YgYUfW`5i ghU`]U]g`ghU]!cZhY!Ufh`8`a`chcb`WJdH`fY`UV`Zc'f'hY'A`c7`Ud`UV'cfU'hc'fmgYgg]cbg`"

## 7 ci fgY'5]a g

H\Y`U]a g'cZh]g`Wci fgY`UfY`hc.

%`b'fcXi W`gh XYbmg'hc`hY`Z`bXUa YbHU`g'cZUbU'ha mUbX`V]ca YWU]b]Wg`UbX`&`fY`UH`hYgY`hc`a YWU]b]WU`UW]hcbg'hc`XY] Y'cd`U`XYdYf'i bXYfghUbX]b[ `cZ`hY`Z]X`cZ\i a Ub'a cj Ya YbhgW]YbW`"

'`"8Y] Y'cd`hY`Z`bXUa YbHU`g'cZ`8`a`chcb`WJdH`fYž`[ U]hUbU'mg]g`UbX'a i gW`cg\_Y'YHU`a cXY`]b[ "`(`b'fcXi W`gh XYbmg'hc`V]ca YWU]b]WU`UbU'mgYg'i g]b[ `XUH`Zca`k`YUfUV'Y`hYVX'bc'c[ m`"

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

5Z]f'gi WW'ggZ`mWca d`Yh]b[ `h]g`Wci fgYž'mci`g\ci`X`VY`UV'Y`hc.

@YUfb]b[ `Ci hWca Y	95`GHU[ Y`%7ca dYH'bW]Yg
%`Gh XYbmg'k`]`VY`UV'Y`hc`i`gY`a`YWU]b]WU`d'f]bW]d`Yg`hc`UbU'mgY` \i a Ub'a cj Ya Ybh	D9`%`&
&`Gh XYbmg'k`]`VY`UV'Y`hc`XYg][`b`UbX`dYfZcfa`Yi`dYf]a`Ybhg`hUh`Yj`U`i`UH` \i a Ub'a cj Ya Ybh	D9`&`%`
'`"Gh XYbmg'k`]`VY`UV'Y`hc`W]h]WU`mUbU'mgY`hY]f`Yi`dYf]a`YbHU`ci`hWca`Yg`]b`hY`VfcUXYf`WcbH`i`h	D9`%`(`
(`"Gh XYbmg'k`]`VY`UV'Y`hc`Wca`a`i`b]WU`h`hY]f`Z]bX]b[`g`YZZ]W]j`Y`m`i`g]b[ `cfU`UbX`k`f]hY`b`a`Yh'cXg	D9`'`"&
)`"7`f]h]WU`mY]j`U`i`UH`X]ZY`fYbh]mdYg`cZk`YUfUV'Y`hYVX'bc'c[ ]Yg`i`gYX`Zc'f`UbU'mg]b[ ` \i a Ub'a cj Ya Ybh	D9`%`"

## HYUW]b[ `GhfUH[ ]Yg`

@YW]h`fYg'k`]`VY`XY`] YfYX`cb`]bY`UbX`]bW`i XY`WcbW`dhXY] Y`cda YbHž`dfcV`Ya`'gc`] b[ `UbX`X]gW`gg]cb`gYgg]cbg`"hYgY`k`]`Wcj Yf`hY`hYcfmigi`ddcf]b[ `Yi`dYf]a`YbHU`a`Yh'cXg`UbX`hY`d'fUW]WU`fYgYUfW`dfcV`Ya`g`@UV'cfU'hc'f]Yg`UbX`h`hc'f]U`g`UfY`XYg][`bYX`hc`Yi`d`U]b`hY`WcbW`dhg`]b'fcXi`WYX`]b`hY`cb`]bY`



## 5 XX]h]cbU`7 ci fgY`bZcfa Uh]cb

6]ca YW\Ub]Mg`]g`hY`gh XmcZhY`YZYWhcZa YW\Ub]WU`d\Ybca YbU`fZcfW`gZj Y`cW]hYgZ UWW`YfU]cbgZ YbYf[ ]YgZdck YfZ`a ca YbH\Z`a ca YbH\Z`Z]W]cbZ`Z]h[ i Y`UbX`Z]i fY`c`b`\i a Ub`VcX]Yg`" #ifY`]Yg`cb`Ub i bXYfgHUbX]b[ `cZa YW\Ub]Mg`UbX`Udd`]Yg`hY`Z bXUa YbH`g`cZa YW\Ub]Mg`hc`hY`gfi Wi fY`UbX`Z bW]cb`cZ hY`\i a Ub`VcXm`

6]ca YW\Ub]Mg`]g`i gYX`]b`U`X]i YfgY`fUb[ Y`cZX]gW]d`]bYg`]bWi X]b[ `V]c`c[ nZ`Yf[ cbca ]MgZ`Yb[ ]bYYf]b[ Z d\mg]c`c[ nZ`a YX]M]bYZ`UbX`a YW\Ub]WU`d\mg]Mg`" A UbmidfcZYgg]cbU`g`-Yb[ ]bYYfgZ`XYg][ bYfgZ`d\mg]WU` hYfUd]ghgZ`cfU` UbX`cfh`cdUYX]Wgi f[ YcbgZ`W]fX]c`c[ ]ghgZ`UbX`UYfcgdUW`Yb[ ]bYYfg`-i gY`dfUW]WU` Udd`]W]h]cbg`cZV]ca YW\Ub]Mg`"

6]ca YW\Ub]Mg`\Ug`Udd`]W]h]cb`]b`U`"UfYUg`cZ\YU`h`W]fY`UbX`a YX]WU`dfcV`Ya`gc`j]b[ `h`UhfYei ]fY d\mg]WU`a Ub]di`Uh]cb`" #ia UmVY`hY`a U`cf`UfYU`cZV`bW`fb`]b`gca Y`]bghUbW`g`fY"[ "Uf]Z]W]U`c`]b]gZ`dfcg`h`Y`h]Mg`UbX`cfh`cgYgZ`a YW\Ub]ga`g`cZd\mg]WU`]b`f`f`c`f`]ha UmVY`U`j ]hU`UX`bW]hc`UbchYf`UfYU`fY"[ "XYg][ b`cZUb`]a d`UbHUV`Y`dUW`a U`Yf`cf`gdYW]U`]ghgi f[ ]WU`hc`c`g`"

5ggYgga Ybh

5ggYgga YbhHUg\_g

5ggYgga YbhHUg_	K Y][ \h	8i Y'8UH	Gh XYbh@YUfb]b[ Ci hWta Yg'5ggYggYX
C b`]bY'E i ]nnYg`	+I	7cbh]bi ci g	%ž' ž)
MUmUbX'6cc'!`C dYbG]a Dcglg`	, I	7cbh]bi ci g	%ž&ž(
GcZk UFY`@UVcfUhc]Yg`	;%\$I	K KYYgK%ž'g%ž+ / ' +	%ž &ž &ž' ž(

7ca d`Yh]cb`mci`a`i`ghdcgh`fY`hja`Yg`hc`fY`Wj`Y`h`Y`a`Uf`g`Zc`f`h`g`Wca`dcbYbhcZ`h`Y`UggYgga`Ybh`  
Dcgh]b[ `Zk`Yf`h`Ub`h`fY`hja`Yg`k`j`fY`gi`h]b`U`g`Wc`fY`cZ`\$`fY[ `UfX`Ygg`cZ`h`Y`a`Uf`g`Ugg][ `bYX`hc`j]bXj] `Xi`U`  
dcg]g`"

5ggYgga`Ybh`. `GcZk`UfY`@UvcfUhc]Yg

GhUfhXUHy`. `K`YY`g`%`z`" `/'`+`

8YhU]`g.

GcZk`UfY`@UvcfUhc]Yg`dfcj`jXY`mci`k`j`h`Ub`cddcfh`b]mhc`YUfb`UbX`i`gY`mci`f`ck`b`XUfU`Wc`Y`W`X`Z`ca`  
h`Y`h`f`c`h`c`A`c7`Ud`UvcfUhc]mhc`UbU`mgY`UbX`g]a`i`U`h`Y`a`Ub`a`cj`Ya`Ybh`6]b[ `mci`f`ck`b`Ud`h`c`d`  
h`W`i`X`Y`g.

- Gw]b[
- h]YfgY`?`]bYa`U]Vg
- h]YfgY`8mbUa`]Vg

7ca`d`Yh]cb`cZUggYgga`Ybh]g`VUgYX`cb`g`c`f`h`k`YY`\_`m`X`Ya`cbgfU]cbg`cZmci`f`a`c`X`Y`h`c`mci`f`  
X`Y`a`cbgfUhc]f`f`Z`c`f`Z`U`W`h`c`Z`U`W`g`h`i`X`Y`b`h`g`c`f`g`i`Va`]h]b[ `U`g`W`Y`Y`b`W`U`d`h`f`Y`X`Y`a`cbgfU]cb`f`Z`c`f`Y`a`c`h`  
g`h`i`X`Y`b`h`g`c`5`g`c`f`Y`e`i`]f`Y`g`g`i`Va`]h]b[ `U`[ `f`c`i`d`f`Y`d`c`f`h`c`Z`mci`f`X]g`W`g`g]c`b`g`"

5ggYgga`Ybh(. `7ca`di`h]h]cbU`@UvcfUhc]Yg

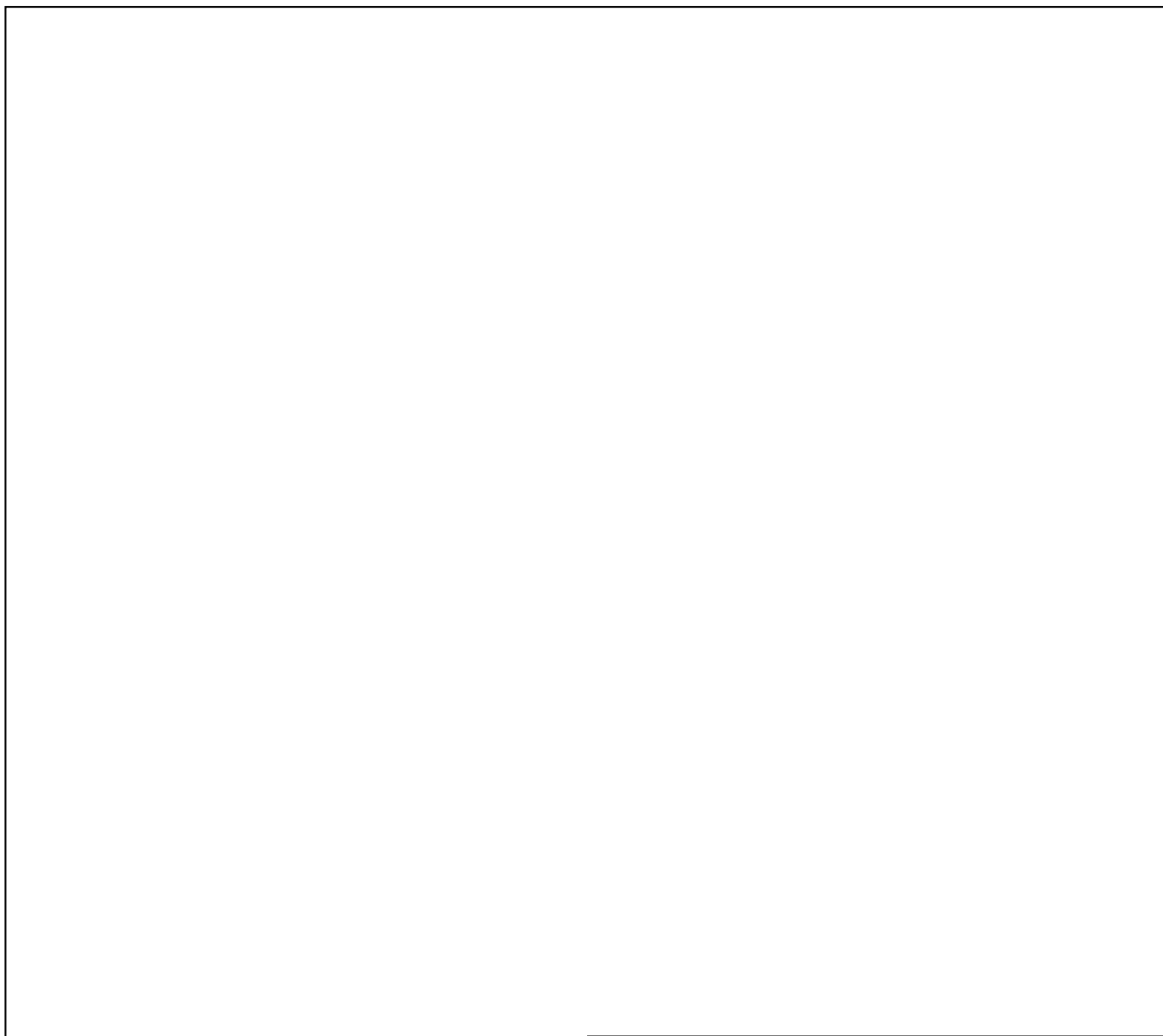
GhUfhXUHy`. `K`YY`g`-`/'`%`\$`

8YhU]`g.

H`Y`c`f`Y`h]W`U`H`i`h`c`f]U`g`dfcj`jXY`mci`k`j`h`Y`c`ddcfh`b]mhc`Udd`m`h`Y`h`Y`c`f`m`mci`Y`U`f`b`Y`X`]b`h`Y`c`b`]b`Y`i`b]g`  
X`i`f]b[ `k`YY`g`%`z`&`z`" `z`-`/'`%`\$`hc`UbU`mgY`h`Y`X`U`f`U`mci`Wc`Y`W`X`X`i`f]b[ `h`Y`UvcfUhc]m`W`U`gg]b`k`YY`\_`&`" `M`c`i`  
k`j`i`g`Y`h`Y`g`Y`X`U`f`U`h`c`W`U`W`U`h`Y`UbX`UbU`mgY`U`b`i`a`V`Y`f`c`Z`i`a`Ub`a`cj`Ya`Y`b`h`d`U`f`U`a`Y`h`f`g`g`i`W`U`g`c`]b`h`







# F Ygci fWg

DfYgWf]VYX`F Ygci fWg`

Gh XYbtg`g\ci`X`Vf]b[`h\Y]f`ck b`Udhd`Wta di hf`hc`GcZk UfY`UbX`7ca di fU]cbU`@UVcfUhc]Yg"

## F YWca a YbXYX`F Ygci fWg

H\Y`fYWca a YbXYX`h\i hZcf`h]g`Wci fgY`UFY.

- F cVYf]gcbž8"; "9"YhU`F YgYUfW`a Yhcxg]b`V]ca YWUb]Wg": ]fghf`f`gYWcbXE`YX]hcbž<i a Ub ? ]bYh]Wgž&\$\$(`f`f`&\$%\*`L"
- K ]bhYfž8"5"6]ca YWUb]Wg`UbX`a chcf`Wcbf`cZ\i a Ub`a cj Ya Ybh`H\]fX`YX]hcbž>c\b`K ]Ym/ Gcbgž`bWž&\$\$) "

C h\Yfi gYž`fYZYfbW`Vcc\_g`h\UhfY`Y`X`]b`h\Y`I`BGK`@]VfUfmiUFY.

- 9bXYfYž>"8"UbX`>"8"6fcbn]bcž`b`f`cXi`W]cb`hc`V]ca YX]W`Yb[ ]bYYf]b[ ž`H\]fX`YX]hcbž5WUXYa ]W DfYggž&\$\$&"
- A Yf]Ua ž>"@`UbX`@; " ? fU][ Yž9b[ ]bYYf]b[ `a YWUb]WgžG] h`YX]hcbž>c\b`K ]Ym/ `Gcbgž&\$\$, "

Gh XYbtg`gYY\_]b[`UXX]h]cbU`fYgci fWg`WUb`Ugc`cVhU]b`Ugg]g]hUbW`Zca`h\Y`I`BGK`@]VfUfmiUhi  
[\hd.##\]VfUfmi.bgk`YXi`"Ui`#`](#)

5XX]h]cbU`fYUX]b[ g]UbX`fYWca a YbXYX`k YVg]hYg`k ]`VY`]ghYX`cb`A ccX`Y`k`Yb`fYei ]fYX"

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

Gh XYbhZYXVUW`Ug`Y`dYX`hc`g`UdY`UbX`XYj`Y`cd`h]g`Wci fgYž]bWi`X]b[`ZYXVUW`cVhU]bYX`Zca`cb! ]bY`Yj`U`i`U]cbg`Ug`dUfhcZ]`BGK`g`a`m9]dYf]YbW`dfcW`gg"Mc]f`ZYXVUW`]g`a`i`W`UddfYW]UHX`UbX`hU`Yb`j`YfmigYf]ci`g`m`7`cb]bi`U`]a`dfcj`Ya`Ybh]UfY`a`UXY`hc`h\Y`Wci`fgY`VUgYX`]b`dUfhcb`gi`W`ZYXVUW`UbX`h]g`Y`dg`i`g`hc`]a`dfcj`Y`h\Y`Wci`fgY`Zcf`Z`h`fY`gh`XYbtg`"bZcfa`U`gh`XYbhZYXVUW`]g`Ugc`gci`[`h`ZYei`Ybh]h]fci`[`ci`h\Y`gYa`YghYf`UbX`i`gYX`hc`Ugg]gh]b`h\Y`dfc[`fYgg]cb`cZ`h\Y`Wci`fgY"

@UVcfUhc]fmK`cf\_g`cd`bZcfa`U]cb

Gh XYbtg`k ]`VY`fYei ]fYX`hc`g][`b`7`C`J`8%`gUZ`XYWUfU]cbg`VYZcfY`UHYbX]b[`UVcfUhc]fmigYgg]cbg"

Gi Va ]gg]cb`cZ5ggYgga YbhiHUg\_g

@UVcfUhcfmifYdcftg`UbX`a U`cf`Ugg][ ba Ybht`k ]`fYei ]fY`U`[Bcb`D`U` \]Uf\]ga`8YWUfU\]cb`7cj`Yf`G`YYh`](#)

@UH`gi Va ]gg]cbg`k ]`VY`dYbU`]gYX`%\$i`cZh`Y`a Uf`Zcf`YUW`WJ`YbXUf`XUm`UH`" `Zmc i`ZcfYgYY`U`dfcV`Ya

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

D@5; =F =GA

6Yk UFY`5b`Ugg][ ba YbhUUh]bWl XYg`d`U[ ]Uf]gYX`a UHf]U`k ]`fYW]j Y`U`\$i : U]žUbX`gh XYbhtg`k \c d`U[ ]Uf]gY`a UmZ]j`hY`Wci fgY`Gh XYbhtg`k \c`d`U[ ]Uf]gY`k ]`Uj Y`hY]f`bUa Yg`YbHYfYX`cb`U`d`U[ ]Uf]ga fY[ ]ghf`UbX`k ]`VY`]UV`Y`hc`X]gW]d`]bUfmiUW]cbž]bWl X]b[ `Yl Wl g]cb`Zca `Ybfc`a`Ybh`  
#]g`Yl dYWYX`hUUhU`gh XYbhtg`a i ghUUhU`h]a Yg`gi Va ]hY]f`ck`b`k`cf`\_`Zcf`UggYgga Ybh`Gi Va ]h]b[ `hY`k`cf`\_`cf`]XYUg`cZgca YcbY`Y`gY`k ]h]ci hWYUfmiUW\_bck`YX[ ]b[ `hY`gci fW`cZVcffck YX`a UHf]U`cf`]XYUg`]g d`U[ ]Uf]ga "

5`UggYgga Ybhtg`k \]Wl`mci `UbX`]b`a i gh`Uj Y`U`[Bcb`D`U\[ \]Uf\]ga`8YWUfU\]cb`7cj`Yf`G`YYH`H\\]g`\]g`Zcf Vch`\]bX\]j`\]Xi`U`UbX`\[ fci`d`k`cf`\\_`5HUVW`\]h\]c`mci`f`Ugg\]\[ ba YbhVYZcfY`gi Va \]h\]b\[ `\]h\]c`hY`7`ci`fgY`7`ccfX\]bUhc`f`cf`UhhY`GVXcc`C`Z\]W"](#)

D`U[ ]Uf]ga `]g`hY`i`gY`cZUbchYf`dYfgcb`g`k`cf`\_`cf`]XYUg`Ug`]ZhYmik YfY`mci`f`ck`b`K` \Yb`]h]g`bYW]ggUfmicf XYg]fUV`Y`hc`i`gY`chYf`dYcd`Y`g`a`UHf]U`mci`g`ci`X`UXYeI`UH`mUW\_bck`YX[ Y`k`cgY`k`cfXg`cf`]XYUg`hYm UfY`UbX`k` \YfY`mci`Zci`bX`hY`a`f`]j`]b[ `hY`Wca`d`YH`fYZYfYbW`XYH]`gž]bWl X]b[ `dU[ Y`bi`a`VYffg]H`H`Y`@YUfb]b[ `7`YbHY`dfcj`]XYg`Z`fH`Yf`]bZcfa`U]cb`cb`k` \UhWcbgh]h`H`g`D`U[ ]Uf]ga `Uh` \Hdg`#]gh XYbhi`bgk`"YXi`"Ui`#]U[ ]Uf]ga

## 5WUXYa ]W=Zcfa Uh]cb

7CI FG9'9J5@! 5H€B'5B8'89J 9@CDA 9BH

Gh XYbhZYXVUW\_\Ug\Y'dYX'hc'g\UdY'UbX'XYj Y'cd'h\]g'Wci fgYz]bWi X]b[ 'ZYXVUW\_cVHU]bYX'Zca'cb!  
]bY'Yj U'i Uh]cbg'Ug'dUfhcZl BGK 'g'Ug'dUfhcZl BGK 'g'a m9l dYf]YbW'dfcW'gg"Mc'i 'UfY'\][\`m  
YbWci fU[ YX'hc'Wca d'YH'gi W\ Ub'cb!]bY'Yj U'i Uh]cb'hck UfX'hY'YbX'cZHYfa "': YYXVUW\_UbX'gi [ [ Ygh]cbg  
dfcj ]XYX'k ]"VY']a dcfhUbh]b]a dfcj ]b[ 'hY'Wci fgY'Zf'Z hi fY'ghi XYbthg"

## 85H9G'HC' BCH9

FYZf'hc'A m BGK 'Zcf' a dcfhUbh8UH'gZ Uj U]UV'Y'Uh  
[\hfdg.##a m'i bgk "YXi "Ui #gh XYbh#fYgci fW'g#? Ym8UH'g"\ha`](#)

57589A => '58J => 9

: cf]bZcfa Uh]cb'UVci h

- "B ch'g'cb'UggYgga Ybth'UbX'd'U[ ]Uf]ga ž
- "GdYV\U'7 cbg]XYfUh]cbgž
- "GWcc"Gh XYbh9h\]W'c Z]W'fz'UbX
- "69GG

fYZf'hc'hY'GWcc'k YVg]H'Uj U]UV'Y'Uh  
[\hfd.##k k k "Yb\[ \]bYYf\]b\[ "i bgk "YXi "Ui #/\]ca YX\]WU!Yb\[ \]bYYf\]b\[ #](#)

## Gi dd'Ya YbHfM9I Ua ]bUh]cbg.

Gi dd'Ya YbHfM9I Ua ]bUh]cbg'Zcf'HYfa " '&\$&\$'k ]"VY'\Y'X'cb'A cbXUm%#h'>Ubi Ufm-: f]XUm%) h  
>Ubi Ufmf]bWi gj Yl'g\ci 'X'mci 'VY'fYei ]fYX'hc'g]hcbY"

=a U[ Y'7 fYX]h

>cgYd\; UthUg'?" fUhcg'cb'hY'gYhcZ"; cX'cZK Uf.'5gW'bg]cb""DcghYX'cb'VY\U'ZcZ>cgYd\; Uth'H\]g  
]a U[ Y'g'ZYY'hc'i gY'i bXYf'hY'7 fYU]j Y'7 ca a cbg'5hff]Vi h]cb!G\UfY'5'] Y' "\$'I bdcf]YX'W'bgY"

7F => CG

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

## 5W\_bck`YX[ Ya YbhcZ'7ci bHfm

K Y'UW\_bck`YX[ Y'hY'6YXY[ U'dYcd'Y'k \c'UfY'hY'hfUX]h]cbU'W ghcX]Ubg'cZ'hY'UbXg'cb'k \]W'1 BGK  
'?Ybg]b[ hc'b'W]a di'g'g'c'W]hYX"

